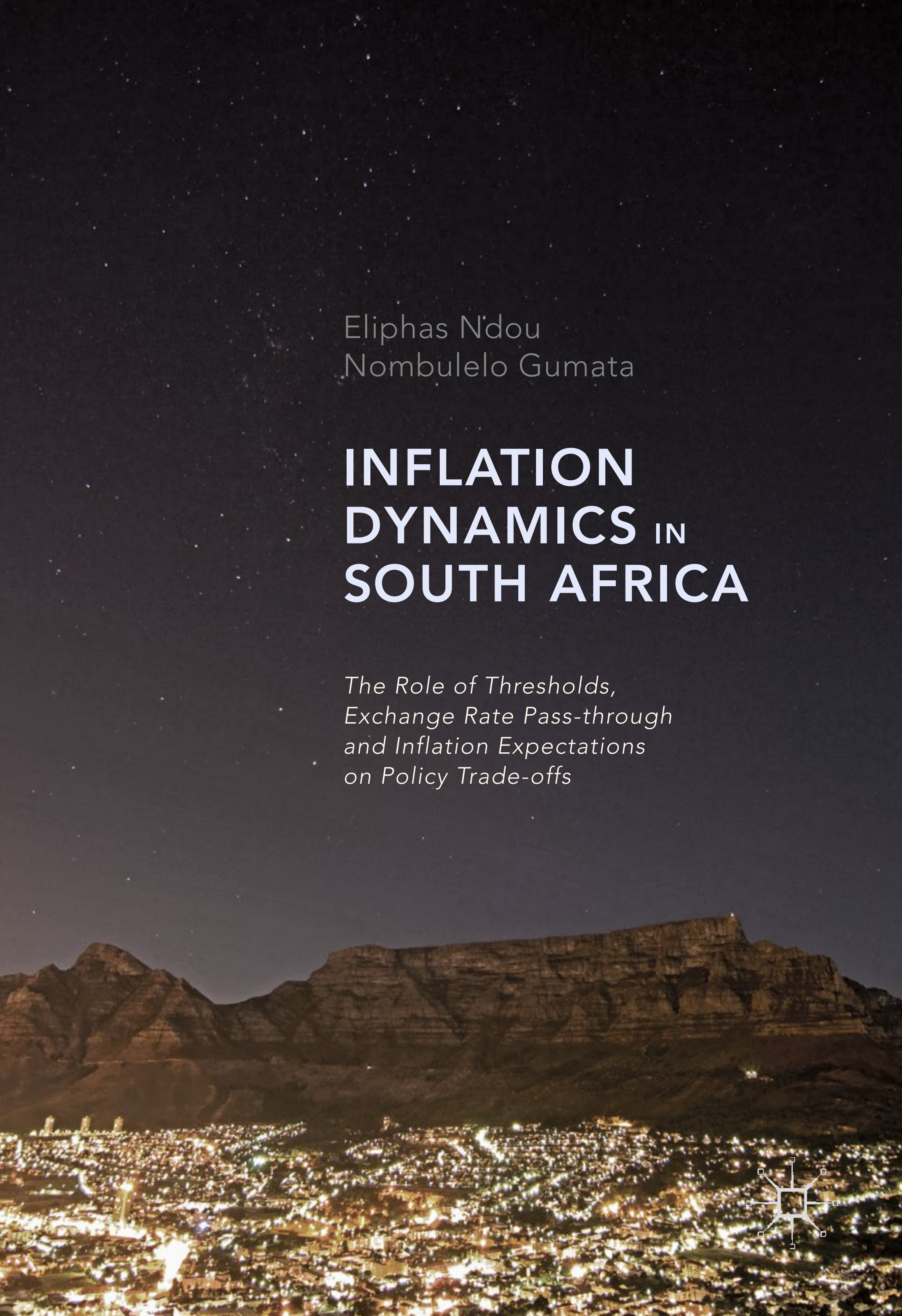

Eliphas Ndou
Nombulelo Gumata

INFLATION DYNAMICS IN SOUTH AFRICA

The Role of Thresholds, Exchange Rate Pass-through and Inflation Expectations on Policy Trade-offs

Inflation Dynamics in South Africa

Eliphas Ndou • Nombulelo Gumata

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Preface

This book focuses on the South African inflation dynamics through analysing the role of thresholds, exchange rate pass-through and inflation expectations on the policy trade-offs. That is, to what extent does evidence point to the need to enforce the price stability and anchoring inflation expectation. The book fills existing policy gaps in South Africa and maintains a clear objective that price stability matters and changing economic conditions require policy makers to use threshold models, nonlinearities and the determination of the ability of macroeconomic variables to propagate the transmission of the economic shocks. In addition the book serves as reference text for both academic and policy discussions.

The evidence provided in this analysis entails examining the role of thresholds, nonlinearities in for example, the exchange rate pass-through and distinguishing between persistent and non-persistent shocks. The economic environment post-2009 requires the adoption of the threshold effects for inflation, GDP growth and the output-gap, transitory and permanent exchange rate volatilities and sovereign spreads. The economic regimes based on the identified thresholds in this book help in the assessment of the appropriate inflation levels and the adjustment of policy settings. In addition, the establishment of inflation thresholds can help the policy makers to better communicate monetary policy decisions to the public. The overview of the contents of the book is as follows.

The second aspect which the South African studies do not show and is dealt with in this book is the magnitudes of propagation effects based on comparisons between actual and counterfactual outcomes. The book applies counterfactual scenario analysis ranging from dissecting the role of fiscal policy in transmitting inflation shock to economic growth, amplification of consumer price inflation by the output gap, sovereign spreads, GDP growth, and the exchange rate. The focus on amplifications has not featured much in policy research and probably policy discussion. It is the purpose of this book to show that some selected economic variables which are causes of economic shocks are no longer propagators of economic shocks, but stifle their transmission and this has implication for policy adjustment and the accompanying magnitudes. The book engages in the required robustness in certain times using different techniques to solicit and encourage policy discourse.

The issues related to enforcement of price stability mandate are clearly distinguished and investigated empirical and evidence is then presented into separated six main groupings. This enables the book to be used as a reference text and as an instigator of further policy deliberation. The book is divided into six main sections with the first part dealing with costs of disinflation, inflation volatility and policy trade-offs. This part investigate issues that are not only confined to but include the costs of disinflation policies, the role of inflation volatility and identifying periods during which the policy trade-offs resulted in high macroeconomic performance. The findings in this section of the book provide evidence of the inflation and output volatility trade-off, the key drivers of inflation volatility. The effects of threshold are introduced.

The second part deals with the role of government and inflation. The role of threshold is used in understanding of fiscal policy in passing inflation shocks to economic growth. The third part deals with non-linearities impacting the first stage exchange rate pass-through to import price inflation and role of global developments. The fourth part deals with thresholds which affect the direct exchange rate pass-through. Has the response of inflation to rand-US dollar exchange rate depreciation shocks changed over time? This section of the books provides further insights into the changing relationship between the inflation process and the exchange rate and how it impacts the exchange rate pass-through. Subsequent to the global financial crisis, a consensus was that the exchange rate pass-through has declined particularly in advanced economies emerged. This analysis contributes to this strand of literature from the South African perspective by showing the differential and asymmetric responses of inflation to the exchange rate shock subject to GDP and credit growth regimes, the exchange volatility regimes, sovereign spreads regimes and inflation regimes.

The fourth part focuses on macroeconomic effects of GDP growth threshold and the role of short term indicators` impact on policy rate adjustment. The main purpose is to show that during periods of elevated macroeconomic and policy uncertainty, the knowledge and classification of existing regimes is an invaluable input to the policy decision making process. Evidence shows that knowledge about whether the existing GDP growth falls into the low or high regime leads to different policy responses. The identification of existing growth regimes also enables the understanding of the extent to which credit growth is stimulatory in each regime. In addition, we show that policy responses differ depending on the existing inflation regime. Thereafter, we determine what the inflation thresholds subject to GDP and credit growth are and whether they lie within the inflation target band. In light of the recent slump in commodity prices, and their impact on the terms-of-trade and threshold analysis shows that terms-of-trade regimes do not constraint monetary policy decisions.

The fifth part focuses on inflation expectations and monetary policy response. We use econometric techniques that enable us to separate the effects of adverse supply shocks from inflation expectations shocks and aggregate demand shocks. The results show how the inflation expectations shocks is positively related to unit labour costs and negatively associated with employment growth. The inflation expectations shocks leads to tighter credit conditions. These are new empirical insights in the South African academic and policy discourse. In addition, we establish that while inflation expectation has been poorly anchored for a long time. The short-term upside risk factors to the inflation outlook are the key drivers of long-term inflation expectations. The counterfactual scenarios of the inflation rate and long-term inflation expectations in the absence of these short-term upside risk to inflation provide further supporting evidence to this effect. We further show that wage increases in excess of six per-cent which is the upper level of the inflation-target band result in higher inflation outcomes and inflation expectations.

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We are grateful and extend thanks to our colleagues at the South African Reserve Bank for their timely responses to data requests. We thank Estima for the RATS software support service and helping us with coding trouble shooting. We also thank Professor Mthuli Ncube and Eric Olson for their inputs in the third chapter.

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1

Introduction

This book focuses on various aspects of inflation dynamics in South Africa. Chapters in the book present empirical evidence on the role of thresholds and asymmetries they introduce to the inflationary process associated with the exchange rate and its volatility on the exchange rate pass-through. The role of adverse shocks emanating from fiscal policy, labour and credit markets; and inflation expectations on policy trade-offs is extensively explored. The appropriateness of the 3 to 6 per cent inflation target band and how it relates to price stability and anchoring inflation expectations is demonstrated via empirical evidence based on the thresholds and the asymmetries they induce on the monetary policy trade-off. Evidence contained in the book shows that the 3 to 6 per cent inflation target band captures the meaning of price stability in South Africa.

Issues related to the enforcement of the price stability mandate are clearly distinguished and investigated empirically, and the evidence presented. The book is divided into six main sections. The first part deals with the costs of disinflation, inflation volatility and the policy trade-offs. The second part covers the role of government and inflation. Parts three and four explore the first stage of the exchange rate pass-through and the role on non-linearities. The remainder of the book

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focuses on inflation expectations and the conduct of monetary policy, and the role of the business cycle phases in the inflation process. The book uses a variety of quantitative techniques ranging from simple to advanced econometric techniques to establish the relationship between inflation, demand and supply side factors. Some of the recurring issues that impact the economy are introduced below.

1.1 Heightened Exchange Rate Volatility and the Persistent Negative Output Gap

As a small open economy, South Africa has been subjected to supply shocks that have been very persistent in nature since the global financial crisis. At the same time, the monetary authorities report that output gaps have been persistently negative for a long time and pass-through has declined, but it is not known when will this phenomenon change. The prevailing approach has been that monetary policy should mostly look through supply-side shocks which induce temporary breaches of the inflation target band. This approach was viewed to be more binding when the output gap is negative. Is this policy inaction ideal in the face of mounting inflationary pressures? At the same time, the exchange rate pass-through has changed and become lower, indicative of non-linear and asymmetric influence of recent macroeconomics development. The prevailing economic conditions include low GDP, high sovereign spreads, big exchange rate depreciations, exchange rate volatility and high inflation. These have implications for exchange rate pass-through. Through empirical evidence, the book shows shows that exchange rate pass-through has implication for policymakers' decisions regarding the policy stance and expected future developments. Evidence shows that the knowledge of non-linearity and asymmetry matters very much and should not be excluded from policy research issues.

1.2 The Dilemma of Partial Accommodative Stance to Shocks and Role of Unanchored Inflation Expectations

The book looks at issues empirically and shows in certain instances that it is important to distinguish between persistent, non-persistent and persistent rising shocks effects, and this has implications for inflation above the upper part of the target band. To what extent should the policy be partially accommodative to these shocks? Does this induce a policy trade-off or shift of curve that depicts the optimal trade-off, which requires minimising the policy loss function measured through interaction of inflation and output volatilities?

As a result, the persistence of long-term inflation expectations around 6 per cent may signal imperfect policy credibility. The empirical analysis in this book shows that these shocks induce shifts in policy function rather than a trade-off along the policy efficient frontier, consistent with optimal monetary policy conduct. So, if shifts are not compatible with an optimal policy trade-off, should the Bank change the policy approach dealing with supply shocks that push inflation outside the target band, raising inflation expectations and making them un-anchored? There is a lack of empirical research to show that expectations are propagators in the transmission of shocks, that lead to tightening of credit conditions and financial conditions if they are not anchored. The book contributes to policy discussions by showing the indirect role of these adverse supply shocks through quantifying the amplifications based on counterfactual analysis. Due to the concurrence of adverse supply shocks and positive inflation expectations shocks, both these shocks tend to move economic variables in the same direction with debilitating effects on economic activity. This means that policymakers have to be willing to pay the costs of disinflation and cannot find themselves in a policy bind when confronted with an upward revision in inflation expectations.

1.3 Is There a Debate Surrounding the Potency of Monetary Policy Effects Conditional on GDP Growth Regimes with Relevance in the Policy Setting Process?

Are the policies clear about the influence of the role of economic variables leading to non-linearity based on thresholds approaches? The role of thresholds is the focus of a large proportion of this book's analysis because of the recent importance of the effects of state dependency on economic variables. Moreover, the policy dependency on GDP growth regimes has become even more important in recent years, as the country consistently registered low GDP growth rates at a time when commodity prices and terms of trade have declined sharply.

At the same time, fiscal policy committed to fiscal consolidation as the revenue sources deteriorated and public debt levels approaches elevated limits, as per the judgement of credit ratings agencies, amongst other role players. These developments require the need to use threshold approaches in the contributions to the policy approaches for such an economic climate. This involves showing that low GDP growth regimes and low terms-of-trade regimes do not necessarily constrain policy reactions to positive inflationary pressures. Rather, they call for a gradual pace and small magnitudes of policy tightening. In addition, this gradual policy approach is supported by the fact that the slowdown in income and demand due to the negative terms-of-trade shock depresses inflation for a longer period.

1.4 Policy Trade-off and Disinflation

The first part of the book provides insights on the relationship between disinflation episodes and GDP growth. The first chapters estimate the inflation persistence, output losses or sacrifice ratios associated with disinflationary policies. Thereafter, we explore the evolution of the Taylor curve in South Africa, and this is a precursor to determining the

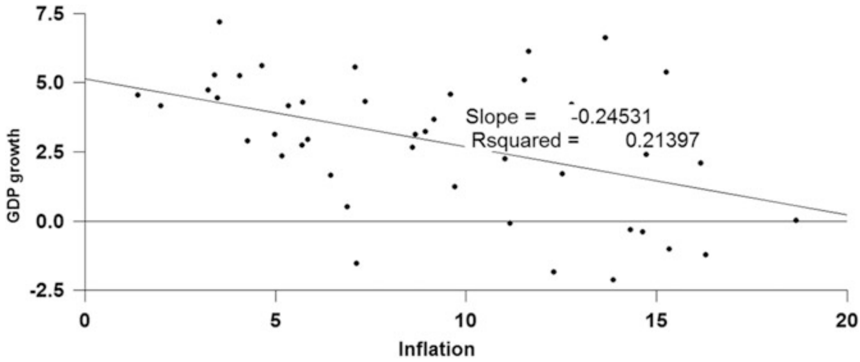

Fig. 1.1 Inflation and GDP growth. *Source*: South African Reserve Bank and authors' calculations

appropriateness of the official inflation target band of 3 to 6 per cent relative to the inflation thresholds.

The first part of the book is premised on the relationship between inflation and GDP growth depicted in Fig. 1.1. The estimated slope of the relationship between inflation and growth for the periods 1966 and 2013 is negative and suggest that as inflation increases GDP growth declines, hence monetary policy should embark on disinflation policy to minimise distortionary effects of high inflation on the economy.

That said, we explore the cost of disinflation or the output cost of fighting inflation using the sacrifice ratio. It is a complex economic phenomenon, but easy to understand as well as being an informative, cost measure. Fig. 1.2 shows how the concept of the sacrifice ratio uses information about output and inflation in the Phillips curve in order to measure how much output would be lost by lowering inflation by one percentage point. This figure shows one possible time path of output and inflation in response to a tighter monetary policy that ultimately lowers inflation by one percentage point as in Filardo (1998). This output loss denoting the idea of the sacrifice ratio corresponds to the output loss in the shaded area expressed as a percentage of GDP. These costs are quantified using different empirical approaches in literature.

Monetary policy, conducted within the flexible inflation targeting framework, considers that price stability is to be achieved without

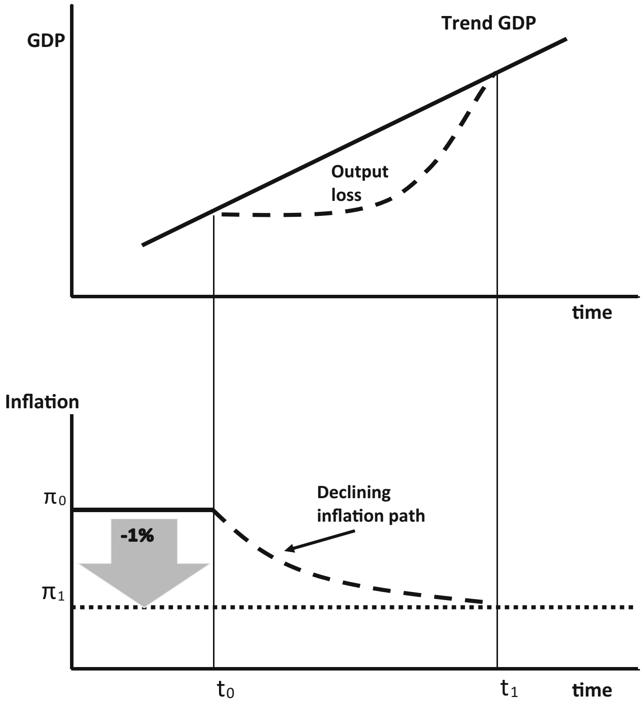

Fig. 1.2 The output loss and inflation. *Source*: Authors' drawing and adapted from Filardo (1998)

incurring excessive real economic costs in the form of low growth and lost production. The achievement of the primary objective on a sustainable basis implies tough choices regarding the output and inflation trade-off. Hence, the chapter empirically explores the inflation and growth volatilities trade-off as shown Fig. 1.3, and as depicted in McCaw and Morka (2005). In the estimation of the Taylor curves, we adopt a specification which allows the volatility transmission. The analysis shows that the exchange rate is among the significant supply shocks that drive inflation and output-gap volatilities in South Africa. The analysis in the book shows that the Taylor curve shifted inwards in the inflation targeting period prior to the recent financial crisis.

Furthermore, the period of the inward shift in the Taylor curve coincided with superior macroeconomic performance. The Taylor curve

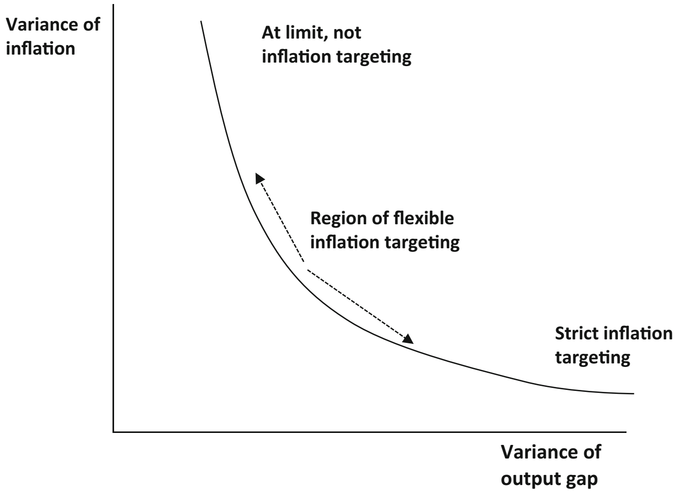

Fig. 1.3 Policy possibilities on efficient policy frontier. *Source*: authors' drawing

is impacted by unexpected positive inflation expectation shocks, exchange rate volatility, and demand and supply shocks. The more persistent the exchange rate volatility the more persistent the shifts in the Taylor curve indicating policy conduct is less than optimal. Thus the findings in this section of the book provide evidence that price stability and the anchoring of inflation expectation matters. By design the flexible inflation targeting framework implies the interplay between constrained discretion and economic growth regimes in the conduct of monetary policy.

1.5 Does Transmission of Inflation Effects on Economic Growth Become Impacted by the Fiscal Policy Conditions?

As stated earlier, the fiscal policy is expected to embark on a fiscal consolidation path. In this regard fiscal policy should matter to the extent that it interacts with monetary policy in its mandate to enforce price stability via impacting the inflation rate. Rather than focusing only on the direct impacts on inflation, the book also analyses how fiscal policy impacts the transmission of inflation shock to economic growth. This involves showing that fiscal policy matters for inflation developments directly and indirectly and this latter channel is further dependent on inflation threshold.

The book shows there is role for fiscal policy that needs to identify the threshold at which inflation does not lower economic growth, but above it has adverse effects on growth. The threshold may indicate an abrupt or smooth or symmetrical relationship between inflation and economic growth. The symmetric relationship suggests that inflation exerts a similar effect on GDP growth at both low and high inflation rates. If this is the case, should the inflation targeting band matter? In contrast in Fig. 1.4 a smooth transition regression model suggests a gradual effect as inflation rises, but above a certain threshold the effect of inflation begins to lower GDP growth. Does this point to imposing the upper part of the target band?

Our study looks at the role of different inflation targets ranges on economic growth and even the amplification of external shocks into import price inflation. This shows that the impact of inflation on GDP growth differs as the level of inflation varies. In addition, at levels above and below the inflation threshold, the effects of inflation on GDP growth change. Moreover, the evidence shows that even if the government acts as a conduit in the transmission of inflation shocks to GDP growth, the role of this fiscal variable changes above and below the inflation threshold. Overall, this part of the study reveals that inflation thresholds have implications for the appropriateness of the inflation target band and conduct of monetary policy, and the role of fiscal policy in transmitting inflation shocks to economic growth.

In addition, the inflation thresholds impact the relationship between finance and economic growth. And this transmission of the shocks are affected and constrained by the role of government consumption expenditure. The inflation bands above 6 per cent amplify the transmission of shocks to import price inflation and this feeds to consumer price inflation. Thus price stability matters.

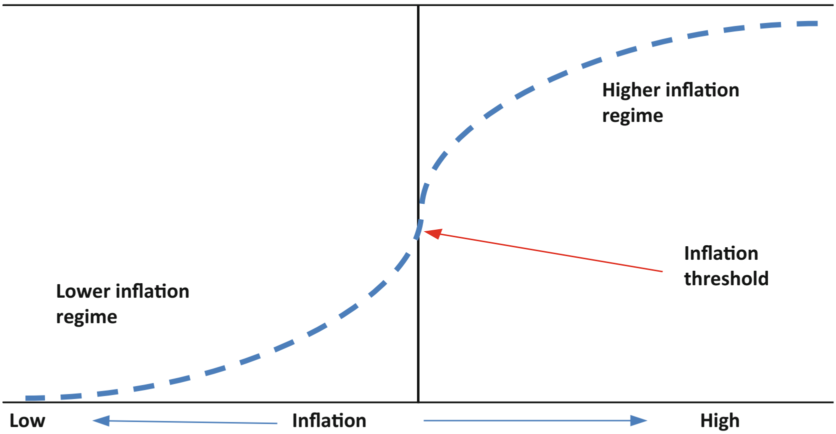

Fig. 1.4 Transition of inflation from low to high inflation regimes. *Source*: Authors' drawing

1.5.1 Inflation and Price Dispersion

The inflation threshold is not only important for economic growth; for instance, it also matters because of the impact of expected inflation on relative price dispersion, which is a major channel of the real effects of inflation. Furthermore, the relationship between inflation and relative price dispersion is non-monotonic, suggesting that there are threshold effects above which the distortionary effects of inflation on welfare become significantly magnified.

1.6 Magnitude of Exchange Rate Changes and Volatility Persistence Shock

As a small open economy, South Africa has been buffeted by a number of supply shocks, some of which have proven to be highly persistent, such as the depreciation and volatility of the exchange rate as shown in Fig. 1.5.

Economic theory argues that the magnitudes of exchange rate changes are significant. The menu costs theory argues that price setters may leave prices unchanged if there are small exchange rate changes but may alter

Fig. 1.5 The R/US$ exchange rate. *Source*: South African Reserve Bank and authors' calculations

them where there are large changes. Hence, we dedicate some chapters to focusing on how the responses of inflation to rand per United States (US) dollar exchange rate depreciation shocks evolved over time and the implication for inflation volatility.

Exchange rate changes and the accompanying volatilities directly influence inflation volatilities through higher inflation and inflation volatility. As a result, inflation volatility increases due to elevated exchange rate volatility. In turn, inflation volatility exerts asymmetric effects on real economic activity. This means that economic growth benefits from a reduction of nominal uncertainty or volatility. This sequence of events, to be prevented, requires support for the implementation of anti-inflation policies that also lower nominal uncertainty. Because increased uncertainty deters investment and raise option to wait and see.

1.7 Non-linear Changes in Feedthrough into Import Price and Consumer Price Inflation

Due to prevailing economic conditions, the analysis separates the exchange rate pass-through effects into first stage pass-through and the direct channels. But these feedthrough effects are not linearly passed through in their entirety as their size may depend on prevailing economic conditions which may lead to non-linear effects. The analysis shows that macroeconomic conditions can amplify or reduce the magnitudes of inflation and import price inflation. This book dedicates certain sections to determining thresholds at which responses of inflation and imported price inflation change, depending on prevailing macroeconomic conditions. Thus we show that negative output gap, low GDP growth and low terms-of-trade regimes do not constrain the ability of monetary policy to respond to inflationary pressure, but slows the pace of adjustment and magnitudes of change.

The output gap plays a role in policy reaction function. But has role of with this variable not changed with time? The book explains how the output gap is used to amplify the inflation response to exchange rate depreciation shocks, but also how this has changed as it lowers the inflation responses. First, the book shows that output gap development post-2009 did not prevent the pass-through of exchange rate shocks into inflation but it did reduce their magnitudes. This is consistent with the relationship between inflation and the output gap depicted in Fig. 1.6, which varies with time.

The negative persistent gap shown in Fig. 1.6 for the time varying output gap measure has implication for transmission of exchange rate shocks to inflation. Second, the book shows through counterfactual analysis that the role of output gap has changed over time and it dampens the inflation responses, making it rise less than what it would be in its absence. Despite the uncertainty surrounding the estimates of the output gap and potential output growth rate, they are both part of the important unobservable macroeconomic variables that are used as guides for setting monetary policy. These variables provide valuable information about supply-side capacity and the degree to which aggregate demand can expand without accelerating inflation.

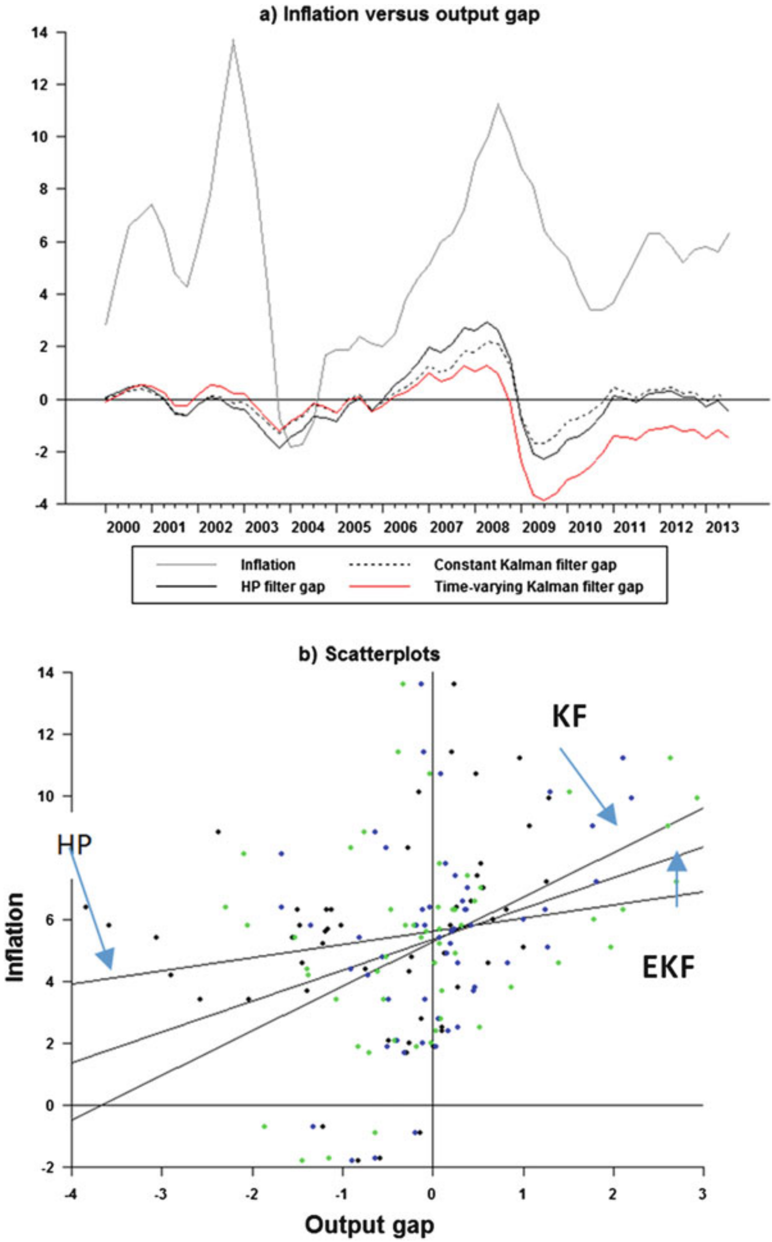

Fig. 1.6 The relationship between various output-gap measures and inflation. *Source*: Authors' calculations. *Note*: The abbreviations in (b) depict the

We show that the relationship between the output gap and inflation has changed since the onset of the recession in 2009 Q1 in Fig. 1.7.

This suggests that the sensitivity of inflation to output-gap has weakened and the output-gap does not explain all movements in inflation. There are other variables that account for movements in inflation.

1.8 Inflation Expectation and Its Role in Labour Market Adjustment

Inflation expectations are important in the price formation process and inflation outcomes. The book provides an intensive investigation of the role and formation of various measures of inflation expectations (including breakeven inflation rates) in South Africa based on both surveys and financial markets. Latest econometric techniques enable us to separate the effects of adverse supply shocks from inflation expectations shocks and aggregate demand shocks to infer the policy implications of how policymakers should think about inflation expectations in the conduct of monetary policy. The analytical framework clearly distinguishes the impact of shocks and derives appropriate policy implications. The chapter differentiates the effects of a positive inflation expectations shock from those of an adverse aggregate supply shock and positive aggregate demand shock. Evidence shows that the effects of a positive inflation expectations shock differ from those of an adverse aggregate supply shock.

Evidence establishes that inflation expectations have been poorly anchored and short-term upside risk factors to the inflation outlook are the key drivers of long-term inflation expectations. Inflation expectations shocks are positively related to unit labour costs and negatively associated with employment growth. In addition, inflation expectations shocks lead to tighter credit conditions. Positive shocks of wage increases in excess of 6 per cent result in higher inflation outcomes and inflation expectations.

Fig. 1.6 (continued) relationship between inflation and specific output gap. KF means constant Kalman filter, EKF means the extended Kalman filter gap and HP means Hodrick Prescott filter

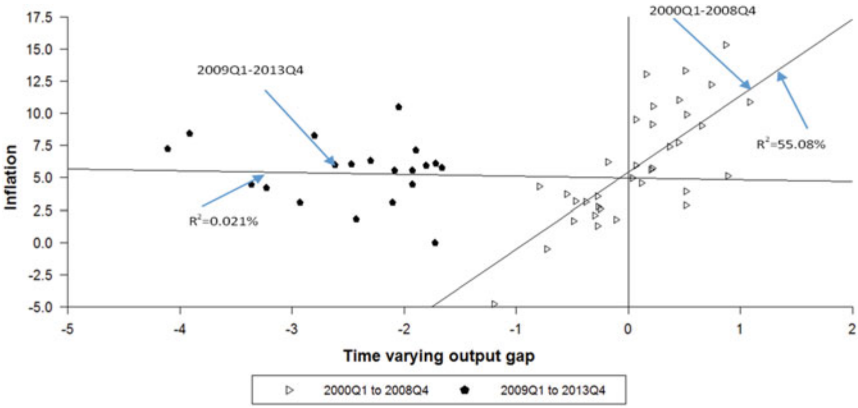

Fig. 1.7 Relationship between inflation and time varying in output gap inflation targeting period. *Source*: Authors' calculations

This indicates that inflation expectations are less anchored as they are not supposed to react to any shock. There are differences between effects of positive food inflation and overall CPI shocks on excess wage growth. Evidence shows that price stability and anchoring inflation expectation is important, using a counterfactual approach and the role of labour market adjustment via wage changes to US quantitative easing shock and adverse global GDP growth shock. These are new empirical insights in the South African academic and policy discourse.

1.9 Updating of Inflation Expectations

The book further looks at how wage increases in excess of 6 per cent impact inflationary dynamics and expectations. How should monetary policy respond and to what extent should inflation expectations be updated? The emphasis is that if inflation expectations are "well" anchored, then the inflation expectations are unlikely to move in response to economic shocks that are projected to temporarily push inflation away from the target. Evidence also shows the period when one and two-year ahead inflation expectations become less anchored due to excess wage inflation shocks. In addition, there is evidence of feedback effects between excess wage increases and inflation. Agents update their inflation expectations both downward and upward and the updating is propagated by upside risk factors to inflation.

1.10 GDP Growth Threshold and the Role of Short-term Conditions Indicators in Policy Path Responses

The book concludes by looking at the extent to which economic (GDP) growth threshold impacts the effects and pace of policy rate adjustments through determining a threshold level that exerts non-linearities in the transmission of the real effects of the policy rate. This will reveal different GDP growth regimes that affect the path of the repo rate.

We identify a GDP growth threshold level that exerts non-linearities in the transmission of the real effects of the policy rate and shows that the GDP growth threshold impacts the magnitudes and pace of policy rate adjustments.

Evidence shows that non-linear responses to policy tightening and loosening are influenced by threshold. Evidence shows that the lack of a clear distinction of the effects of the real policy shocks based on the GDP growth regime overestimates the potency of policy effects on economic growth. The analysis further shows deteriorating business cycle indicators and tight credit conditions affect the repo rate adjustment to positive inflation shock.

The chapter shows the implications of annual changes in the business cycles leading and coincident indicators and the credit condition index for the policy adjustments towards positive inflation shocks since 2007 M8. The counterfactual scenarios based on shutting of indicators suggest the slower policy rate adjustment to positive inflation shock since 2007 M8. This shows that business cycle indicators play an important role on policy rate adjustments. The last shows that terms of trade regimes do not impact constraint monetary policy responses to inflation shocks but slow the pace of policy adjustment.

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Part I

Costs of Disinflation, Inflation Volatility and Policy Trade-offs

2

The Ball Approach to Disinflation Episodes, Output Costs and Sacrifice Ratios in South Africa

Learning Objectives

- To determine cumulative output losses associated with a permanent reduction in inflation during disinflation episodes
- To understand the link between inflation persistence and output costs during disinflation episodes
- To understand sacrifice ratios after incorporating the Zhang and Hoffstetter assumptions
- To estimate the propagation effects of disinflationary shocks on GDP growth due to the exchange rate depreciation, food inflation in excess of 6 per cent and inflation expectations.

2.1 Introduction

In periods during which inflation is forecast to persist outside the target band policymakers embark on a phase of monetary policy-tightening. Policymakers know that restrictive monetary policy is associated with output losses and sacrifice ratios. However, the primary mandate of price stability is equally important. A deceleration in the actual inflation rate in response to a tighter monetary policy stance points to the start of a

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disinflation period. But in most cases the inflation adjustments are very sluggish and forecasts tend to be persistent around the upper band of the target range. This may suggest that disinflation is also linked with output losses or sacrifice ratios and inflation persistence.

Within the nexus of disinflationary costs, sacrifice ratios and inflation persistence lies the credibility of the inflation target. Literature shows that the lack of credibility of the inflation target is also an important source of inflation persistence itself.[1] However, the existence of multiple price rigidities (or frictions) even in the presence of an appropriate conduct of monetary policy can result in the sluggish adjustment of inflation outcomes and expectations to changes in monetary policy. This can therefore contribute to factors compromising the credibility of monetary policy (Andersen and Wascher 1999).

This chapter shows these links and infers policy implications from the empirical findings by examining the following questions. What are the magnitudes of the cumulative losses of output from its trend and sacrifice ratios associated with a 1 per cent permanent reduction in inflation during each disinflation episode? What is the behavior of inflation persistence during the identified disinflation periods? How does inflation persistence relate to output losses or sacrifice ratios in these periods?

Policymakers care about the short-term output losses and sacrifice ratios associated with policy actions to disinflate the economy. They acknowledge that these costs are inevitable and may even be substantial at certain times. However, these output losses are expected to be short-lived and diminish as the disinflation process progresses. Thereafter, gains from a low inflation environment for prolonged periods are expected (Mayes and Chapple 1995).

Why should inflation persistence matter in the analysis of output costs or sacrifice ratios? The rate and the degree of inflation persistence are highly dependent on the behaviour of price setters in the economy. It is true that prices may not fully adjust due to frictions, the dominance of

[1] Empirical evidence has shown that the key determinants of disinflation costs are (i) lack of central bank credibility (ii) slow adjustments of inflation expectations to changes in monetary policy (iii) imperfect information, wages and prices stickiness. All these factors lead to high adjustment costs during a disinflation process. Hence, the evaluation of these short-term costs through the estimation of a sacrifice ratio can convey important information to policy makers (Durand et al. 2008).

imperfect competition including the manner in which price expectations are formed. The inflation expectations formation process matters even more in cases where price formation process is dominated by the simple averaging of past inflation. This can result in elevated inflation persistence particularly if past inflation outcomes are high. For instance, the more reluctant the price setters are to adjust the price setting behaviour following policy tightening, and a slowdown in demand, the more it becomes difficult for policymakers to achieve the desired disinflationary process. This may lead to increased costs of disinflation and may indeed require longer periods of policy tightening given any size of disinflationary pressures (Mayes and Chapple 1995).

2.2 What Is the Nature of the Relationship Between Inflation and Growth?

Policymakers consider the existing macro-economic conditions when adjusting the policy rate. However, the attainment of the primary mandate of price stability is important as high inflation levels are bad for growth. Why is high inflation bad for growth? There is vast literature and empirical evidence on this aspect. However, the key thread linking all the negative effects of inflation were best summed up by Friedman (1977), who showed that high inflation distorts the allocation of resources and affects the relative prices of goods in the economy, thus leading to adverse effects on economic growth. Moreover, high levels of inflation are linked with high inflation variability. Inflation variability adds further expenses to economic agents when covering risks involved. Similarly, vast studies show that during periods of high inflation it becomes expensive to change prices. There are costs involved in the renegotiation of contracts, changing labels and lists. In addition, it is costly to inform customers about these changes. Hence, in trying to avert the adverse inflation effects on the economy and in maintaining price stability, policymakers embark on disinflationary policies aimed at slowing inflation.

The empirical analysis starts by assessing the relationship between GDP growth and inflation. Fig. 2.1(b) confirms the negative relationship

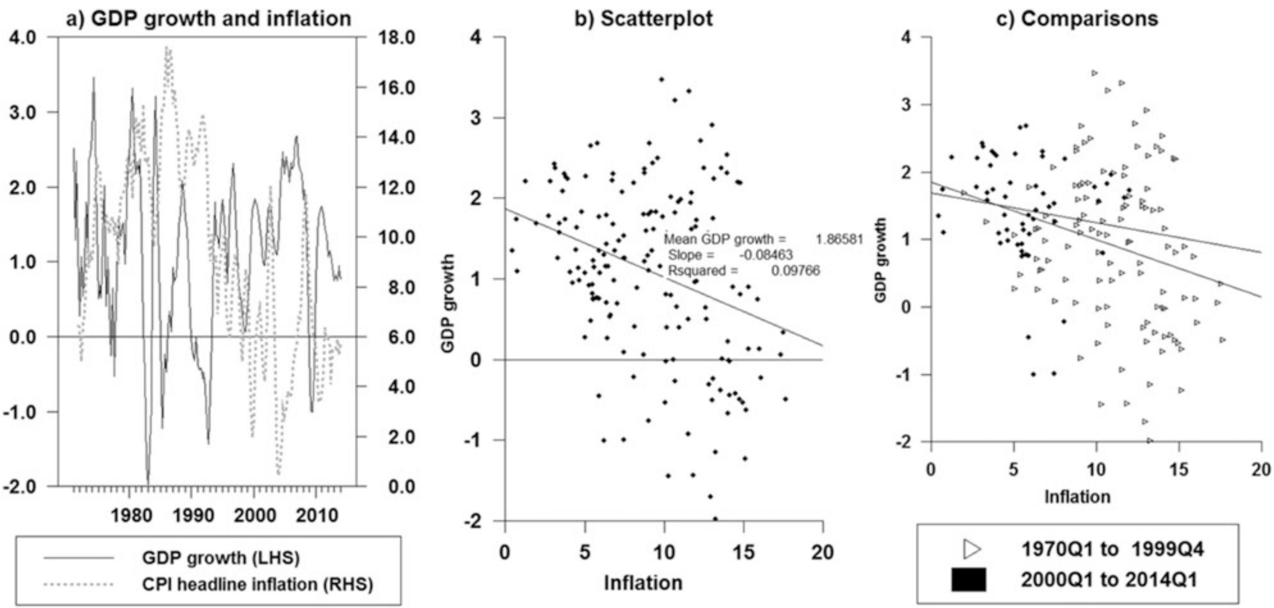

Fig. 2.1 Inflation and GDP growth. *Source*: South African Reserve Bank (SARB) and authors' own calculations

between inflation and GDP growth. In addition, the scatterplots in (c) show that the negative relationship is steeper in 1970Q1 to 1999Q4 before the adoption of the inflation targeting policy framework compared to 2000Q1 to 2014Q1.

The negative relationship depicted in Fig. 2.1 is mostly applicable and evident in the medium to long run and does not necessarily hold when looking at short-term association. As a result, to ascertain the extent of the variation across the samples, the cross-correlations over time are shown in Fig. 2.2. These show what happens when an increase in inflation leads GDP growth. These show a negative relationship but with varying strengths, particularly when inflation leads GDP growth. This means that high inflation today is associated with a decline in GDP growth in later periods. This relationship is stronger in the period 2000Q1 to 2014Q1 compared to other sample periods. However, cross-correlation neither tests for the direction of causality and effects, nor the existence of threshold effects of inflation on GDP growth.

Overall, the preceding two graphs reveal a negative relationship between inflation and GDP growth. This, therefore, establishes early evidence to the effect that a disinflationary policy stance is necessary to minimise the adverse effects of inflation on GDP growth.

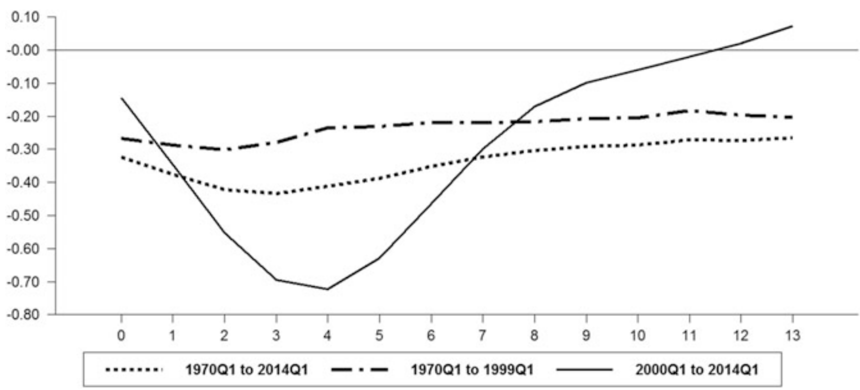

Fig. 2.2 Cross-correlations between inflation and GDP growth. *Source*: Authors' own calculations

2.3 What Are Sacrifice Ratios and Why Do They Matter?

The sacrifice ratio can be defined as the cumulative output loss resulting from a one percentage point reduction in the inflation rate. Sacrifice ratios refers to the degree to which demand has to be reduced to achieve a given reduction in the inflation rate.[2] Quantifying output losses of disinflation episodes is important because disinflation tends to be a major cause of recession in advanced economies (Ball 1994). However, not all episodes of elevated inflation are associated with an overheating economy or demand. There are cases highly dominated by external factors and supply-side shocks. Nonetheless, irrespective of the sources of inflationary pressures, empirical evidence shows that lowering inflation is necessary for price stability. Price stability contributes to raising potential growth, particularly in relation to relative prices and lowering the inflation risk premium.

Despite literature and empirical evidence emphasizing a positive effect of containing inflation on long-term growth, the recessionary effects brought about by a disinflationary policy stance are likely to constrain growth. Therefore, to what extent is growth constrained by a disinflationary policy? This is tackled through estimating the magnitudes of sacrifice ratios based on the Ball (1994) approach. The Ball approach has been extensively used, and is widely preferred, to select disinflation episodes rather than estimating the sacrifice ratio from a Phillips curve, for example. The main drawback and criticism of using the Phillips curve to measure the sacrifice ratio is that it constrains the inflation-output trade-off to be the same in both periods of disinflation and rising inflation (Durand et al. 2008). This does not mean that the Ball (1994) methodology does not have any drawbacks. The later sections of this chapter show that the alternative methodological improvements brought forward by Zhang (2005) and Hofstetter (2008) result in even worse and magnified costs associated with disinflationary episodes.

[2] Alternatively, sacrifice ratios measure the extent to which real output is forgone in order to reduce trend inflation by one percentage point.

2.4 Ball's Trend and Actual Output Dynamics and the Role of Inflation Persistence

To give context to the analysis of disinflation periods and associated sacrifice ratios, Fig. 2.3 shows the hypothetical trajectories of the role of inflation persistence, actual and trend output in determining the costs of lowering inflation by 1 per cent on output as adapted from Filardo (1998) and Zhang and Clovis (2009). The top part of Fig. 2.3 shows the relationship between trend and actual output. The bottom part shows the inflation trajectories separated into low and high inflation persistence categories. It is evident that the theoretical output losses are highly dependent and influenced by the persistence of inflation. In fact, the output losses are lower in a less persistent inflationary environment relative to higher persistent regimes, shown by the fine dotted line in the bottom part of Fig. 2.3.

2.5 Actual Output Relative to Trend Output During Disinflation Episodes

The disinflation periods identified using the Ball (1994) episode-specific approach use quarterly (Q) data from 1970Q1 to 2014Q1. The trend inflation is extracted from the actual by using the nine-quarter centred moving average of quarterly CPI inflation. This smoothing technique eliminates the influence of the supply shocks that lead to temporary inflation departures from trend. Thereafter, peaks and troughs are identified using trend inflation as shown in Fig. 2.4. A peak of inflation at time ***t*** occurs when trend inflation at time ***t*** exceeds the preceding four quarters and those in the subsquent quarters. A trough occurs when inflation at time ***t*** is lower than in the preceeding four quarters and the following four quarters.

The calculation of the sacrifice ratio using the Ball (1994) approach relies on two main assumptions regarding the path of trend output and when it returns to actual output. The assumptions state that (i) output is at its trend at the peak of inflation, (ii) it returns to trend four quarters after the end of

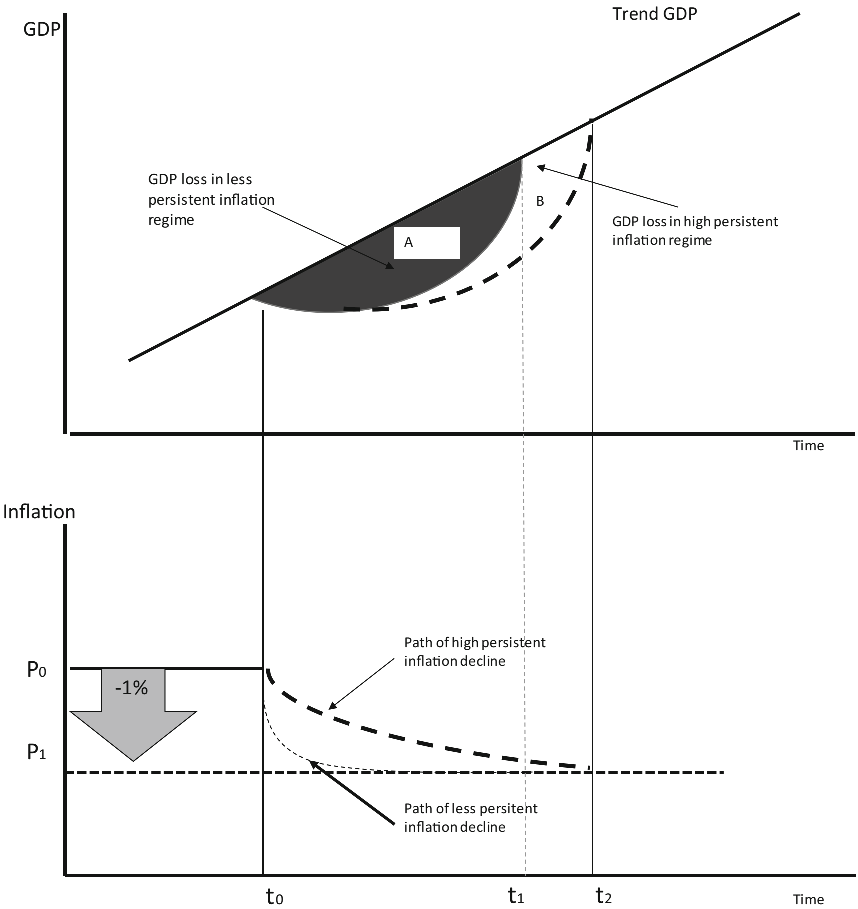

Fig. 2.3 Hypothetical paths of actual and trend and inflation dynamics. *Source*: Authors' drawing and adapted from Filardo (1998). *Note*: GDP loss in the upper part in high inflation regime are given by sum of shaded area A and unshaded area B. The disinflation involves inflation declining by 1 per cent from inflation rate P_0 to P_1

the disinflation episode, (iii) trend output grows log-linearly between these periods, and (iv) therefore, trend output follows a straight line connecting the beginning point of disinflation to a year after disinflation. The sacrifice ratio is then calculated as the sum of the deviations between the fitted line for trend output and the log of output. This is then divided by the change in trend inflation over the course of the episode.

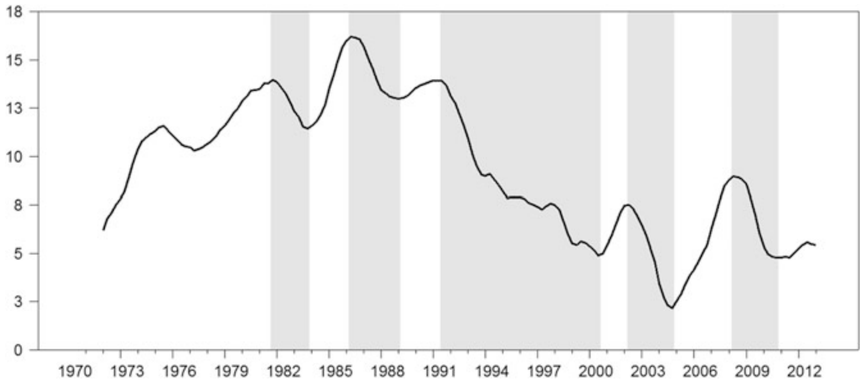

Fig. 2.4 Inflation and disinflation periods. *Source*: Authors' calculations. *Note*: Shaded areas refer to disinflation periods which are at least 2 percentage points lower than at the peak. The centred nine-quarter moving average inflation is expressed in per cent

Following the Ball (1994) approach, the disinflation occurs only when trend inflation declines by at least 2 percentage points from its peak. Why is the 2 per cent rule important? It separates significant aggregate demand shifts from those of fluctuations arising from other shocks. This assumes that monetary policy accounts for all cyclical output variation. The estimated disinflation periods are shown in Fig. 2.4.

Applying the Ball (1994) approach, using a rule that trend inflation should exceed 2 percentage points, leads to identifying that the longest disinflation episode occurred between 1991Q1 and 2001Q3 with trend inflation declining by 9.05 percentage points. Ranking the sizes of disinflation from largest to smallest, this preceding episode is followed by a decline of 5.33 per cent in the inflation trend in 2002Q2 to 2005Q4 and 4.18 per cent in 2008Q2 to 2011Q4. This is followed by 3.3 per cent in 1986Q2 to 1989Q1 and 2.51 per cent the 1981Q4 to 1984Q4. These estimates and dates of the disinflation periods correspond to dates that end a year earlier following Ball's approach.

Subsequent to the identification of the disinflationary episodes, how did actual output relate to trend output? This is answered by plotting actual and trend output based on the identified disinflation periods, as can be seen in Fig. 2.5.

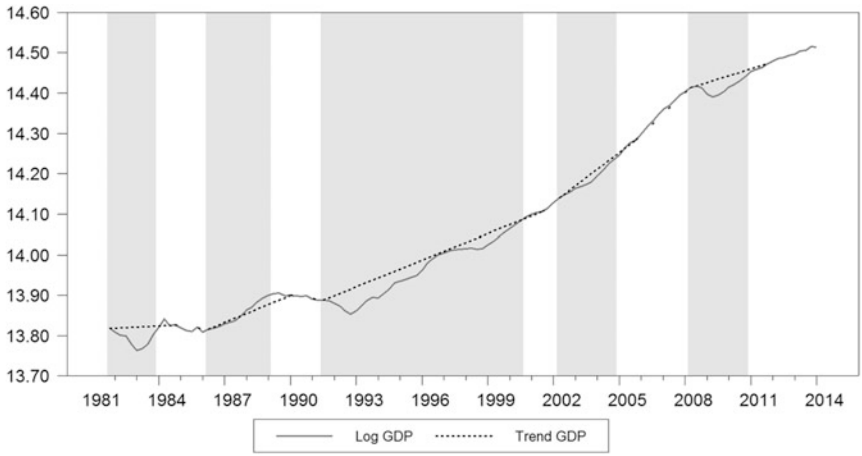

Fig. 2.5 Actual and trend output during disinflation episodes. *Source*: Authors' calculations. *Note*: The shaded areas refer to disinflation periods

In four of the five identified episodes, actual output was below trend output in Fig. 2.5. This reveals that periods of disinflation are associated with output slowing down below trend. Disinflation policies tend to result in output costs in the short run, corroborating the estimated results in Fig. 2.2.

2.6 Costs of Disinflation and Inflation Persistence During the Disinflation Periods

Why bring inflation persistence into the analysis? It is because market price-setting behaviour depends on expected prices and expected monetary policy; hence the process of the price formation of expectations has implications for sacrifice ratios (Husek and Formanek 2005). Firms engaging in forward-looking price formation expectations will adjust prices in a highly flexible way, in anticipation of monetary policy tightening. Thus prices adjust more, and inflation is not highly persistent and real output losses are very limited, leading to low sacrifice ratios (see Fig. 2.3). In contrast, in a backward-looking inflation expectations formation process,

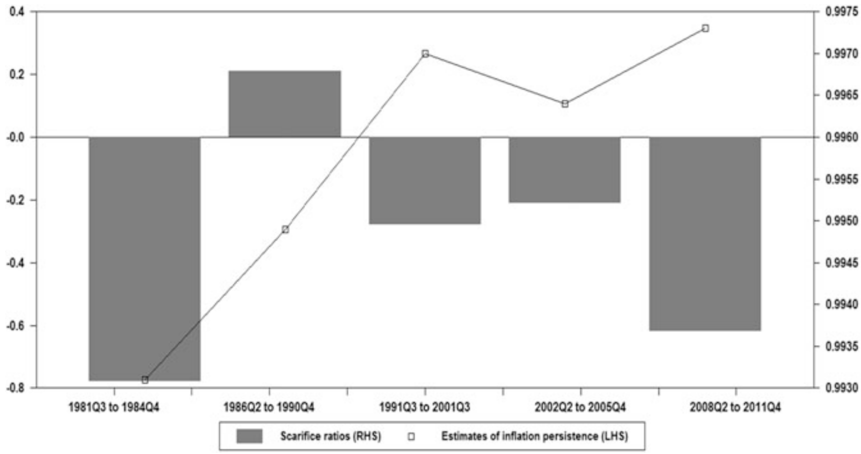

Fig. 2.6 Inflation persistence coefficients and sacrifice ratios. *Source*: Authors' calculations. *Note*: The periods shown in the bar graph refer to inflation duration effects on output as shown in Figs. 2.3 and 2.7. They are consistent with the depiction in Fig. 2.3

prices change very sluggishly. Inflation is very persistent, such that monetary policy tightening has very little effect on prices and a big impact on output, which leads to high sacrifice ratios.

The sacrifice ratio for each disinflation episode and the corresponding sizes of inflation persistence are shown in Fig. 2.6(a) and (b). The results of inflation persistence measures are based on the equation specified by Zhang and Clovis (2009). In the estimations, we used monthly data for the inflation rate and output is proxied by manufacturing production data. The values were adjusted for Heteroscedasticity and Autocorrelation Consistent.

What is the degree of inflation persistence in the identified disinflation episodes in South Africa?

During the inflation-targeting regime, the sacrifice ratios are larger for the 2008Q2–2011Q4 period and this is associated with larger persistence in this period as shown in Fig. 2.6. This is followed by the 1999Q1–2001Q3 and 2002Q2–2005Q4 periods. Therefore, since 1991 the inflation persistence coefficients are associated with higher magnitudes of sacrifice ratios. The negative values mean that a 1 per cent reduction in inflation leads to output losses. The higher the size of the inflation persistence coefficient, the higher the output sacrifice ratio. This means that in the presence of high persistence, an aggressive policy stance may lead to large output losses. As indicated earlier, this is prevalent in a backward-looking price formation expectations environment. The positive sacrifice ratio value in the 1986Q2 to 1990Q4 period suggests that during this episode a reduction in inflation led to an improvement in output.

Only four out five disinflation periods in Fig. 2.7 mimic the classic assumption of the Ball (1994) approach. However, the results for 1986Q2 to 1990Q4 are different. The other episodes are accompanied by the associated disinflation trends in parts (e)–(f). The dotted lines in parts (e)–(f) show inflation over four quarters following the disinflation trough.

It is evident that the trends for the 2008Q2–2011Q4 period output losses were very large and the inflation trend was flat a year after the disinflation period compared to the other episodes.

2.7 Sacrifice Ratios Based on the Zhang and Hoffstetter Assumptions

As stated in the earlier section, Zhang and Hofstetter challenged the assumptions regarding trend output. Hofstetter argues that disinflation episodes begin a year earlier, while Zhang (2005) argues that actual output may delay its return to trend output after the disinflationary period. Zhang (2005) hypothesizes that output grows at the rate of potential output at the beginning of the disinflationary period. Hoffstetter is of the same opinion, but adds another dimension that by the time Ball (1994) observes disinflation, this would have started a year earlier.

Despite the uncertainties of measuring trend and potential output, both arguments are appealing. However, the recent experience following the financial crisis provides evidence that it is highly possible that output returns to its long-term trend at a much more slower pace relative to Ball's assertion. This is assessed by examining whether it could be true of the experience of recent financial crisis. Has actual output returned to its trend level after the recent crisis? The implications of the Ball (1994) assumptions are shown in Fig. 2.8.

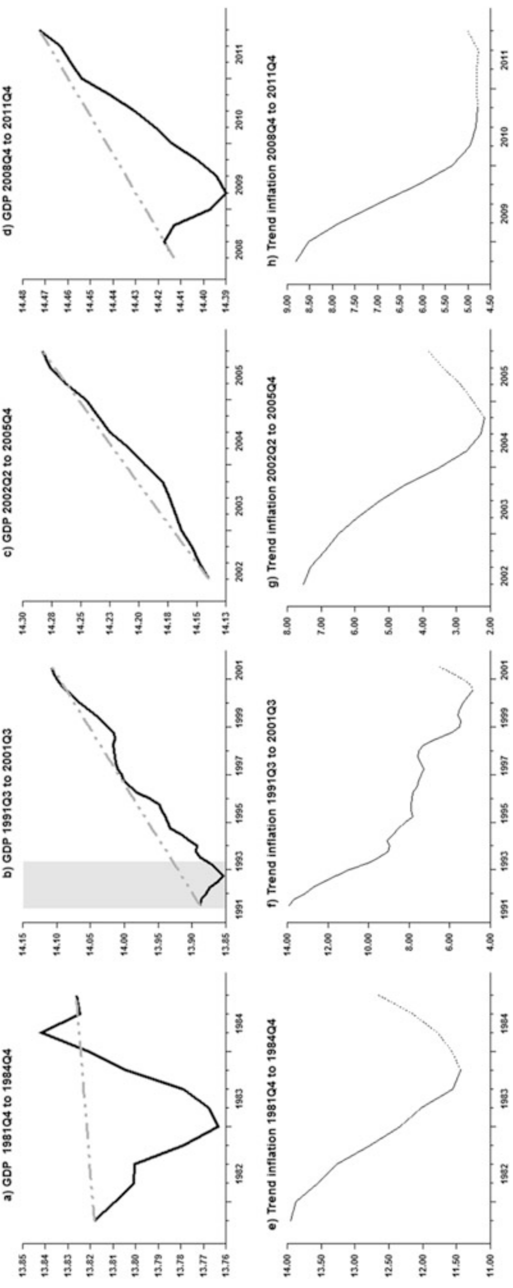

Fig. 2.7 Actual and trend output during disinflation episodes. *Source*: Authors' calculations. *Note*: The dotted lines in trend inflation show inflation a year after the disinflation period

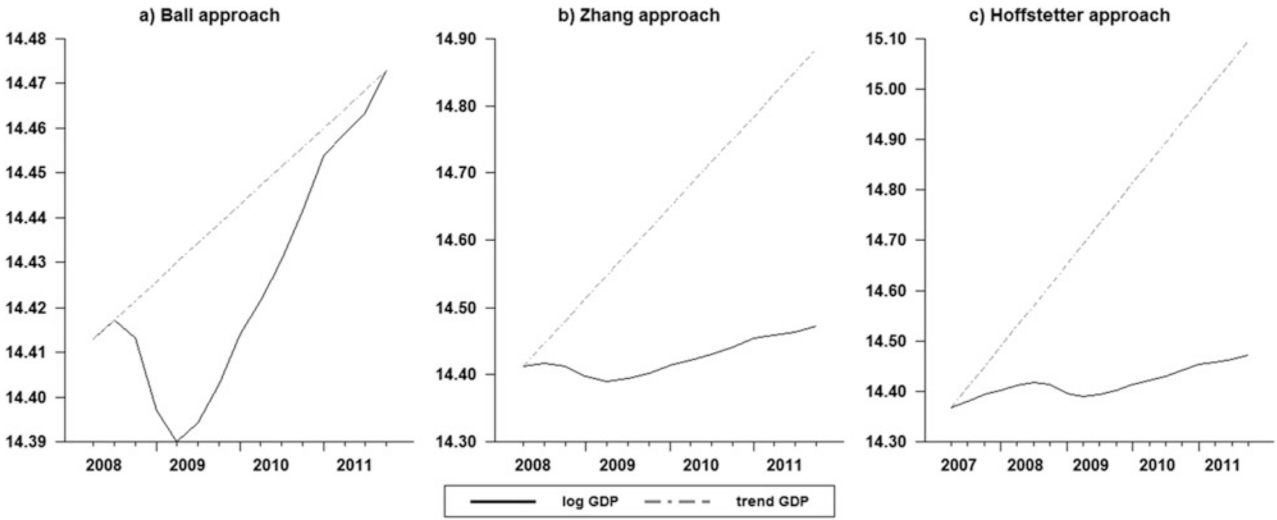

Fig. 2.8 Trend and actual output based on the Ball, Zhang and Hoffstetter approaches. *Source*: Authors' calculations. *Note*: The blue lines refer to actual output and red lines refer to trend output. The data is log transformed. The dotted blue line for actual output in part C, should period depicting disinflation period a year earlier

The divergence between trend and actual output suggests that in reducing inflation by one percentage point, policymakers may reduce more output *per se*. The results show that Ball's approach gives the smallest output lossess and output does return to trend. The Zhang and Hoffstetter approaches show that output does not return to trend.

2.8 The Role of the Exchange Rate Depreciation, Food Inflation in Excess of 6 Per Cent and Inflation Expectations in the Transmission of Disinflation Shocks to GDP Growth

Fig. 2.6 showed that the 2008Q2 to 2011Q4 exhibits higher inflation persistence than other periods. Hence this section examines the extent of disinflation based on different techniques that generates dummy variables. The analysis is based on the modified Pentecôte and Rondeau (2015) and Cerra and Saxena (2008) applied to the GDP growth Eq. (2.1).

$$GDP\,growth_t = constant + \sum_{i=1}^{4} \beta_i \mathrm{GDP}\,growth_{t\text{-}i} + \sum_{i=0}^{4} w_i Disinflation\_Dummy_{t\text{-}i} + \varepsilon_t \tag{2.1}$$

where, ε_t denotes an error term and $Disinflation\_Dummy_{t\text{-}i}$ denotes the disinflation period which equal one for the duration and zero otherwise. This equation is used to derive the GDP responses to the disinflation shock in the period. Evidence suggests that disinflation shock leads to GDP growth contraction but the magnitudes of the decline differ. In particular, we are interested in the disinflation episodes during the inflation targeting period. We modify Eq. (2.1) and include the inflation rate and a financial crisis dummy *Crisis*_2007 which equals one for 2007Q3 to the end of the sample and zero otherwise in Eq. (2.2).

$$GDP\,growth_t = constant + \sum_{i=1}^{4} \beta_i \mathrm{GDP}\,growth_{t\text{-}i} + \sum_{i=1}^{4} \beta_i\, inflation_{t\text{-}i} + \sum_{i=0}^{4} w_i\, Disinflation\_Dummy_{t\text{-}i} + \sum_{i=1}^{1} q_i \mathrm{Crisis\_2007} + \varepsilon_t \tag{2.2}$$

Two disinflation dummy variables used in this analysis are for 2002Q2 to 2005Q4 and 2008Q2 to 2011Q4. To demonstrate the effects above and below 6 per cent, we generate two inflation dummy variables. The first dummy equals the value of inflation when it is below 6 per cent and zero otherwise. The second dummy equals the value of inflation when inflation is above 6 per cent and zero otherwise. The dummy variables replace the inflation variable in Eq. (2.2) and are included separately in the model. Evidence in Fig. 2.9 shows these disinflation shocks had adverse effects on GDP growth. The disinflation shock in 2008Q4 to 2011Q4 resulted in larger GDP contraction than that during 2002Q2 to 2005Q4. Furthermore, Fig. 2.10 shows that the level of inflation plays a role on the effects of disinflation shocks on GDP growth.

Eq. (2.2) is augmented and re-estimated to separate the role of inflation. Two models are estimated: one including inflation, and in the second model the role of inflation is shut off to generate a counterfactual impulse response. The difference between the GDP growth responses generated captures the role of inflation in transmitting the disinflation shocks into GDP growth. Evidence shows that high inflation exacerbates the effects of disinflation shock on GDP growth, which can be seen in Fig. 2.10.

In addition, there are differences in the GDP growth responses depending on whether inflation is above or below 6 per cent, as can be seen in Fig. 2.10 (c). High levels of inflation lead to a decline in GDP growth due to disinflation shocks but the effects tend to be large when inflation is above 6 per cent. The policy implication is that price stability matters.

The analysis concludes by looking at the role of the exchange rate, food inflation and inflation expectations in the transmission of disinflation shocks to GDP growth. For this analysis, inflation is replaced with annual

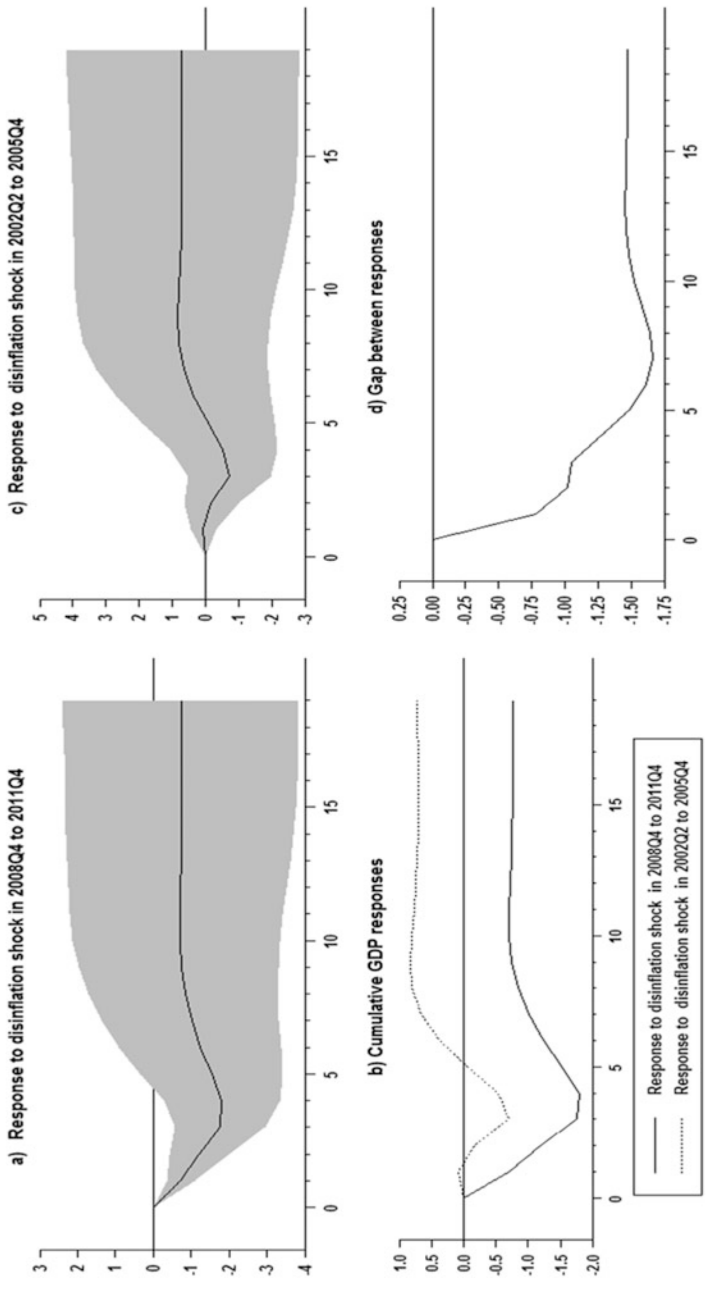

Fig. 2.9 GDP growth responses to disinflation shock. *Source*: Authors' calculations

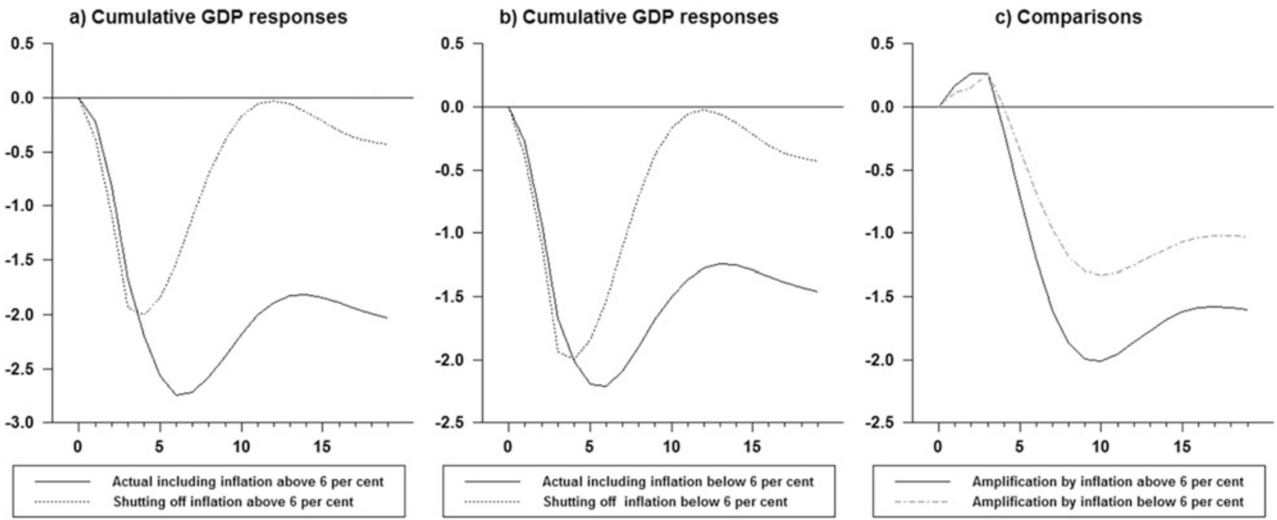

Fig. 2.10 Actual and counterfactual GDP growth responses to disinflation shock. *Source*: Authors' calculations

exchange rate changes, food inflation and inflation expectations in Eq. (2.2). A dummy variable is created for food inflation changes that exceed 6 per cent and zero otherwise. The dummy variable for the exchange rate is created for the depreciation, which equals one for positive exchange rate changes only and zero otherwise. To differentiate between sizes of the depreciation a second exchange rate dummy is created which equals one for annual changes above 10 per cent and zero otherwise. This aspect of the exchange rate depreciation dummy variable captures the role of asymmetry based on the size of the exchange rate changes.

Fig. 2.11 shows that exchange rate depreciation (exch rate dep) worsen the GDP growth decline due to disinflation shock.

However, there are asymmetries and the decline is large when depreciation exceeds 10 per cent as shown in Fig. 2.11(a) relative to (b). On the other hand, Fig. 2.11(c) shows that elevated food inflation above 6 per cent also worsens the decline in GDP growth following a disinflationary shock. The cumulative amplification magnitudes show that large exchange rate depreciations lead to pronounced decline in GDP growth during periods of disinflation. Similarly, Fig. 2.12 shows that elevated inflation expectations leads to larger declines in GDP growth. This is particularly the case in the effect of one-year-ahead inflation expectations. This evidence shows the importance of anchored inflation expectations.

2.9 Conclusion and Policy Implications

In efforts to maintain and reinforce the primary mandate of price stability, policymakers embark on monetary policy-tightening. Restrictive monetary policy actions aimed at disinflation are associated with subsequent output loss and sacrifice ratios. The Ball (1994) approach, establishes that four out of five disinflationary episodes were very costly. These costly disinflationary episodes were associated with high levels of inflation persistence. The results indicate that the scarifice ratios are larger when inflation persistence is high. This was particularly the case under the inflation-targeting regime. Furthermore, exchange rate depreciations above 10 per cent, food inflation in excess of 6 per cent and unanchored inflation expectations propagate the disinflation shocks on GDP growth.

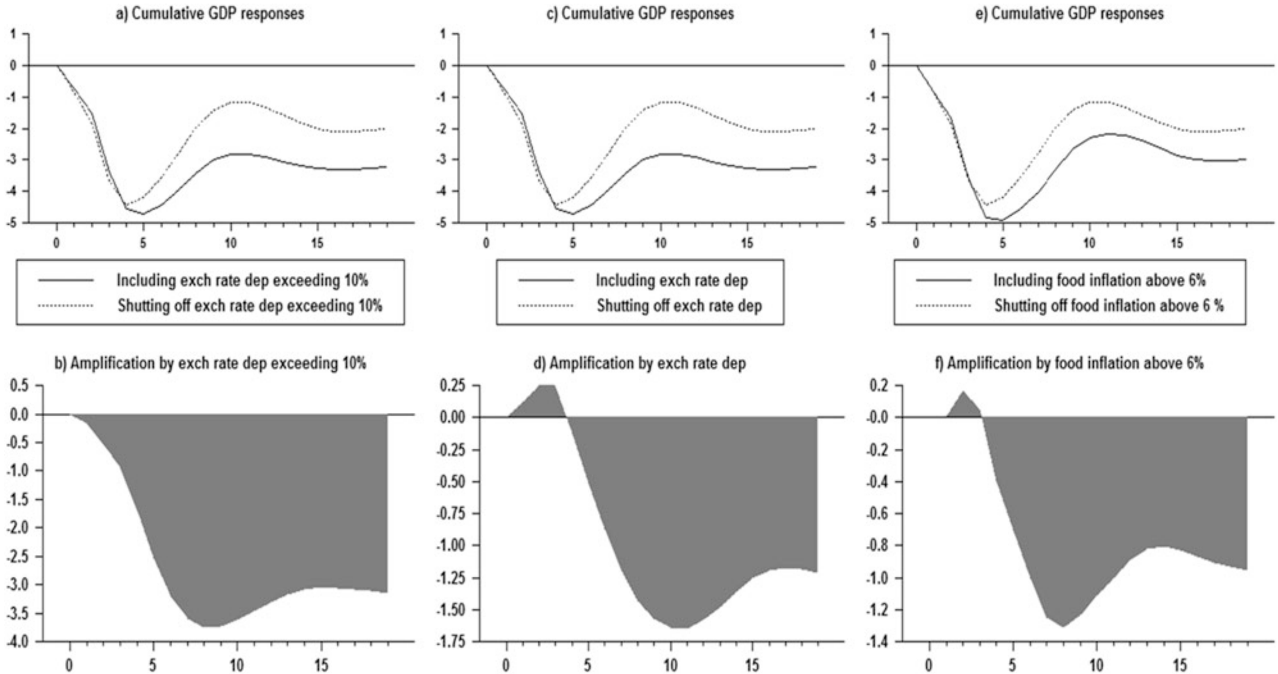

Fig. 2.11 The role of exchange rate change and food inflation in the transmission of disinflation shock to GDP growth. *Source*: Authors' calculations

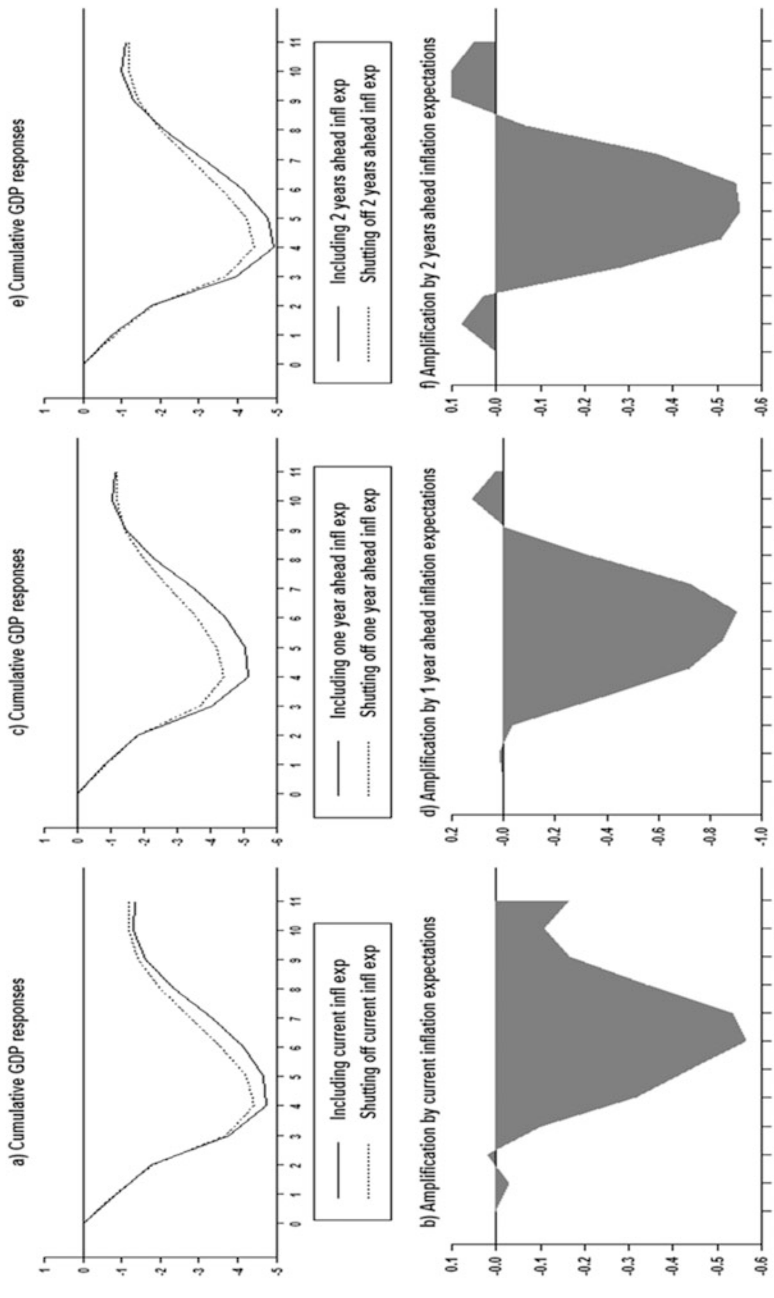

Fig. 2.12 The role of inflation expectations in the transmission of disinflation shock to GDP growth. *Source*: Authors' calculations

The policy implications of these findings are that policymakers should strive to anchor inflation expectations to well within the target range. This means that policymakers remain responsible for the implementation of even firmer commitments to reduce inflation persistence and discourage increased reliance on backward-looking inflation expectations. Such commitment yields lower GDP adjustment and disinflation costs. In addition, with lowered inflation, policymakers have a very compelling case to keep inflation stable within the target range.

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3

The Output and Inflation Trade-off in South Africa

Learning Objectives

- Show how the policy trade-offs as depicted by the Taylor curve have shifted over time
- Determine periods during which macroeconomic performance is superior based on minimal volatilities in both inflation and the output gap
- The extent to which demand and supply shocks impact the volatility of inflation and output gap
- The impact of unanchored inflation expectations on the Taylor curve

3.1 Introduction

The primary objective of the Monetary Policy Committee (MPC) is to ensure that inflation remains within the 3 to 6 per cent inflation band. But in so doing the MPC should be mindful of the implications of its policy actions on growth. The achievement of the primary objective on a sustainable basis implies tough choices regarding the output and inflation trade-off; alternatively the Taylor curve. This is a particularly compelling case when the domestic economy is subjected to a number of severe

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supply side shocks at a time when the output gap is persistently negative. The policy choices open to policymakers are depicted by movements along the efficient policy frontier in Fig. 3.1. The policy frontier may shift either outward or inwards as indicated in Fig. 3.1(a). In addition, the trade-offs can move along the curve as in Fig. 3.1(b).

3.2 What Does the Taylor Curve Capture?

The efficient policy frontier in Fig. 3.1 requires the understanding of the correlation between the output and inflation volatilities or variance as stated in the central bank loss function. This involves a model with a specification of the loss function that represents the social costs of deviations of inflation from the inflation target and growth from its long-run rate or potential output. Taylor (1979) also refers to the Taylor curve as the second-order Phillips curve, in which there is a permanent trade-off between the variance of inflation and the variance of the output gap. The trade-off arises because monetary policy cannot simultaneously offset both types of variability.

The standard Taylor curve begins with a central bank trying to minimise the expected value of the loss function in Eq. (3.1)

$$L = \lambda(\pi_t - \pi^*)^2 + (1 - \lambda)(y_t - y^*)^2 \tag{3.1}$$

where π_t is the inflation rate, π^* is the inflation target and λ is the central bank's weight given the inflation rate, y_t is output and y^* is the target output level. Given the structural equations of the economy and the weight assigned to inflation, through varying λ the efficiency frontier, which is a locus of points indicating the smallest variance of inflation obtainable for any given variance of the output gap, can be plotted. The central bank tries to minimise a loss function and varies the weighted average of the variability in inflation and output. This involves the selection that represents the social costs of deviations of inflation from the target and of deviations of growth from its long-run or potential.

A zero weight on the inflation (output) reduces the central bank's objective to output (inflation) alone. As the weight varies between the inflation and the output gaps, the central bank's objectives also

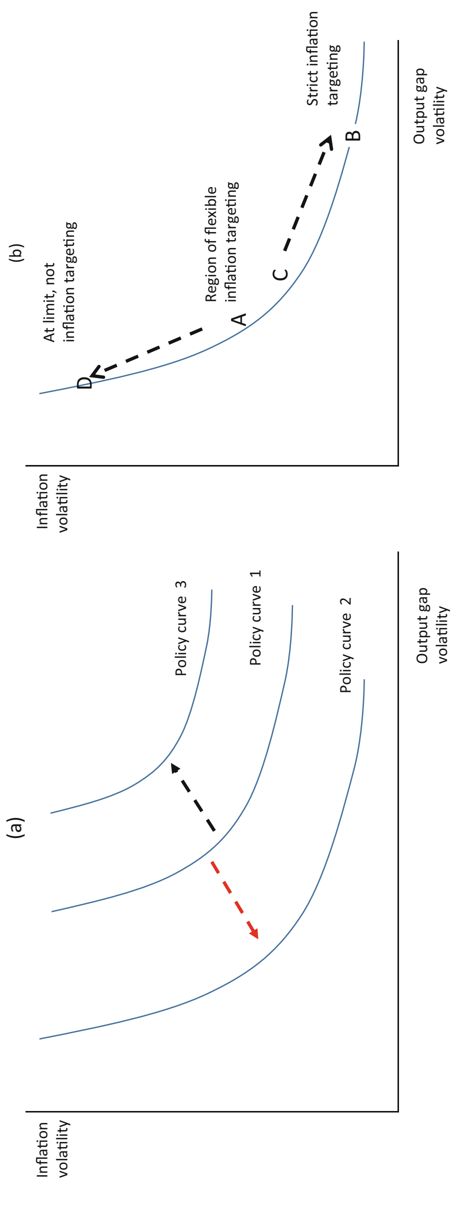

Fig. 3.1 The Taylor curve. *Source*: Authors' drawing

shift. Based on the description in Taylor (2000), the positions on the Taylor curve best describe policy choices available to policymakers as in Fig. 3.1(b) and can be summed up as follows:

1. *Strict inflation targeting* along to point B. For policymakers more concerned about the variability in inflation, the choice to aggressively lower the variability in inflation and deviations from the targeted path means that they will be located in a position such as B on the Taylor curve. This results in an outcome where the variability of output is relatively high whereas that of inflation rate is low.
2. *Output targeting* along point D characterises a choice of less aggressive policy actions in lowering deviations in inflation from the targeted path. Hence the variability in output is low whereas that of inflation rate is relatively high.
3. *Flexible inflation targeting* along points like A and C as they represent a variability combination for which there is likely to be consensus.[1] The variability combinations in the vicinity of these points bring closer the diversity of views about the relative demerits of inflation and output variability represented by the extreme lying points.

Movements from A to C in either direction reflect change in the policy framework approach. Furthermore, theoretically the optimal point on the output-inflation efficiency frontier can only be achieved when a central banker has the independence to set policy without political backlash. Hence, discretionary policymaking translates to the central banker being able to choose the appropriate inflation variability aversion parameter to solve the minimisation problem and make independent policy decisions with a positive influence on a country's stability and growth.

This chapter empirically estimates the relationship between output and inflation volatilities. We investigate whether the Taylor curve has shifted over time and determine the role of demand and supply shocks effects on the conditional volatilities of inflation and the output gap. Do demand

[1] Synonymous to what King (2013) refers to as the value of the constrained discretion built into the inflation targeting regime.

and supply shocks lead to a departures or shift in the Taylor curve?[2] Has the policy efficient frontier shifted over time? If so, which periods were associated with minimum inflation and output volatilities?

We use a multivariate Garch model discussed in Engle and Kroner (1995) and modify the Olson et al. (2012) approach to include the real effective exchange rate (REER). This is because the REER is among the significant drivers of the inflation and output gap volatilities in South Africa. Furthermore, we use the Pakko (2000) and Cover and Hueng (2002) approaches and estimate the correlation between inflation and the output gap as a time-varying process. This is in contrast to studies that use constant correlations.

3.3 The Garch Methodology

The multivariate BEKK Garch model is discussed in Engle and Kroner (1995). We start with the mean equations in Eqs. (3.2) and (3.3)

$$\begin{aligned} y_t = c_{1,0} &+ \sum\nolimits_{i=1}^{n} \alpha_{1,i} y_{t-i} + \sum\nolimits_{i=1}^{n} \beta_{1,i} \pi_{t-i} + \sum\nolimits_{i=1}^{n} \phi_{1,i} r_{t-i} \\ &+ \sum\nolimits_{i=1}^{n} \kappa_{1,i} reer_{t-i} + \sum\nolimits_{i=1}^{n} \gamma_{1,i+t} oil_{t-i} + \varepsilon_{y,t} \end{aligned} \tag{3.2}$$

$$\begin{aligned} \pi_t = c_{2,0} &+ \sum\nolimits_{i=1}^{n} \alpha_{2,i} y_{t-i} + \sum\nolimits_{i=1}^{n} \beta_{2,i} \pi_{t-i} + \sum\nolimits_{i=1}^{n} \kappa_{2,i} reer_{t-i} \\ &+ \sum\nolimits_{i=1}^{n} \gamma_{2,i+t} oil_{t-i} + \varepsilon_{\pi,t} \end{aligned} \tag{3.3}$$

Eq. (3.2), which represents the aggregate demand equation, suggests that aggregate demand y_t is a function of its own lags, lags of the short-term nominal interest rate r_t, lags of the inflation rate π_t and lags of the deviation of the oil price oil_t from trend using the Hodrick-Prescott filter. Eq. (3.3) represents the Phillips curve equation in which inflation is a function of its own lags, lags of the deviation of the oil price from the Hodrick Prescott trend, lags of the deviation of the real effective exchange

[2] Cecchetti and Ehrmann (2002) argue that the economy can be hit by aggregate demand and supply shocks. Aggregate demand shocks move both inflation and output to the same direction. Supply shocks move inflation and output in the opposite direction. Since monetary policy can move output and inflation in same direction, it can be used to offset aggregate demand shocks. Hence in an aggregate supply shock authorities face a trade-off between output and inflation variability.

rate (REER) from the Hodrick Prescott trend and the output gap. $\varepsilon_t = [\varepsilon_{y,t}\varepsilon_{\pi,t}]'$ refers to aggregate demand and supply shocks and $(\varepsilon_t | \Omega_{t-1}) : N(0, H_t)$, where, Ω_{t-1} refers to the information set up to time $t-1$.

To derive the volatilities, we estimate a bivariate VAR with the conditional covariance matrix following the BEKK representation, in which the stochastic behaviour of H_t, is parameterised as in Eq. (3.4)

$$H_t = \gamma\gamma' + A'\varepsilon_{t-1}\varepsilon_{t-1}'A + B'H_{t-1}B \quad \forall t = 1, \ldots, T \tag{3.4}$$

where

$$\gamma = \begin{bmatrix} \gamma_{yy} & 0 \\ \gamma_{\pi y} & \gamma_{\pi\pi} \end{bmatrix}, \quad A = \begin{bmatrix} \alpha_{yy} & \alpha_{y\pi} \\ \alpha_{\pi y} & \alpha_{\pi\pi} \end{bmatrix}, \quad B = \begin{bmatrix} \beta_{yy} & \beta_{y\pi} \\ \beta_{\pi y} & \beta_{\pi\pi} \end{bmatrix}$$

where H_t is a symmetric 2×2 matrix containing the conditional covariance of output gap and inflation. $vech\,(H_t) = (h_{\pi t}, h_{\pi y,t}, h_{yt})'$. γ is a 2×2 lower triangular matrix with three intercepts representing the mean levels of the conditional variances of the output gap (γ_{yy}), inflation ($\gamma_{\pi\pi}$) and covariance level ($\gamma_{y\pi}$). The parameters in A show the extent to which the conditional variances of inflation ($\alpha_{\pi\pi}$) and output (α_{yy}) are correlated with past squared errors (i.e. deviations from their means). However, the off-diagonal shows how the past squared error of one variable affects the conditional variance of another variable. For example, ($\alpha_{y\pi}$) measures the cross effect running from the lagged inflation error to the output variance. In contrast, ($\alpha_{\pi y}$) measures the cross effect from lagged output to inflation variance. The diagonals ($\beta_{\pi\pi}$) and (β_{yy}) in B measure the levels of persistence in the conditional variance. In addition the off-diagonals ($\beta_{y\pi}$) and ($\beta_{\pi y}$) show the extent to which the conditional variance of one variable is correlated with the lagged conditional variances of other variables.

3.4 The Inflation-Output Volatility Trade-offs

Enders (2010) argued that the numerical estimation of a BEKK can be problematic because it has a large number of parameters. However, the rich interaction of the conditional variances in the specification allows for

Table 3.1 Variance equation

	Model 1 (Int)		Model 2 (Intd)	
Intercept matrix				
γ_{yy}	0.345	(0.568)	−0.299	(0.103)
$\gamma_{y\pi}$	0.599	(0.000)*	−0.614	(0.000)*
$\gamma_{\pi\pi}$	0.000	(0.999)	0.000	(0.999)
Volatility transmission				
α_{yy}	0.236	(0.465)	0.217	(0.172)
$\alpha_{y\pi}$	−0.313	(0.025)**	−0.335	(0.000)*
$\alpha_{\pi y}$	0.119	(0.590)	0.098	(0.563)
$\alpha_{\pi\pi}$	0.204	(0.089)***	0.204	(0.088)***
Volatility trade-offs				
$\boldsymbol{\beta_{y\pi}}$	**0.152**	**(0.444)**	**0.157**	**(0.091)*** **
$\boldsymbol{\beta_{\pi y}}$	**−0.809**	**(0.041)** **	**−0.853**	**(0.000)* **
Wald test for cross effects				
Inflation → output				
H0: $\alpha_{y\pi} = \beta_{y\pi} = 0$	2.89	(0.089)***	27.96	(0.000)*
Output → inflation				
H0: $\alpha_{\pi y} = \beta_{y\pi} = 0$	3.82	(0.051)***	15.89	(0.000)**
Volatility persistence				
$\boldsymbol{\beta_{yy}}$	**0.740**	**(0.000)* **	**0.730**	**(0.000)* **
$\boldsymbol{\beta_{\pi\pi}}$	**0.506**	**(0.114)**	**0.457**	**(0.000)* **

Source: South African Reserve Bank and authors' calculations
Note: The *, **, *** refer to significances at 1%, 5% and 10%, respectively

the assessment of the volatility transmission using the off-diagonals and diagonals. The off-diagonals show how the past squared error of one variable affects the conditional variance of another variable, whereas the diagonals measure own variance.

The analysis uses quarterly (Q) data from 1975Q1 to 2012Q3. All the variables used in the estimation have been multiplied by 100 prior to transformation. Inflation is measured by the quarterly difference in the log of the headline consumer price index (CPI), $[\pi_t = \log(CPI_t/CPI_{t-1})]$. The output, oil price and exchange rate gaps are calculated as deviations from actual output, oil price and exchange rate of trend derived from the Hodrick-Prescott filter. The smoothing parameter is 1600.

Table 3.1 reports the results of the variance equation. The estimates of $(\alpha_{y\pi})$ suggest a negative cross effect running from the lagged inflation error to the output variance. In contrast, the estimate for $(\alpha_{\pi y})$ suggests no statistically significant cross effect from lagged output to inflation variance. The BEKK model is estimated with the interest rate in levels (Int) and another with the interest rate in difference Intd form in the mean equations. Columns 2 and 3 in the results presented in Table 3.1 show that there is no difference in the signs excluding those for the intercept matrix and little differences in the magnitudes of the coefficients.

The volatility trade-offs given by the off-diagonals ($\beta_{y\pi}$) and ($\beta_{\pi y}$) show the extent to which the conditional variances of one variable are correlated with lagged conditional variances of other variables. Evidence shows significant effects of lagged output effects on inflation volatility. The diagonals ($\beta_{\pi\pi}$) and (β_{yy}) measure the levels of persistence in the conditional variance. The results indicate that the output gap tends to have high volatility than inflation, suggesting that it is slightly persistent. The model is adequately estimated as it passed all model diagnostics tests. Based on the Wald test statistics, the null hypothesis of no-cross effects is rejected for the transmission running from the output gap to inflation and vice versa.

3.4.1 Does the Inclusion of the Period of Financial Crisis Impact the Results?

The analysis is extended to assess the robustness of the preceding results by subdividing the sample to include (i) the effects of the financial crisis and the recession in 2009, and (ii) the period of global uncertainty dominated by the euro area sovereign debt crisis. The results in Table 3.2 apart from intercept confirm earlier findings indicating robustness to changes in the sample size.

The output and inflation volatilities are shown in Fig. 3.2 and exhibit high transitory positive correlation between the output gap and inflation volatilities. In certain instances, there are large negative correlations based on one-year rolling correlations between the volatilities for the larger part of the inflation targeting regime. The one-year and two-year rolling correlations show evidence of a positive trade-off during the recession in 2009.

Table 3.2 The Garch coefficients

	1975Q1–2007Q3		1975Q1–2010Q3		1975Q1–2012Q3	
Intercept						
γ_{yy}	−0.299	(0.103)	0.154	(0.575)	0.138	(0.575)
$\gamma_{\pi y}$	−0.614	(0.000)*	0.602	(0.000)*	0.594	(0.000)*
$\gamma_{\pi\pi}$	0.000	(0.999)	0.000	(0.999)	0.000	(0.999)
Volatility transmission						
α_{yy}	0.217	(0.172)	0.200	(0.260)	0.166	(0.231)
$\alpha_{y\pi}$	−0.335	(0.000)*	−0.354	(0.000)*	−0.348	(0.000)*
$\alpha_{\pi y}$	0.098	(0.563)	0.013	(0.923)	0.055	(0.711)
$\alpha_{\pi\pi}$	0.204	(0.088)***	0.182	(0.091)***	0.173	(0.173)
Volatility persistence						
β_{yy}	0.730	(0.000)*	0.785	(0.000)*	0.774	(0.000)*
$\beta_{\pi\pi}$	0.457	(0.000)*	0.405	(0.002)*	0.402	(0.001)*
Volatility trade-offs						
$\beta_{y\pi}$	0.157	(0.091)***	0.202	(0.028)**	0.195	(0.035)**
$\beta_{\pi y}$	−0.853	(0.000)*	−0.833	(0.001)*	−0.880	(0.000)*

Source: South African Reserve Bank and authors' calculations
Note: The *, **, *** refer to significances at 1%, 5% and 10%, respectively

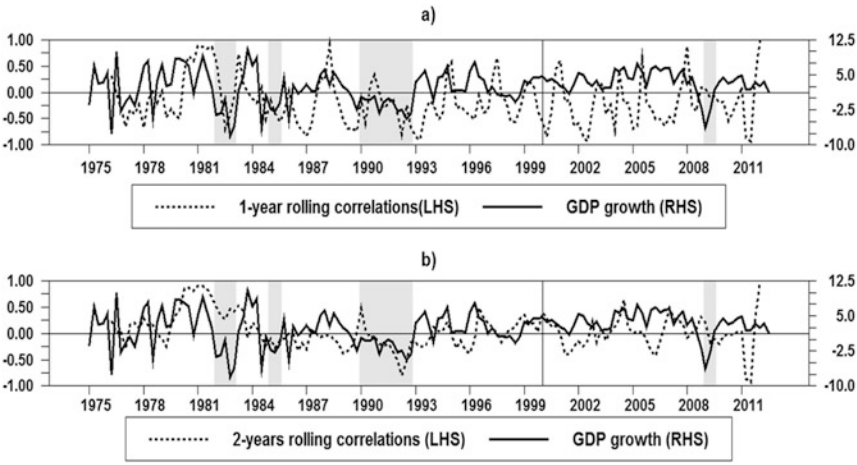

Fig. 3.2 Rolling correlations of inflation and GDP growth volatilities. *Source*: South African Reserve Bank and authors' calculations. *Note*: One and two-year refer to rolling correlation of inflation and output volatilities over these time periods

3.4.2 Evidence of Taylor Curve Shifts

What is the nature of the relationship between the Taylor Curve and macroeconomic performance, or in other words, the nature of the correlations in the volatilities between the output gap and inflation over the business cycle phases? We use one- and two-year rolling correlations to make this assessment. Table 3.3 shows the average volatilities of inflation and the output gap, the volatility trade-off measured by the correlations and average economic growth rates for four different periods. The lowest inflation volatility and output gap volatilities occurred in 2000Q1 to 2007Q2 and the accompanying correlation was more negative than in other periods. This period also achieved the highest average growth rate of 4.2 per cent. The lowest average growth of 1.98 per cent was in 1975Q1 to 1999Q4 periods, which have the highest inflation and output gap volatilities. This suggests that high macroeconomic performance in terms of higher average growth tends to be associated with periods of more negative trade-off in volatilities.

Fig. 3.3 visualises the relationships in Table 3.3 graphically by showing the average conditional volatilities for the output gap and inflation for 1975Q1–1999Q4, 2000Q1–2007Q2 and 2007Q3–2012Q3. The average volatilities for the period 1975 to 1999 show the contrasting performance relative to those observed in the period 2000 to 2007. A vast amount of literature documents that better policy can take some credit for this improvement. For instance, King (2013) suggests that the anchoring of inflation expectations led to a huge reduction in inflation volatility. Carney (2013) argues that while causality remains an area of debate, it is evident that inflation targeting was at least consistent with economic stability.

Table 3.3 Average volatilities, trade-off and economic growth

Periods	Inflation volatility	Output gap volatility	Correlation	GDP growth
1975Q1–1999Q4	0.930	1.431	−0.153	1.985
2000Q1–2007Q2	0.791	1.153	−0.306	4.286
2007Q3–2012Q3	0.832	1.238	−0.079	2.352
1975Q1–2012Q3	0.888	1.348	−0.175	2.493

Source: South African Reserve Bank and authors' calculations
Note: Bold shows the period with lowest volatilities and higher average economic growth

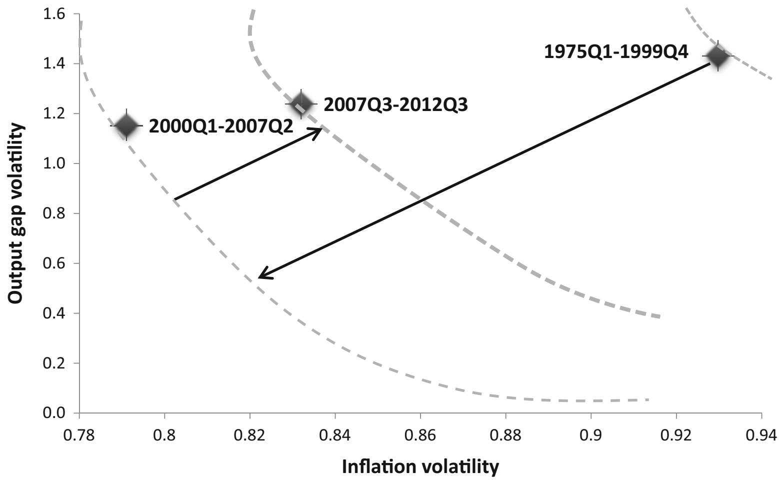

Fig. 3.3 Shifts in South African Taylor curves. *Source*: Authors' calculations and drawing

However, following the financial crisis the variance of the output gap and inflation has been much higher and the Taylor curve has shifted outwards for the period 2007 to 2012 shown in Fig. 3.3.

There are a number of factors that could have caused this outward shift, including the change in (i) the structure of the economy, and (ii) a series of large unanticipated shocks that have hit the economy, of which the global financial crisis has been relatively persistent. The results indicate that these shocks have heightened macro-economic instability and have contributed to the volatilities of output and inflation moving in the same direction.

3.5 The Role of Inflation Expectations on the Policy Trade-offs

We use Eq. (3.5) to examine the impact of positive (increase) inflation expectations shock on the Taylor curve.[3] In particular, we are interested on the effects when current inflation expectations exceed (below) 6 per

[3] The equation is based on the modified Pentecôte and Rondeau (2015) and Cerra and Saxena (2008) approaches.

cent. Such an analysis enables the distinction between the role of well-anchored and unanchored inflation expectations.

$$Taylor\, curve_t = constant + \sum_{i=1}^{4} \beta_i Taylor\, curve_{t-i} + \sum_{i=1}^{4} q_i Inflation\, expectations_{t-i} + \varepsilon_t \qquad (3.5)$$

where, ε_t is the error shock and *Inflation expectations* is the inflation expectations variable over different horizons (i) current, (ii) one year ahead, and (iii) two years ahead. The inflation expectations dummy in Eq. (3.5) is replaced with two dummies in different estimations. The first dummy is equal to one when current inflation expectations exceed 6 per cent and zero otherwise. The second dummy is equal to one when current inflation expectations are below 6 per cent and zero otherwise. The third dummy equals to one when current inflation is below 4.5 per cent and zero otherwise Fig. 3.4 shows that a positive inflation expectations shock shifts the Taylor curve outwards when inflation expectations exceed 6 per cent but there are no effects when inflation expectations are below six. This suggests that elevated inflation expectations induce a shift in the Taylor, in contrast well-anchored current inflation expectations have no effect on the Taylor curve compared to unanchored inflation expectations. Well anchored inflation expectations lead to the inward shift in the Taylor Curve suggesting that it minimizes inflation and output-gap volatilities.

3.5.1 Asymmetry in Inflation Expectations Shock on the Policy Trade-off

The analysis of the impact of inflation expectations is extended to show the asymmetric effects of negative inflation expectations shocks based on the size of negative shocks. The estimations of the asymmetric effects are conducted within the Killian and Vigfusson (2011) asymmetric bivariate VAR approach. The model uses the Taylor curve series and deviations of inflation expectations from 6 per cent. The model is estimated with two lags and 10, 000 Monte Carlo draws Fig. 3.5 indicates that the Taylor

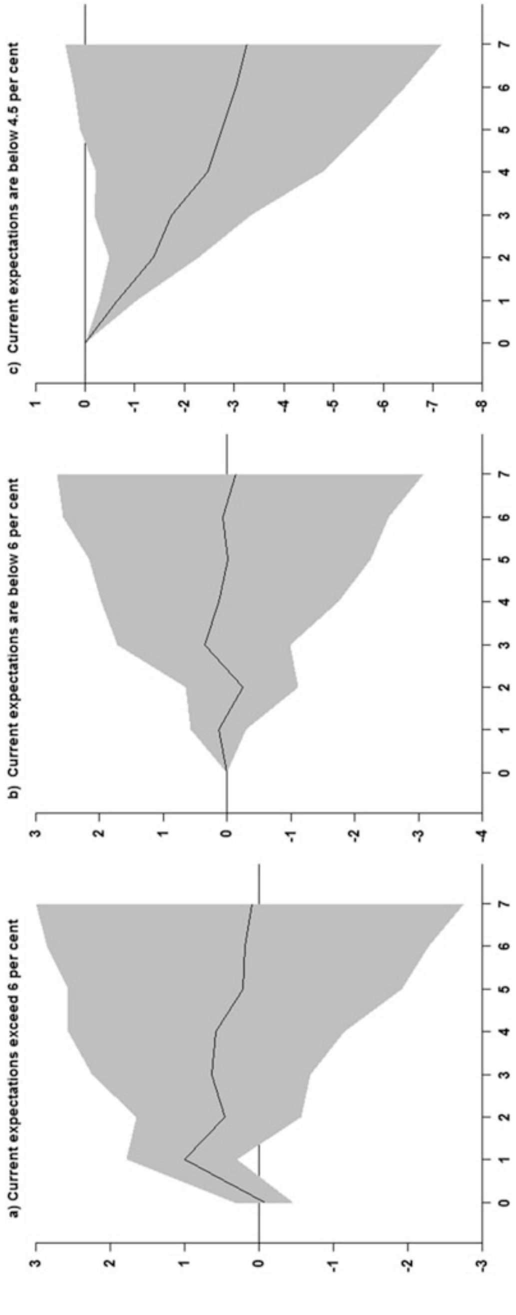

Fig. 3.4 Taylor curve responses to positive inflation expectations shock. *Source*: Authors' calculations

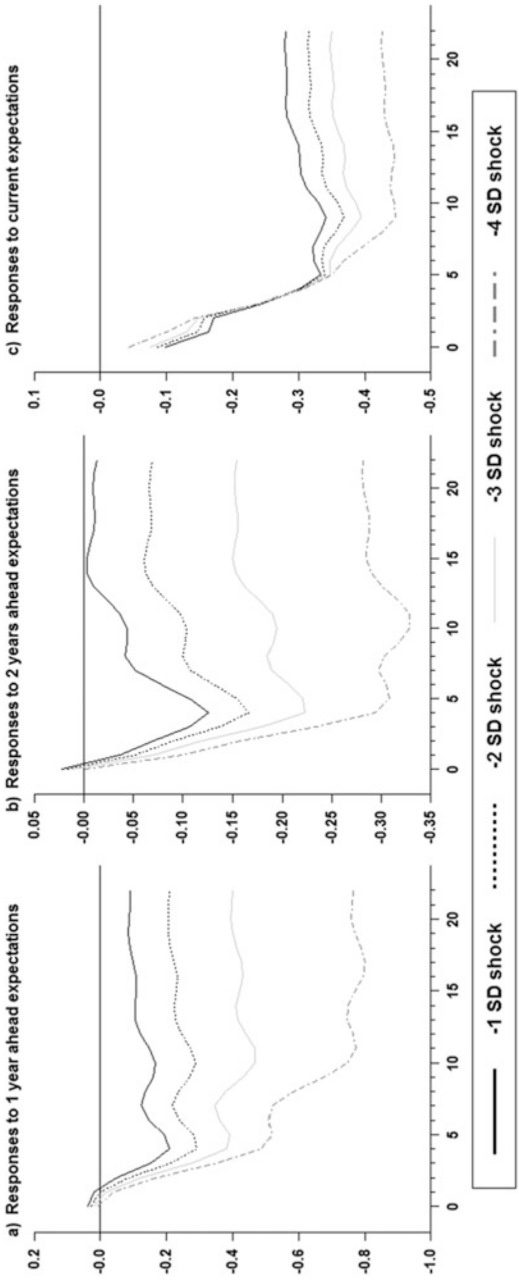

Fig. 3.5 Taylor curve responses to negative inflation expectations shocks. *Source*: Authors' calculations

curve shifts in response to a negative shock to inflation expectations and the shifts differ depending on the size of the negative shocks. This means welfare costs are minimized by anchoring inflation expectations.

3.5.2 Do Demand and Supply Shocks Move the Inflation and Output Volatilities?

To what extent do the demand and supply shocks impact the inflation and output volatilities? This section determines how structural shocks $\varepsilon_{y,t}$ (demand shocks) and $\varepsilon_{\pi,t}$ (supply shocks) derived from the mean equations affect the output gap and inflation conditional variances. Fig. 3.6 shows that the demand and supply shocks' own effects are highly transitory as the impulse responses of output and inflation volatilities are short-lived.

3.5.3 Persistent and Non-Persistent Demand and Supply Shock Effects

The preceding results are based on a one-off shock; hence, the analysis in this section focuses on the scenarios of persistent and non-persistent demand and supply shocks. Evidence in Fig. 3.7 shows that non-persistent demand and supply shocks result in transitory increases in inflation and output volatility compared to persistent shock.

3.6 Conclusion and Policy Implications

This chapter empirically investigated the relationship between output and inflation volatilities. To capture the time varying Taylor curve relationship we used rolling correlations. The results show that the Taylor curve has shifted over the sample period. The Taylor curve shifted inward under the inflation targeting regime and the macroeconomic performance was superior during this period as the inflation and output volatilities were small. Evidence shows that peaks of a positive trade-off in the inflation and

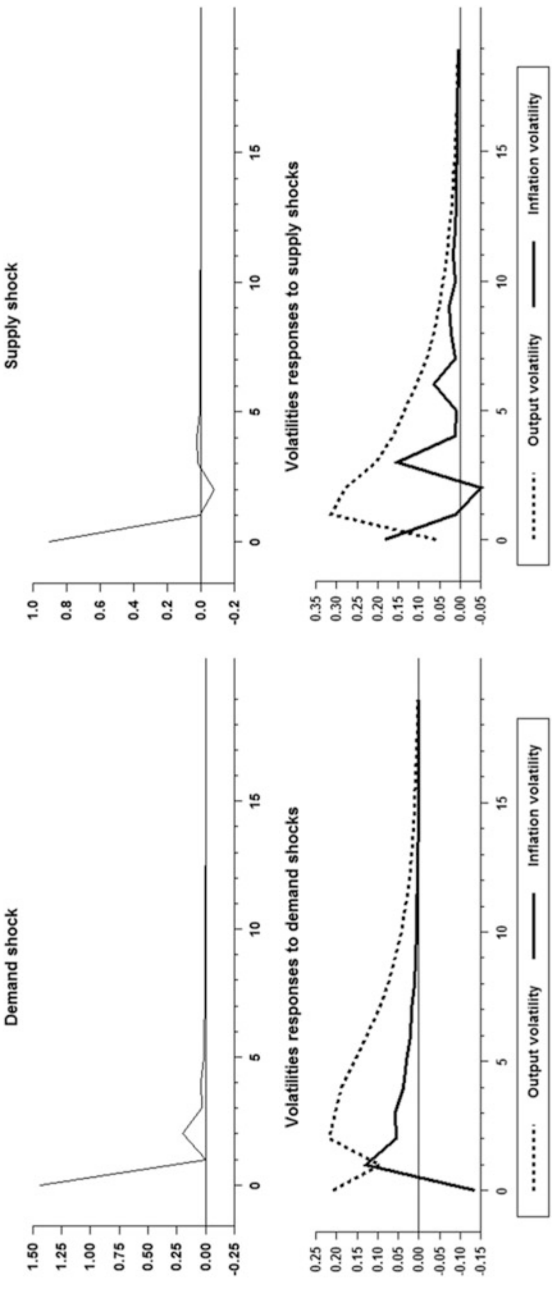

Fig. 3.6 Impact of positive demand and supply shocks on inflation and output conditional volatilities. *Source*: Authors' calculations

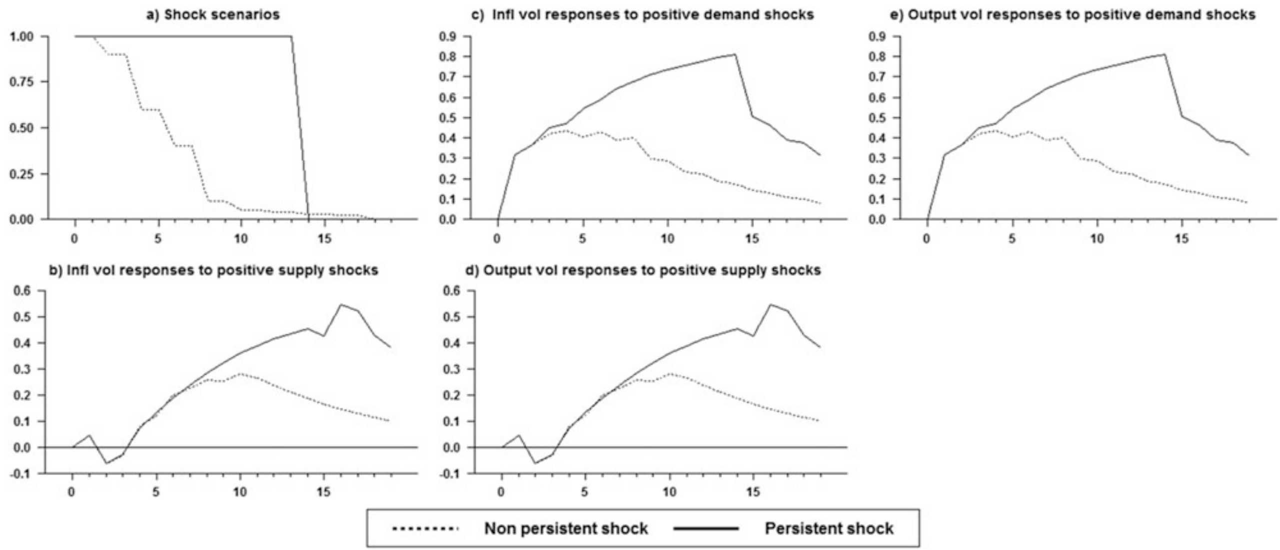

Fig. 3.7 Inflation and output volatility responses to persistent and non-persistent demand and supply shocks. *Source*: Authors' calculations

output gap volatilities preceded slowdowns in economic performance. The effects of demand and supply shocks on the volatilities of inflation and the output gap are not persistent.

The shift to the inflation targeting policy framework minimised the inflation volatility and managed to achieve price stability. The conduct of policy under this framework managed to minimise anticipated and unanticipated deviations in inflation. However, the outward shifts in the Taylor curve since the onset of the financial crisis suggests that policymakers should aim at reducing the inflation and output-gap volatility. This may minimise the volatilities and result in the inward shift of the Taylor curve. Furthermore, positive trade-off tends to be followed by a slowdown in economic growth, meaning that when inflation and output volatilities move in the same direction economic growth tends to slow down. The implication is that periods of positive trade-offs indicate suboptimal monetary policy settings and these may adversely impact economic growth performance.

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4

Persistent Exchange Rate Volatility on the Taylor Curve

Learning Objectives

- The impact of various events on the inflation and R/US$ exchange rate volatilities
- The impact of permanent and transitory R/US$ exchange rate on the Taylor curve

4.1 Introduction

Shocks to exchange rates are one element of aggregate supply shocks. An inherent characteristic of aggregate supply shocks is the ability to move inflation and output in different directions. Cecchetti and Ehrmann (1999) postulated that aggregate supply shocks pose a dilemma for policymakers because they force a policy choice. Is this the case in South Africa? To what extent does the exchange rate volatility impact the Taylor curve? Does it matter whether the exchange rate volatility is permanent or transitory or not? What does the covariance relationship between inflation volatility and the exchange rate volatility tell policymakers? This chapter shows the extent to which certain one-off

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shocks impact inflation and exchange rate volatilities and their covariance. Thereafter, we show the effects of exchange rate volatility on the Taylor curve. The analysis distinguishes between the impact of non-persistent, persistent and persistently rising exchange rate shocks on the Taylor curve.

4.2 The Role of the Exchange Rate in the Taylor Curve

The question of whether to explicitly include the exchange rate and exchange rate volatility in the loss function remains open (Agenor 2001). Literature shows that under full exchange rate flexibility, policy choices facing policymakers are not independent of exchange rate dynamics. The full exchange rate flexibility approach requires policymakers to answer whether the exchange rate is either an instrument towards achieving price and output gap objectives or an objective of policy itself? Without advocating for any policy stance Edwards (2006a,b) shows that when exchange rate changes reflect misalignments that affect the inflation and output volatilities, optimal policy settings should consider how exchange rate developments impinge on these two components of the loss function rather than include the exchange rate directly in the loss function.

In addition, Gersl and Holub (2006) argue that policy makers have a number of tools they can use to deal with the exchange rate and its volatility effects on inflation and the output gap. For example, interest rates, foreign exchange reserves and macroprudential can be used to prevent heightened exchange rate volatility and its effects on inflation and inflation expectations. Exchange rate management through accumulating foreign currency reserves plays an important role in the inflation targeting framework. For small open economies increased foreign reserves accumulations can complement interest rates and reduce the harmful effects of large aggregate supply-side shocks. Furthermore, because interest rate changes lead to exchange rate changes, in the absence of other shocks, this interdependence can also reduce exchange rate volatility. This minimises the loss function and shifts the Taylor curve inwards.

4.3 Conditional Inflation and Exchange Rate Volatilities

A BEKK model is estimated to obtain estimates of the conditional variances and the Garch interactions between the exchange rate and inflation volatilities. Fig. 4.1 shows the conditional variances from the BEKK specifications. The estimates are based on the monthly rand per US dollar exchange rate and inflation from 1990M1 to 2015M11. The exchange rate volatilities peak noticeably around 1998/1999, 2001/2002 and 2008/2009 as the rand exchange rate depreciates by large magnitudes. The inflation volatilities also peak around the same dates. Furthermore, the covariance shows that during these episodes, the exchange rate volatility and inflation volatilities peaks tend to coincide.

4.3.1 How Did the Various Shocks Impact the Inflation and Exchange Rate Conditional Volatilities?

We use the Hafner and Herwartz (2006) approach to examine the impact of a specific shock at the time of occurrence. The approach does not use dummy variables but rather uses the value of the volatility on the specific date on which it occurs. The approach enables us to show how a number of shocks impacted the conditional volatilities and their covariance relationship. We assess the impact of the exchange rate shock episodes for 1998/1999, 2001/2002 and selected dates during the implementation of US QE1 (December 2008 to March 2010), QE2 (November 2010 to June 2011) and QE3 (September 2012 to December 2013).

The announcements, implementation, halting of various rounds of QE and the tapering of asset purchases had implications for capital flows in emerging markets economies. On a comparative basis, are there lessons that can be learned from the covariance of the inflation and exchange rate volatilities during the taper tantrum in 2013 and the 1998/1999 Asian crisis? Fig. 4.2 shows that despite the two shocks exerting nearly similar effects in the same direction, the taper tantrum had a bigger impact on the exchange rate and inflation volatilities.

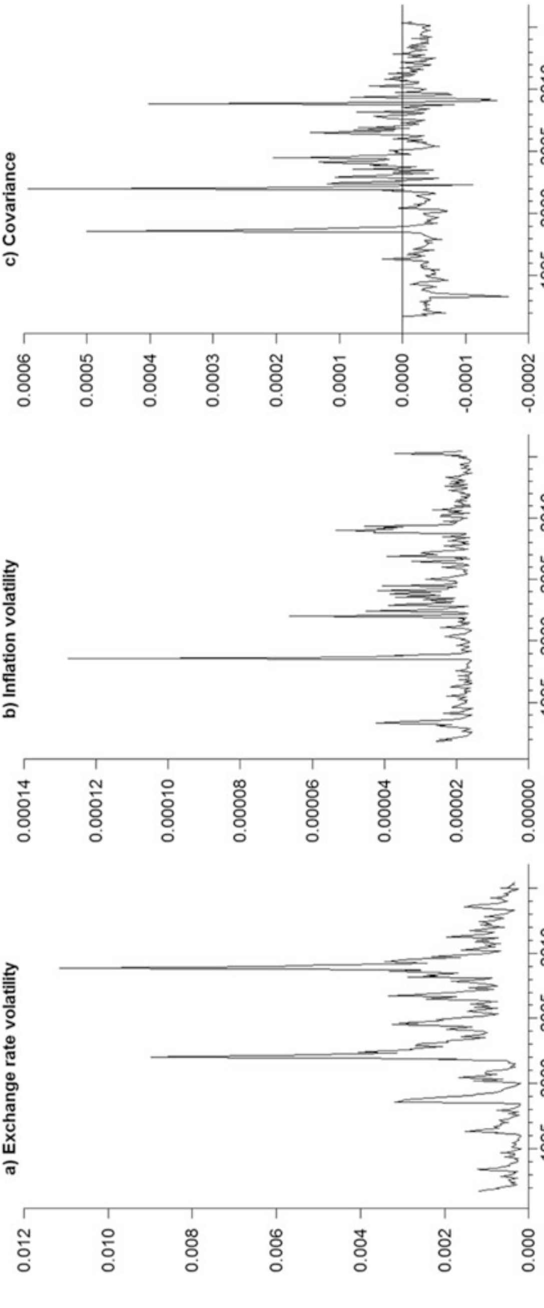

Fig. 4.1 Inflation and exchange rate volatilities. *Source*: Authors' calculations

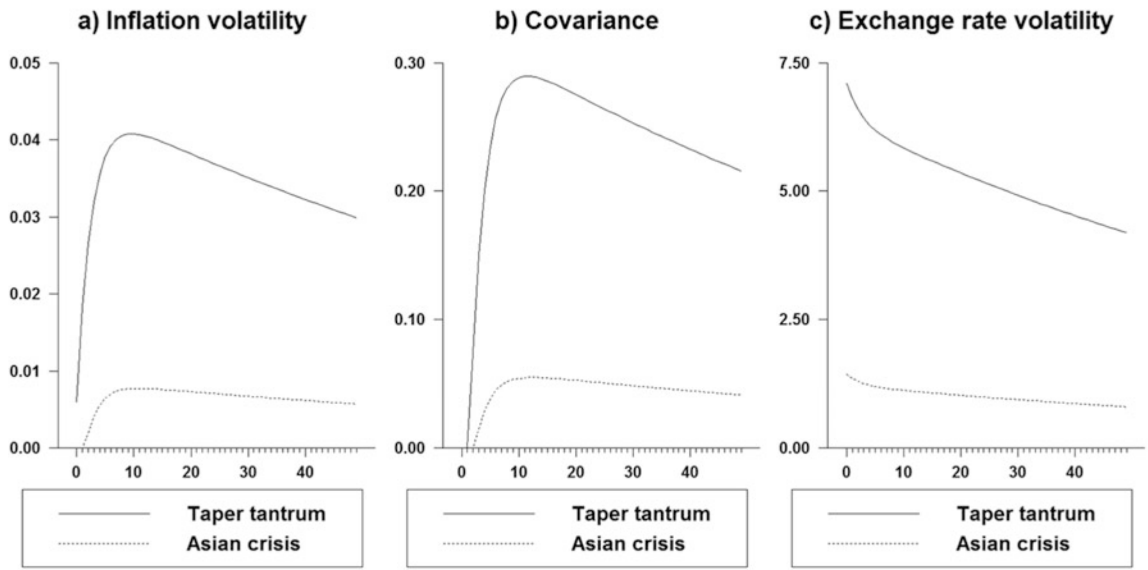

Fig. 4.2 Inflation and R/US$ exchange rate responses to taper tantrum and Asian crisis shocks. *Source*: Authors' calculations

What about the 2001/02 rand depreciation versus taper tantrum? Fig. 4.3 shows that the volatility impulse responses are higher during the rand depreciation shock in 2001 than during the taper tantrum in 2013. In addition, although these two episodes moved the covariance between inflation and the exchange rate volatilities in the same direction, the effects are elevated due to the rand depreciation in 2001.

This suggests that the R/US$ exchange rate depreciation driven by domestic events has a larger impact in driving the covariance between inflation and the exchange rate volatilities in the same direction. This episode was characterised by drought conditions coinciding with the prevalence of parity pricing in the grains pricing.

4.3.2 Do the Various Rounds of US QE Matter?

Fig. 4.4 shows that the various rounds of US QE had a varying impact on the R/US$ exchange rate and inflation. Furthermore, various rounds of QE display diminishing returns of additional monetary policy stimulus using the same tool as reported in other empirical studies. These findings support and concretise concerns about the impact of additional QE and negative interest rates policies on global interest rates and exchange rates.

Are there differential responses between halting of QE1 and the beginning of QE3? Fig. 4.5 shows that the implementation of QE1 had different effects to QE3. The QE1 shock induced more volatility in inflation and the exchange rate and their covariance than the beginning of QE3.

4.4 The Taylor Curve Effect of the Exchange Rate Volatility

To derive policy implications this section uses the approach in Ndou et al. (2013) to get the Taylor curve. What do positive exchange rate volatility shocks do to the correlation between inflation and output volatilities? Fig. 4.6 shows that the exchange rate volatility is positively related to the

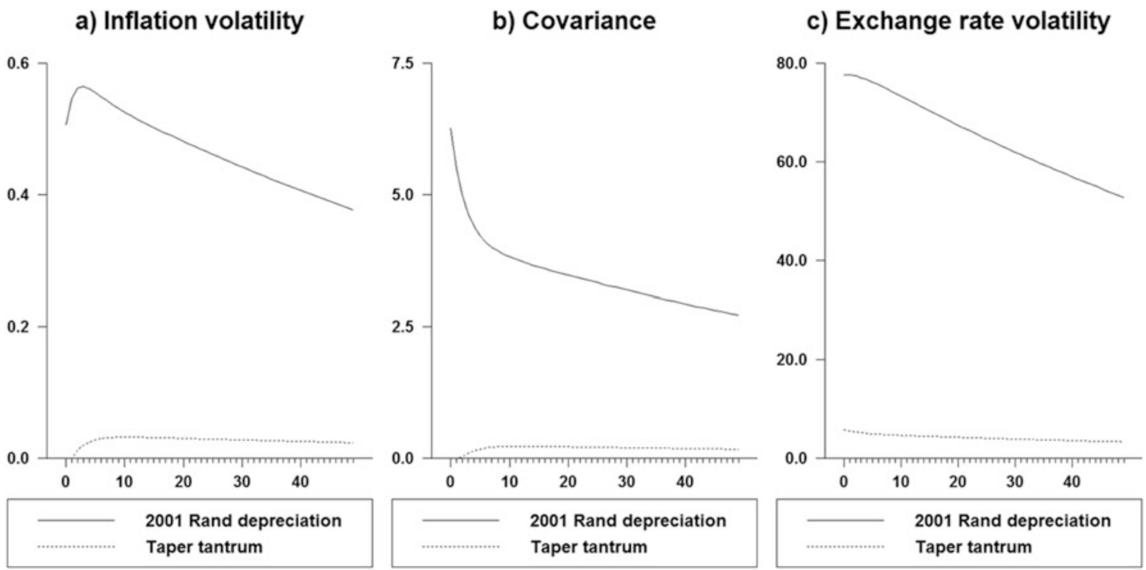

Fig. 4.3 Inflation and R/US$ exchange rate responses to the 2001 and taper tantrum shocks. *Source*: Authors' calculations

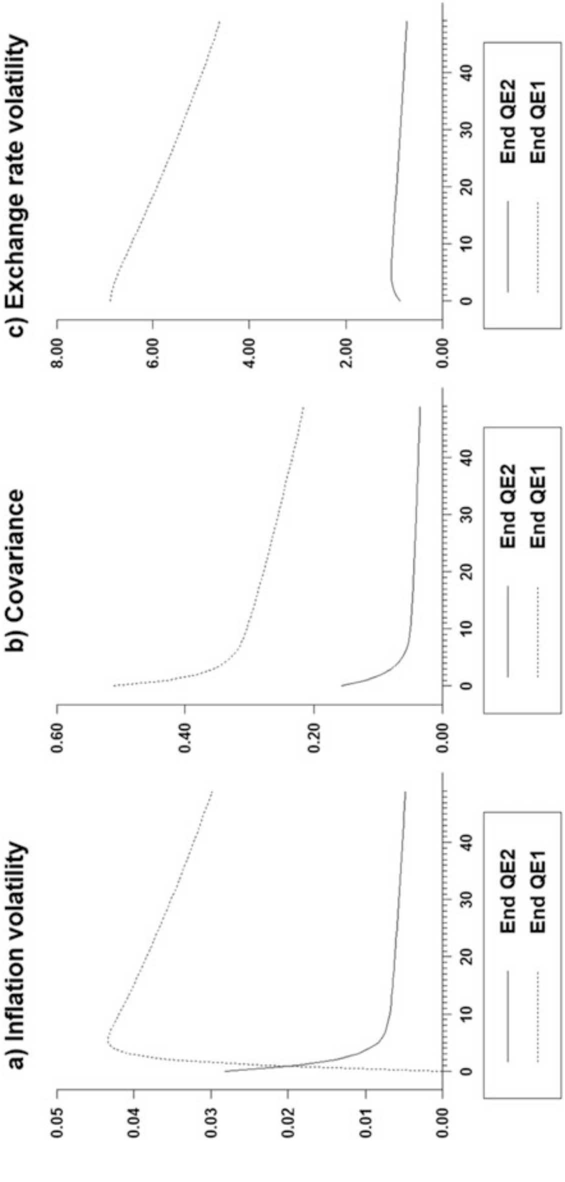

Fig. 4.4 Inflation and R/US$ exchange rate responses to halting QE1 and QE2 shocks. *Source*: Authors' calculations

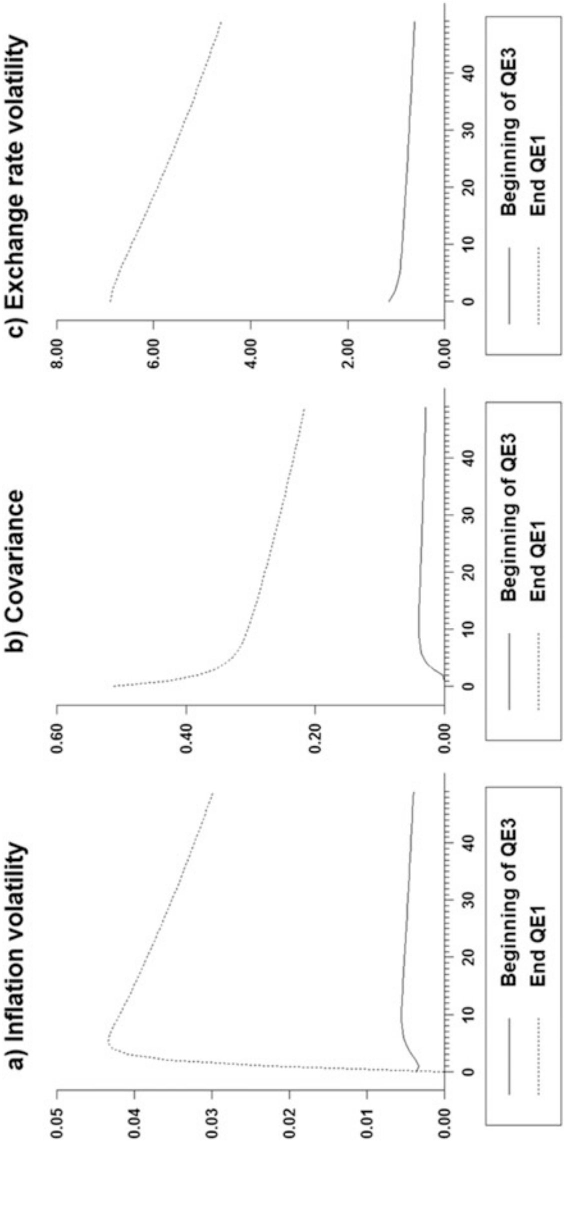

Fig. 4.5 Inflation and R/US$ exchange rate responses to QE1 and QE3 shocks. *Source*: Authors' calculations

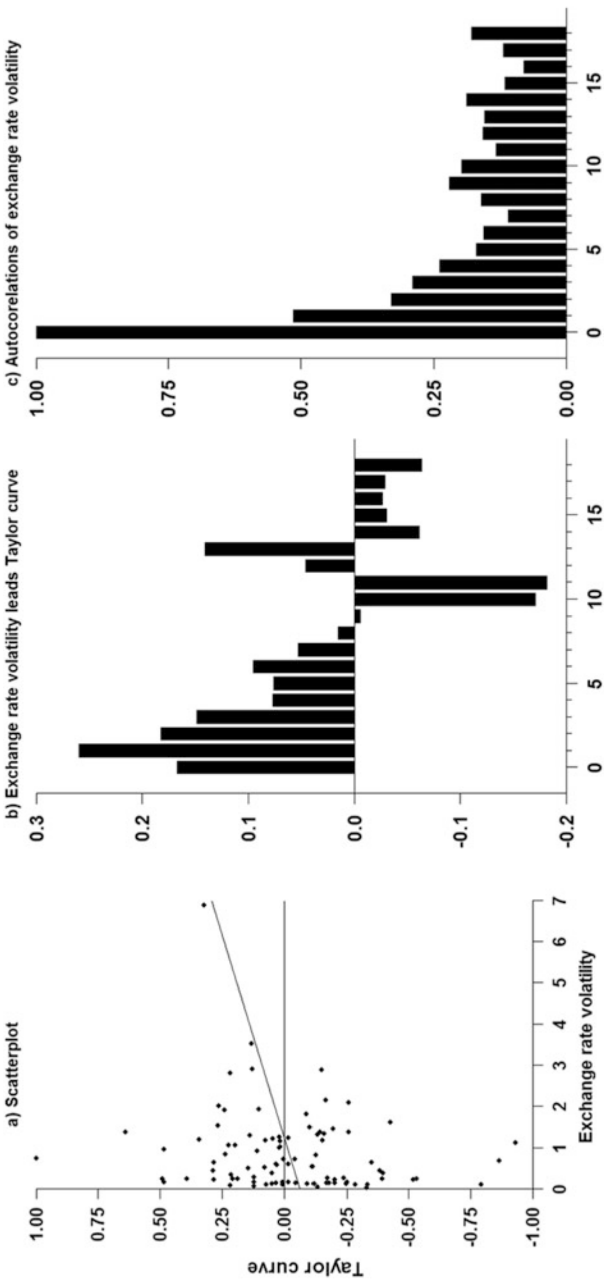

Fig. 4.6 The exchange rate volatility and the Taylor curve. *Source*: Authors' calculations

Taylor curve. This suggests that elevated exchange rate volatility raises trade-off between inflation and output volatilities.

Fig. 4.6(b) shows a positive relationship between the Taylor curve and the exchange rate volatility meaning that the Taylor curve tends to shift upwards (increase) for nearly seven quarters when preceded by elevated exchange rate volatility. The persistence of exchange rate volatility shock shown by the autocorrelation plots suggests that the exchange rate volatility declines significantly in the first two quarters and persists thereafter. This suggests that after a shock moves the exchange rate in either direction, it does partially correct from the shock but stabilises at a different level. Therefore, this may mean that shocks to the exchange rate also induce persistent level shifts.

4.4.1 The Impact of Persistent and Non-persistent Exchange Rate Shocks on the Taylor Curve

This section estimates a bivariate VAR model with the exchange rate volatility and the two-year moving correlation between inflation and output volatilities. The choice of two-year rolling correlations is compatible with the lag length of the monetary policy transmission mechanism. In addition, evidence based on the lead relationship shows that the Taylor curve tends to increase for nearly seven quarters when preceded by elevated exchange rate volatility. The VAR model is estimated with four lags and 10,000 Monte Carlo draws.

Fig. 4.7(a) and (b) shows that the exchange rate volatility rises due to own positive shocks for nearly 10 quarters and returns to pre-shock levels. The half-life of the response to the shock occurs within the first quarter.

In Fig. 4.8(b) the trade-off between inflation and output volatilities rises significantly for four quarters. The exchange rate volatility explains around 9 per cent of the fluctuations in the trade-off between inflation and output volatilities in the first three quarters. Furthermore, a persistently rising exchange rate volatility shock leads to pronounced positive correlation between inflation and output gap volatilities, as shown in Fig. 4.8.

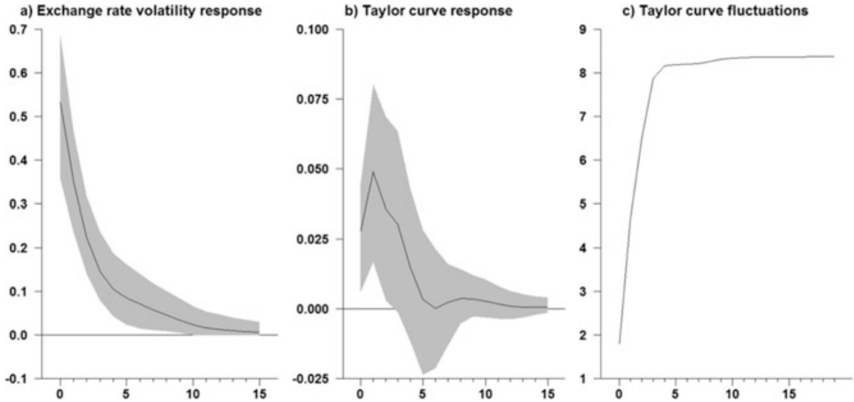

Fig. 4.7 Half-life responses to exchange rate volatility shocks. *Source*: Authors' calculations

In contrast, a non-persistent shock leads to positive and transitory correlations. This evidence indicates that the persistence of the exchange rate volatilities matter more. Robustness analysis via the permanent and transitory exchange rate volatilities shocks indicates that permanent exchange rate volatility shock increases the Taylor curve significantly compared to the transitory exchange rate volatility shocks.[1] Furthermore, Fig. 4.9 shows that inflation (Infl_vol) and output volatility (Y_vol) increases significantly in response to all components of the exchange rate volatility shock. This means that the Taylor curve shifts outwards, and shifts in the Taylor curve are mostly driven by inflation volatility on impact after the shock and spill over to output volatility.

[1] We the Garch (1,1) model for the daily exchange rates from January 1990 to November 2015 and convert these volatilities into monthly averages. The model decomposes overall volatility into permanent and transitory volatilities.

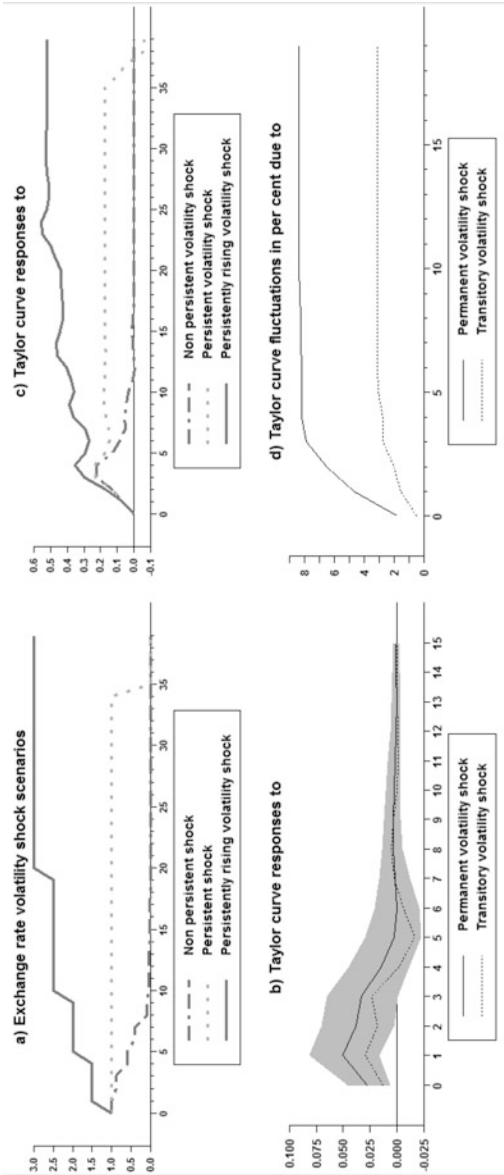

Fig. 4.8 Exchange rate volatility shock scenarios and the Taylor curve. *Source*: Authors' calculations

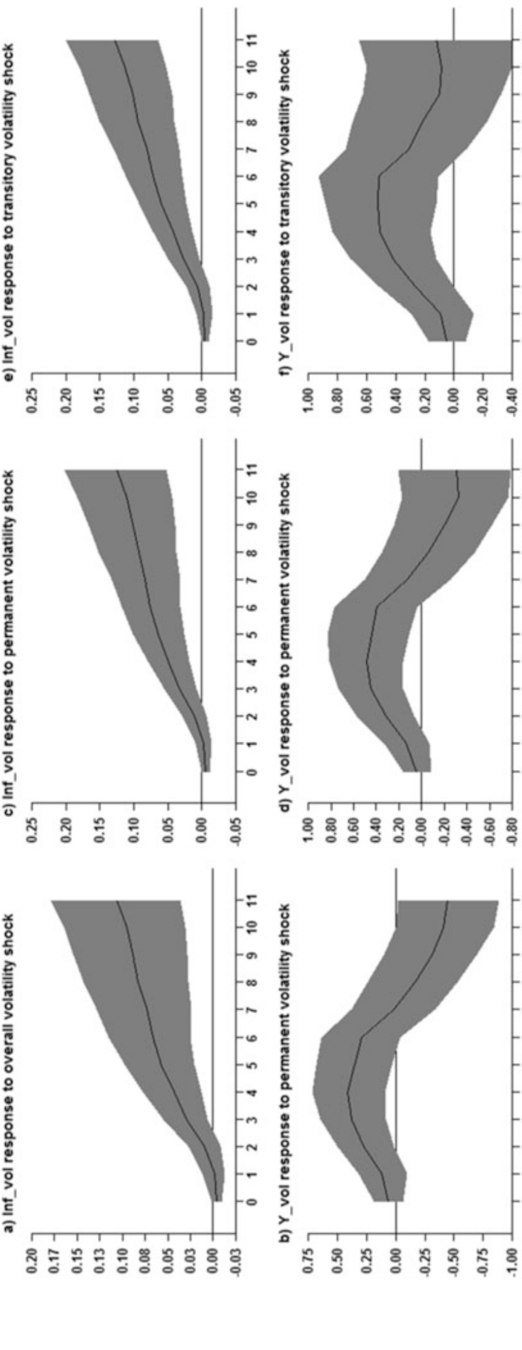

Fig. 4.9 Cumulative responses to various exchange rate volatility shocks. *Source*: Authors' calculations.
Note: Infl_vol implies inflation volatility. Y_vol implies output gap volatility.

4.5 Conclusion and Policy Implications

How does the correlation between inflation and output volatilities react to the exchange rate volatility shock in South Africa? This chapter used known events to derive policy lessons from economic shocks, such as the 1997/98 and 2001 rand depreciation, and various phases of US QE on inflation and exchange rate volatility and their covariance relationship. Evidence shows that shocks in 1997/1998, 2001 and various rounds of QE phases result in an increase in the volatilities and covariance of inflation and the exchange rate. Domestic factors tend to propagate and accentuate the exchange rate effects. Various rounds of US QE had varying impact on the rand exchange and inflation.

Furthermore, a persistently rising exchange rate volatility shock leads to pronounced positive correlation between inflation and output gap volatilities. Inflation and output gap volatilities increase due to a higher level of exchange rate volatility, implying that the Taylor curve shifts outwards. This holds for overall, permanent and transitory exchange rate volatility shocks. The implication is that policy authorities should implement a policy stance that will shift the policy frontier curve to one consistent with lower inflation and output gap volatilities.

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5

Inflation Volatility and Non-Linear Effects of Inflation Shocks

Learning Objectives

- Demonstrate the non-linear effects of positive inflation shocks on inflation volatility
- Show the link between an unexpected positive inflation volatility and output growth

5.1 Introduction

The Brainard (1967) thesis asserts that various forms of macroeconomic uncertainty are not neutral in monetary policy making. If this hypothesis is binding, it is possible that it leads to cautious and gradual policy adjustments. The concurrence of large volatile changes in the exchange rate and commodity prices during 2015/2016 brought the issue of imperfect information about the true state of the economy back to the centre of policy making. In view of the importance of the exchange rate and commodity price changes on the South African economy, this chapter explores whether inflation volatility shocks exert significant macroeconomic effects. Furthermore, does inflation volatility react in a non-linear manner to inflation shocks?

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Inflation regime shifts as articulated by Friedman (1977) are important sources of inflation uncertainty. Evans and Watchel (1993) show that this is because economic agents take time to learn about the new inflation regime and adjust their expectations based on the recurrence of previous regimes. It is for this reason that this chapter explores the importance of inflation and inflation volatility regimes. We explore the relationships by distinguishing the effects of following hypotheses:

Hypothesis 1: Positive inflation shocks exert non-linear effects on inflation volatility in low and high inflation regimes.

Hypothesis 2: Large unexpected inflation shocks exert different effects on inflation volatility relative to small inflation shocks in the low and high inflation regimes.

Hypothesis 3: Unexpected positive (increase) and negative (decline) inflation shocks impact inflation volatility differently in low and high inflation regimes.

Hypothesis 4: Unexpected positive (increase) and negative (decline) inflation volatility shocks impact output growth differently in low and high inflation volatility regimes.

Hypothesis 5: Unexpected positive inflation volatility shock lower output growth volatility.

5.2 How Has Monthly Inflation Volatility Evolved?

Inflation volatility is measured by the conditional variance, which captures both anticipated and unanticipated volatility effects. The monthly (M) data is from January 1990 to June 2015.[1] The conditional inflation volatility is

[1] The data are log differenced and multiplied by 100 to express them in per cent. The model satisfies all the stability conditions and model diagnostics.

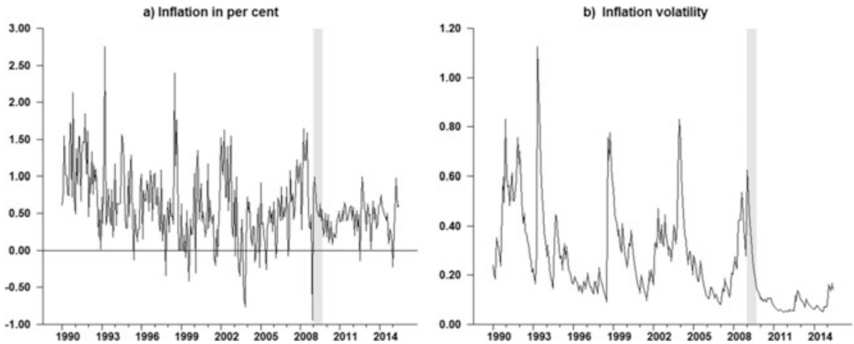

Fig. 5.1 Inflation and inflation volatility. *Source*: Authors' calculations

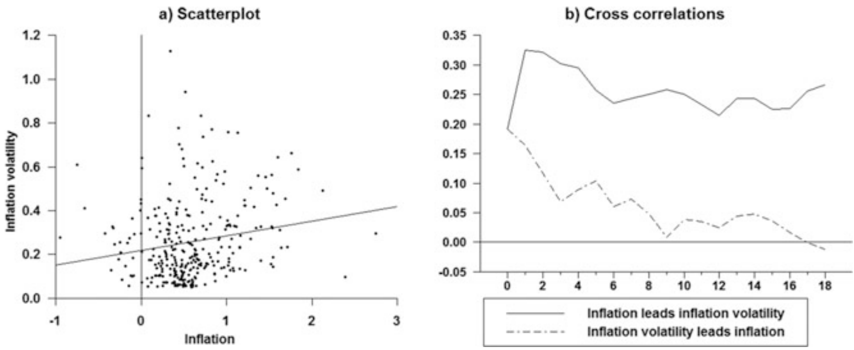

Fig. 5.2 Relationship between inflation and inflation volatility. *Source*: Authors' calculations

extracted from the estimated Garch(1,1)-in-mean model[2]. The mean inflation equation contains lagged inflation, inflation volatility and a constant. Fig. 5.1 shows that inflation volatility has systematically declined since 1990 and significantly so since 2010. The peaks in inflation volatility are the lowest on average since 2010 and inflation volatility has been subdued. It is also noticeable that inflation volatility has risen in 2015 and is currently above the previous peak of 0.36 per cent in August 2012.

[2] Garch means Generalised autoregressive conditional heteroscedasticity model.

Furthermore, Fig. 5.2(a) shows a positive relationship between inflation and inflation volatility indicating that increases in inflation lead to heightened inflation volatility. The cross-correlations establish a strong positive relationship between inflation and inflation volatility, particularly when inflation leads inflation volatility.

5.3 Do Inflation Regimes Matter for the Impact of Inflation Shocks on Inflation Volatility?

This section analyses the non-linear effects of inflation shocks on inflation volatility by applying the modified Balke (2000) threshold VAR approach to determine a threshold in the monthly inflation rate. A bivariate threshold VAR model is estimated with three lags as selected by Akaike Information Criterion (AIC). The bivariate model consists of inflation volatility and inflation. The model estimates that the threshold occurs at 0.60877 per cent as shown in Fig. 5.3. A distinct trend emerges from 2008 onwards and becomes persistent after the recession in 2009. Monthly inflation rates are not only bounded by the threshold and the zero line, they are persistently around an average of 0.43 per cent, although there are few brief breaches.

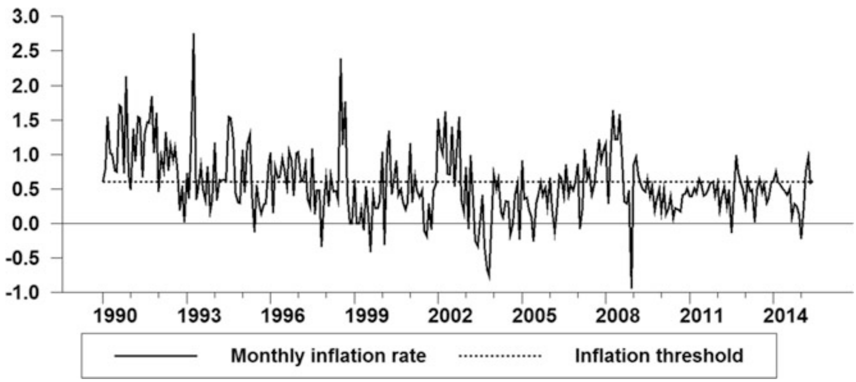

Fig. 5.3 Monthly inflation rates and the threshold. *Source*: Authors' calculations

The monthly inflation threshold enables the classification of monthly inflation rates into a high and low regime. The high (low) regime occurs when the inflation rate exceeds (is below) the threshold. This enables the estimation of the regime dependent impulse responses to positive inflation shocks and inflation volatility as articulated in Hypothesis 1.

- Hypothesis 1: Positive inflation shocks exert nonlinear effects on inflation volatility in low and high inflation regimes.

The regime dependent impulse responses of inflation volatility to positive inflation shocks in Fig. 5.4(a) and (b) indicate that inflation volatility rises in response to an unexpected positive inflation shock in both regimes. However, the inflation volatility increases more in the high inflation regime relative to the low inflation regime. The increases are statistically significant and robust to the ordering of the variables.

What explains this phenomenon? Evans (1991) suggests that the frequency of individual price changes rises as the economy moves towards

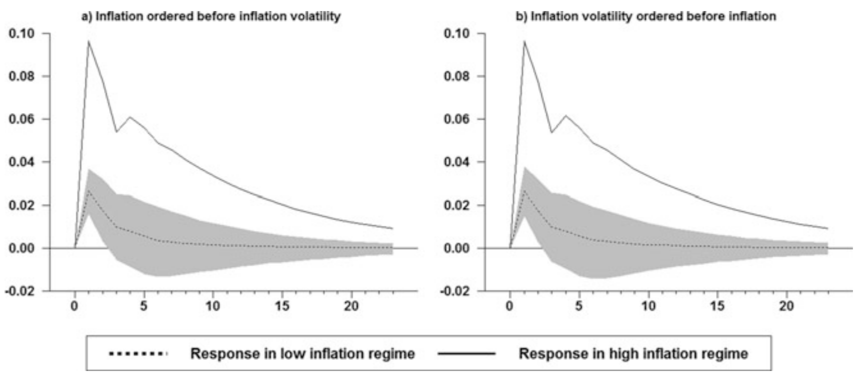

Fig. 5.4 Inflation volatility responses to positive inflation shocks. *Source*: Authors' calculations. *Note*: The shaded area denotes 16th and 84th confidence bands

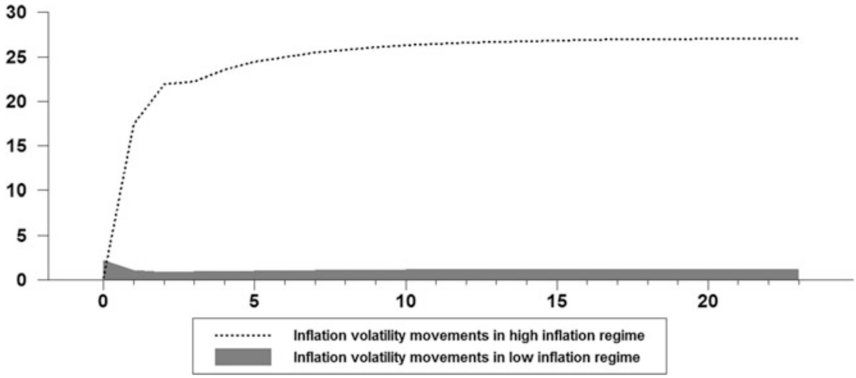

Fig. 5.5 Variation in inflation volatility due to inflation shocks. *Source*: Authors' calculations

higher inflation regimes. In such cases, the aggregate price level responds more quickly to nominal shocks. Hence, the prolonged increase in the rate of inflation will raise inflation volatility independently of the perceived frequency of nominal shocks.

The variance decompositions analysis in Fig. 5.5 shows that inflation shocks explain a proportionally high variation of about 30 per cent of the fluctuations in inflation volatility in the high inflation regime compared to less than 5 per cent in the low inflation regime.

Furthermore, Fig. 5.6(a) shows that persistence of inflation shocks matters. The persistently rising shocks leads to persistently rising inflation volatility. In contrast, the non-persistent inflation shock leads to non-persistent inflation volatility. The magnitudes are smaller in the low inflation regime than in high inflation regime.

The impulse response analysis and the variance decompositions indicate that positive inflation shocks exert non-linear effects on inflation volatility. This means that it is important to understand the costs linked to inflation. Furthermore, this evidence presents a case for an anti-inflation policy approach which also aims at less volatility in future inflation.

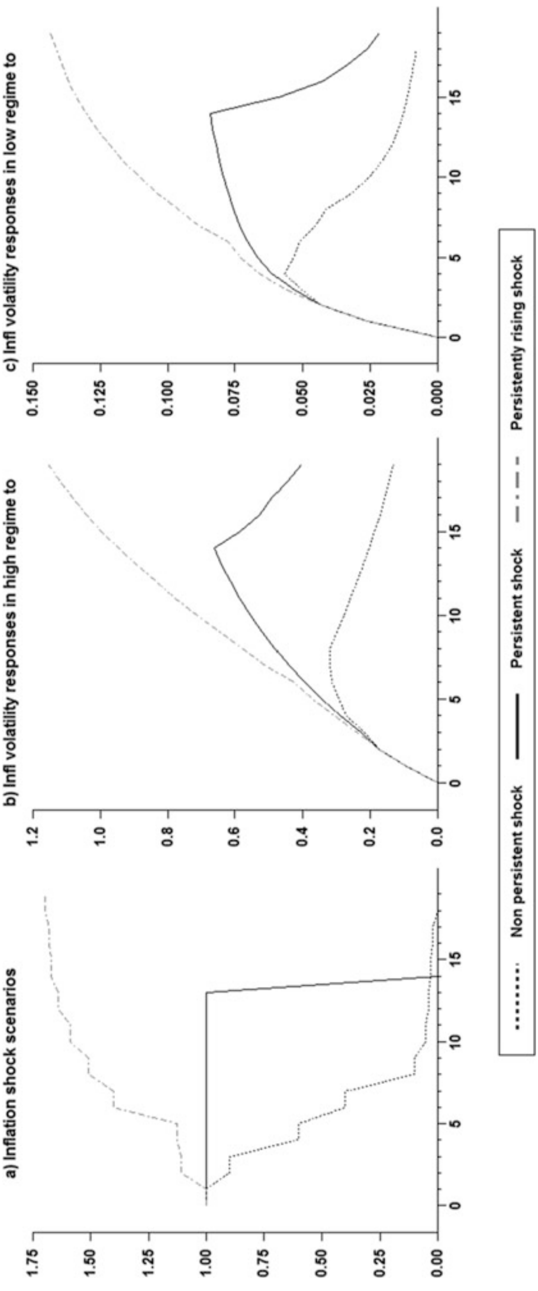

Fig. 5.6 Inflation volatility responses to persistent and non-persistent inflation shocks. *Source*: Authors' calculations

5.4 Are There Asymmetric Inflation Effects on Inflation Volatility?

The asymmetric inflation shock effects on inflation volatility are assessed for the effects of small and large magnitudes and the direction (positive and negative) of inflation shocks on inflation volatility. The asymmetry effect is tested using the Balke (2000) threshold VAR approach with three lags and test hypotheses 2 and 3:

- Hypothesis 2: Large unexpected inflation shocks exert different effects on inflation volatility relative to small inflation shocks in the low and high inflation regimes.
- Hypothesis 3: Unexpected positive (increase) and negative (decline) inflation shocks impact inflation volatility differently in low and high inflation regimes.

Fig. 5.7 shows that positive inflation shocks in high and low regimes increase inflation volatility. Large inflation shocks lead to bigger effects on inflation volatility. This evidence shows that different sizes of inflation shocks exert asymmetric effects on inflation uncertainty.

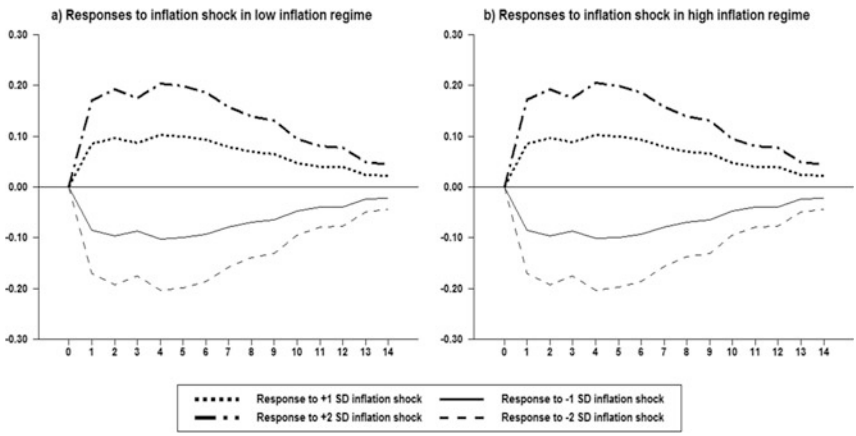

Fig. 5.7 Asymmetric responses of inflation volatility. *Source*: Authors' calculations

Evidence shows that inflation has a stronger positive effect on inflation volatility in the high-inflation regime and supports hypotheses 2 and 3.

5.5 Do Inflation Volatility Regimes Matter for Real Economic Activity?

Friedman (1977) postulates that higher inflation levels lead to increased inflation uncertainty. This is undesirable for policymakers because price volatility weakens and hampers the importance of relative prices. This leads to inefficient allocation of resources in the economy and welfare losses. Pindyck (1991) suggests that the adverse effects of volatility on economic growth occur via the investment channel. In addition, Taylor (1979) hypothesises a negative relationship between real and nominal uncertainties in the presence of real world rigidities. Does the size and sign of inflation volatility shock matter for real economic costs in the inflation volatility regimes? This is captured by hypothesis 4 below:

- Hypothesis 4: Unexpected positive (increase) and negative (decline) inflation volatility shocks impact output growth differently in low and high inflation volatility regimes.

Output growth is proxied with annual manufacturing production growth. Similar to earlier approach, a bivariate threshold VAR model is estimated with inflation volatility and manufacturing output growth. Two lags are used and 10,000 Monte Carlo draws. Fig. 5.8 shows that positive inflation volatility shocks lead to a decline in manufacturing production growth after two months.

Large inflation volatility shocks have a bigger impact on manufacturing production growth relative to small shocks. This means that an increase in inflation volatility raises the risks associated with future profits, which lowers manufacturing production growth. In addition, the irreversibility of investment implies that increased inflation volatility can delay investment decisions, thereby lowering economic growth. Evidence of asymmetric responses is visible in the peak responses as manufacturing production growth declines due to an unexpected increase in inflation

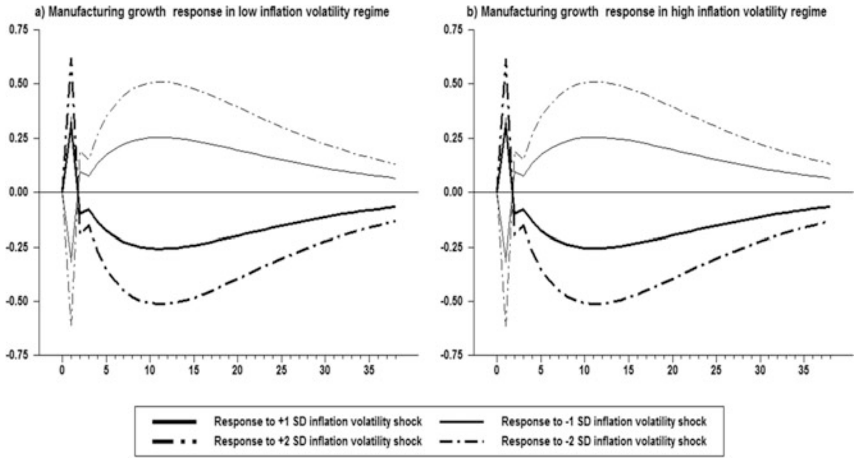

Fig. 5.8 Asymmetric effects of inflation volatility on real economic activity. *Source*: Authors' calculations. *Note*: 1 standard deviation is 0.043 and 2 standard deviations is 0.085. The magnitudes apply to both directions of the shock

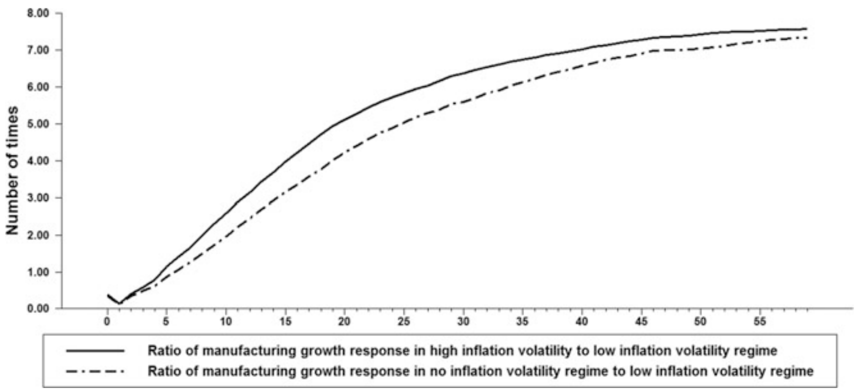

Fig. 5.9 Ratio of manufacturing declines due to inflation volatility in both inflation volatility regimes. *Source*: Authors' calculations

volatility more than it increases due to the reduction in inflation uncertainty. This suggests that economic growth benefits from a reduction of nominal uncertainty. Furthermore, Fig. 5.9 shows the ratio of the decline in manufacturing production in high inflation volatility regime relative to those in the low inflation regimes given by Eqs. (5.1) and (5.2).

$$Ratio = (Impulse\ responses\ in\ high\ inflation\ volatility\ regime/ \\ impulse\ responses\ in\ low\ inflation\ volatility\ regime) \tag{5.1}$$

$$Ratio = (Impulse\ responses\ in\ no\ inflation\ volatility\ regime/ \\ impulse\ responses\ in\ low\ inflation\ volatility\ regime) \tag{5.2}$$

The ratios indicate that inflation volatility is several times more detrimental to real economic activity in high inflation volatility regimes than in low inflation volatility regime. In addition inflation volatility is more detrimental to economic growth when no distinction is made regarding inflation volatility regimes relative to low inflation volatility regime. This shows that high inflation volatility is bad for real economic growth.

Why is inflation volatility so bad in both inflation regimes? This could be explained by the differential effects in both regimes and the severity in the high regime may also reflect the effects of increased volatility on inflation outcomes. The inflation volatility effects spillover into macroeconomic volatility; hence, business may find it optimal to delay hiring, production, and investment until such time volatility is minimised (Golob 1994). These are some of the possible explanations as to why output growth contracts significantly in the high inflation volatility environment.

Hypothesis 5 predicts negative effects of positive inflation volatility on growth volatility which is synonymous with testing for the Taylor curve relationship. Fig. 5.10(a) shows that output growth volatility declines with varying magnitudes due to an unexpected positive inflation volatility shock. The trade-off is more pronounced in the first ten months, then declines and retracts toward the pre-shock level, suggesting that the trade-off weakens over time. This trade-off is most evident in the post- and pre-inflation targeting framework.

Furthermore, persistent, non-persistent and persistently rising inflation volatility shock shown in Fig. 5.11 indicate that persistently rising inflation volatility shock leads to big declines in manufacturing growth volatilities.

These results confirm a negative trade-off between inflation and growth volatility, suggesting that anti-inflation policies to lower inflation minimise inflation volatility.

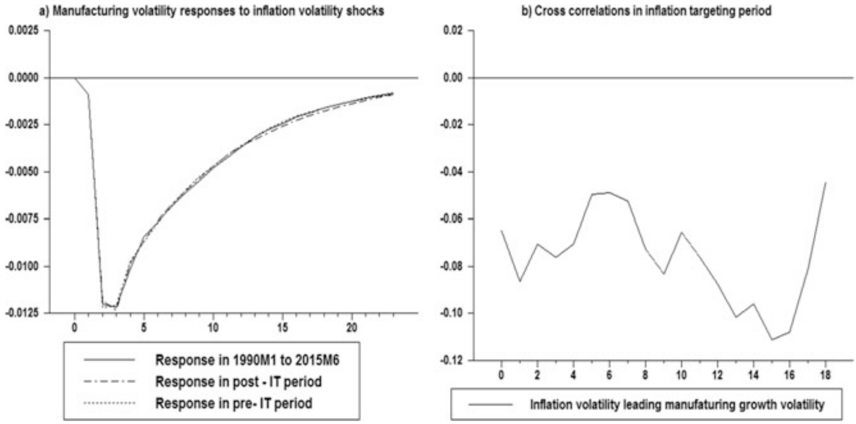

Fig. 5.10 Trade-off between output growth volatility and inflation volatility. *Source*: Authors' calculations. *Note*: IT means inflation targeting period

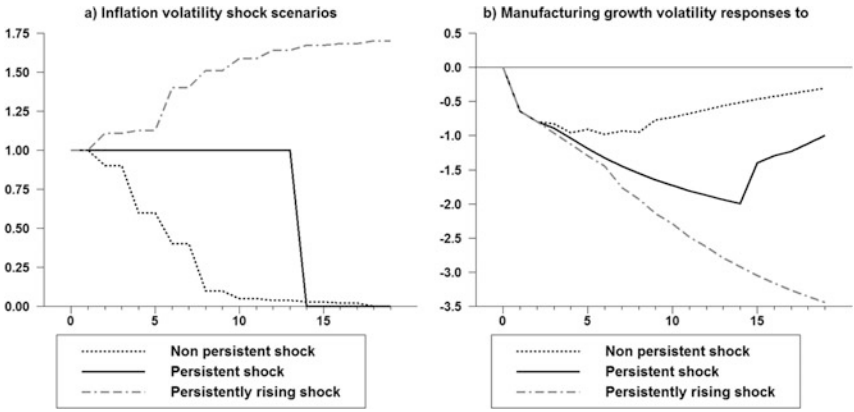

Fig. 5.11 Impact of persistent and non-persistent inflation volatility shocks. *Source*: Authors' calculations

5.6 Conclusion and Policy Implications

This chapter empirically assessed the impact of inflation shocks on inflation volatility and the trade-off between inflation and growth volatilities. The volatilities are estimated using Garch models. Evidence shows that conditional inflation volatility has systematically declined since 2009. Evidence supports the Friedman hypothesis that higher inflation causes higher rates of inflation uncertainty. Furthermore, positive inflation shocks exert non-linear effects on inflation uncertainty. This means that inflation volatility increases very much due to inflation shocks in the high inflation regime.

In addition, evidence shows that output growth volatility tends to decline in response to an unexpected positive inflation volatility shock. The evidence shows that low and stable inflation is good for economic activity. This reinforces the view that by lowering inflation and inflation uncertainty, monetary policy contributes to containing the adverse costs of inflation and inflation volatility on real economic activity.

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6

Exchange Rate Volatility Shock Effects on Inflation Volatility

Learning Objectives

- How supply side factors such as exchange rate shocks shift the Taylor curve
- How the exchange rate volatility shock is passed-through to inflation volatility
- The disproportionate effects of exchange rate depreciation shocks on overall, transitory and permanent volatility

6.1 Introduction

The previous chapters showed that supply side factors such as the exchange rate shocks can result in shifts along and in the Taylor curve. As a small open economy, the exchange rate and its volatility play a significant role in influencing nominal and real variables. This chapter explores the hypothesis that the exchange rate volatility is another factor contributing to inflation volatility, as given by Eq. (6.1).

$$\textit{Inflation volatility} = f(\textit{inflation}, \textit{exchange rate volatility}) \tag{6.1}$$

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6.2 Under What Conditions Is the Exchange Rate Volatility Linked to Inflation Volatility?

Theory suggests that inflation has positive effects on inflation volatility. For instance, Cushman (1983) and Dixit (1989) suggest that unanticipated movements in the exchange rate have significant effects on foreign trade and foreign investment. Currency depreciation affects domestic inflationary pressures via the import price channel. Furthermore, depending on the exchange rate pass-through, this may raise the overall domestic inflation rate. The second channel operates via the currency substitution effects. This hypothesis suggests that domestic residents as rational holders of money balances maximise their returns by holding both domestic and foreign currencies. The depreciation (appreciation) of the domestic currency relative to foreign currency leads to reduced (increased) demand for the domestic currency, which in turn leads to excessive supply (demand) of domestic money. Increased (decreased) money supply should increase (dampen) inflationary pressures.

What do these hypotheses mean for policymaking? They suggest that inflation volatility may be influenced by the volatile exchange rate via a positive relationship between the exchange and inflation rates volatilities.

6.3 What is the Nature of the Relationship between the Exchange and Inflation Volatilities?

The empirical analysis assesses the relationship between overall exchange rate volatility and inflation volatility. The inflation and exchange rate volatilities are based on the component Garch (1,1) model, which decomposes overall exchange rate volatility into permanent and transitory exchange rate volatilities. The sample period is 1990M1 to 2015M7. Fig. 6.1 shows that peaks in overall and permanent volatility coincide with those of inflation volatility. The scatterplots show that both overall and permanent volatilities have a positive relationship with inflation volatility. This suggests that there are some exchange rate volatility effects that are passed through to inflation volatility.

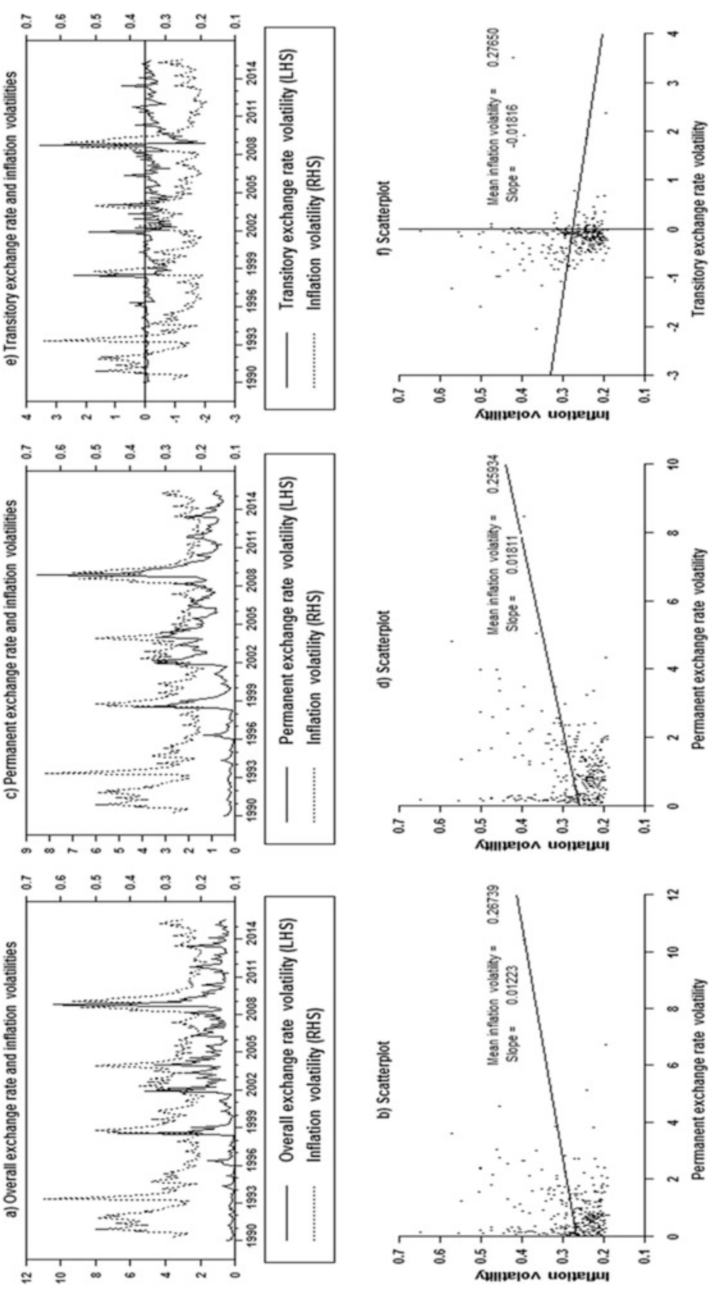

Fig. 6.1 Relationship between exchange rate and inflation volatilities. *Source*: Authors' calculations

In contrast Fig. 6.1(f) shows a negative relationship between transitory exchange rate volatility and inflation volatility. This is counterintuitive but could be explained by the fact that shocks that affect transitory volatility die fairly fast in contrast to their persistence on permanent and overall volatility components. The cross-correlation approach examines the relationship between the exchange rate and inflation volatilities. Fig. 6.2 shows that elevated overall and permanent exchange rate volatilities lead to an increase in inflation volatility for at least seven quarters.

However, transitory exchange rate volatility increases inflation volatility after two quarters, indicating the relationship is not fairly immediate. This evidence shows that there is a positive relationship between all measures of the exchange rate volatility and inflation volatility at different horizons. The autocorrelation for the overall, permanent and transitory exchange rate volatility to determine the individual persistence effects indicate that permanent exchange rate volatility has slightly higher persistence than transitory volatility. Furthermore, the results of the cross-correlations for the sub-samples before and after inflation targeting period show that the relationship is much stronger during the inflation targeting period compared to before the inflation targeting period. This suggests that inflation volatility is more likely to rise when preceded by elevated exchange rate volatility.

6.3.1 Is There Interdependence or Feedback Between the Exchange Rate and Inflation Volatilities?

A bivariate VAR impulse response analysis is used to determine if there is any interdependence or feedback between the exchange rate and inflation volatilities. The bivariate VAR has inflation and exchange rate volatility and uses four lags selected by the Akaike Information Criterion (AIC)[1]. The model is estimated using 10,000 Monte Carlo draws. Evidence shown in Fig. 6.3 suggests that inflation volatility increases more due to one unexpected positive standard deviation exchange rate volatility shock. Furthermore, there is a feedback effect of the exchange rate volatility in Fig. 6.3(b) on inflation volatility, but the effect is very temporary.

[1] It is a statistic used to select a model.

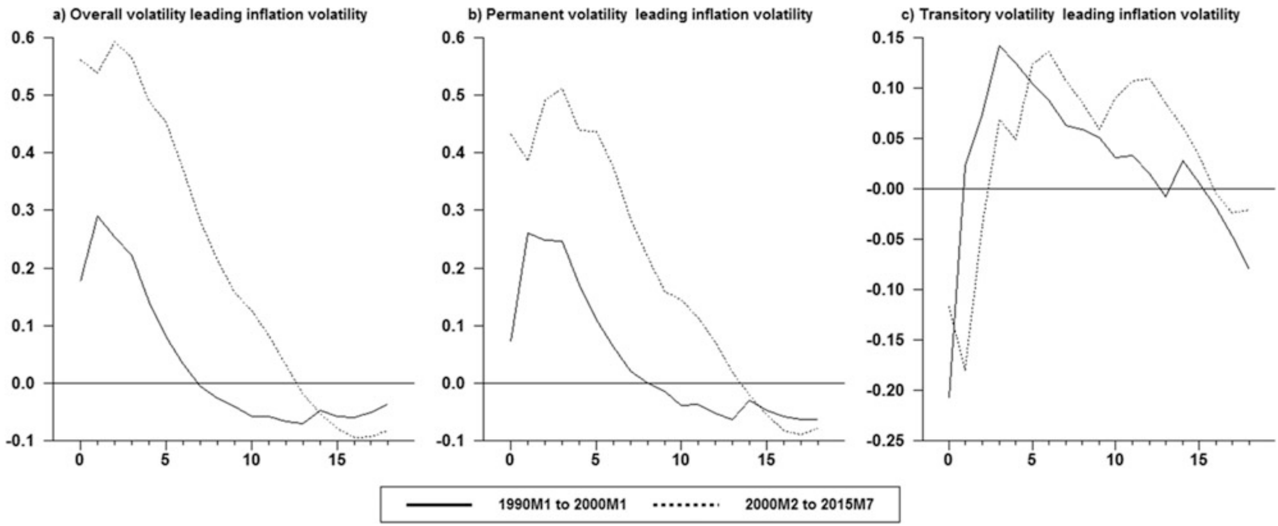

Fig. 6.2 Cross-correlations and autocorrelation plots. *Source*: Authors' calculations

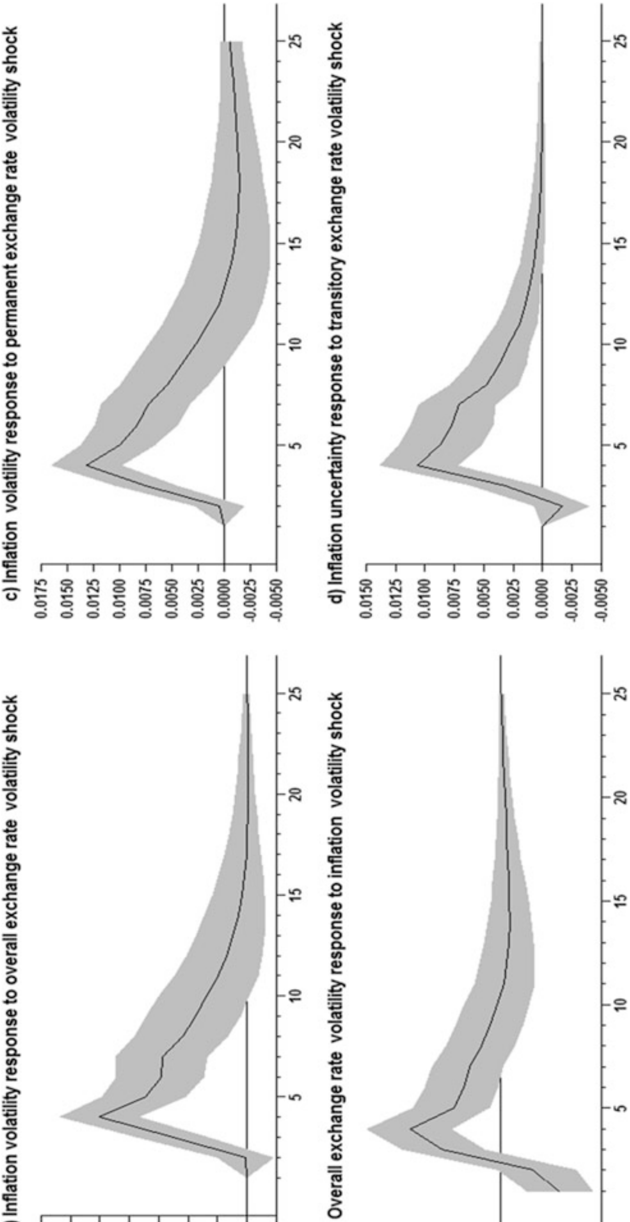

Fig. 6.3 Inflation volatility responses to the exchange rate volatility shock. *Source*: Authors' calculations

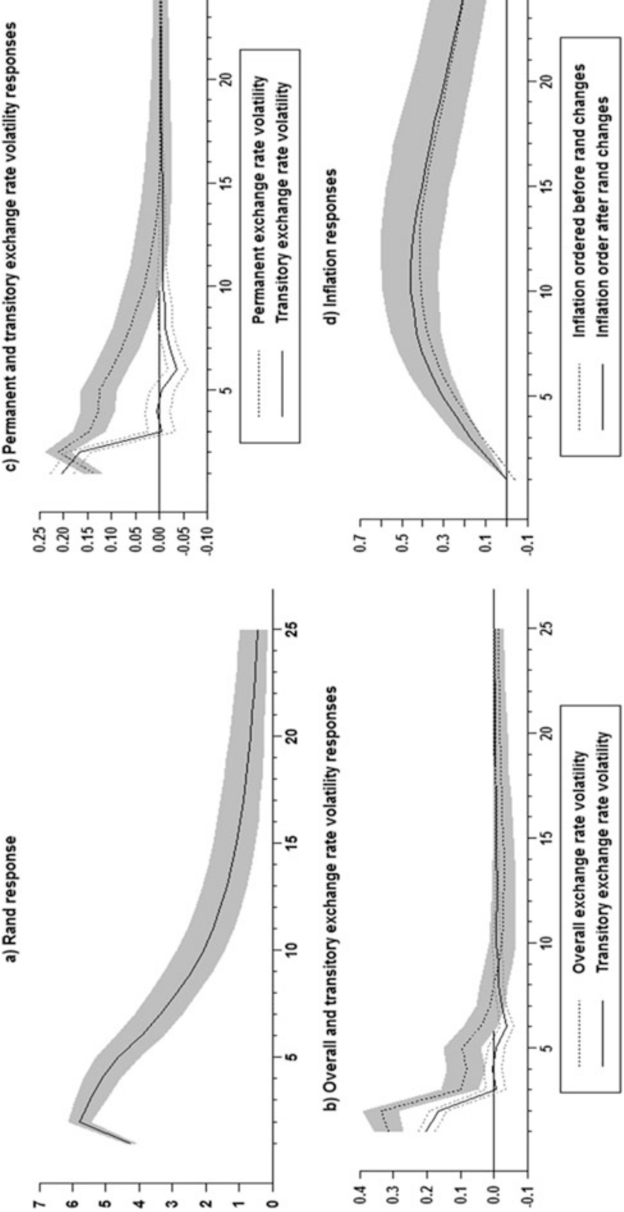

Fig. 6.4 Effects of the rand depreciation shock on inflation and the exchange rate. *Source*: Authors' calculations. *Note*: The shaded area denotes the 16th and 84th percentiles confidence bands

This may imply that periods of heightened exchange rate and inflation volatilities are likely to result in elevated inflation.

The analysis of the proportion of fluctuations in inflation volatility that is explained by the exchange rate volatility shocks show that overall exchange rate volatility explains relatively more fluctuations in inflation volatility. However, inflation volatility shocks explain very little of the fluctuations in exchange rate volatility. In addition, the rand depreciation tends to be persistent following a rand depreciation shock in Fig. 6.4 (a) and inflation rises significantly for prolonged periods. The comparison of the results testing for the effect of ordering of the variables in the bivariate VAR model with four lags in Fig. 6.4(b) shows that these results are robust and are bounded by the same error bands.

6.4 Conclusion and Policy Implications

Using various approaches, the chapter showed that components of the exchange rate volatility increase inflation volatility. Evidence shows a feedback effect of the exchange rate volatility on inflation volatility although it is very transitory. This may imply that periods of elevated exchange rate and inflation volatility are likely to induce more inflation volatility, particularly when inflation is close to the upper band of the inflation target. Overall and permanent exchange rate volatility explains more fluctuations in inflation volatility, meaning that increased persistence in the effects may be detrimental to economic activity via inflation volatility channels. The policy implication of this evidence is that elevated inflation volatility introduces a policy trade-off towards a zone that is not compatible with the inflation targeting framework. This means that policy initiatives aimed at reducing the exchange rate volatility will reduce the welfare costs of the variability in the inflation rate.

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7

Does the Volatility of the R/US$ Exchange Rate Threshold Exert Non-Linear Effects on Inflation?

Learning Objectives

- Show that the volatility of the exchange rate and its persistence has a significant effect on the exchange rate pass-through to inflation
- Determine the exchange rate volatility threshold and the non-linearities it introduced on the exchange rate pass-through to inflation

7.1 Introduction

Not only has the Rand–US dollar exchange rate persistently depreciated since 2011 (Fig. 7.1), its volatility has also increased. This chapter assesses the possibility that the volatility of the exchange rate and its persistence have a significant effect on the short-run dynamics of the exchange rate pass-through to inflation. Are there non-linearities introduced by low versus high exchange rate volatility regimes on the exchange rate pass-through to inflation? This chapter estimates the response of inflation to rand depreciation shocks and determine if it varies according to exchange rate volatility regimes. This has implications for price stability and the policy trade-off within the flexible inflation targeting framework.

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Fig. 7.1 The R/US$ exchange rate. *Source*: South African Reserve Bank and authors' calculations. *Note*: The first arrow corresponds to the period February 1996 to July 2001 and the second arrow corresponds to the period July 2011 to August 2015. The grey area denotes the start of the inflation targeting framework in 2000. The black dotted line is the average exchange rate for the period October 2003 to October 2007. However, we extended the line to show that the correction to the sharp depreciation 2008/2009 reverted to the same level

The menu costs theory postulates that the impact of the exchange rate volatility on the exchange rate pass-through may arise from the need by firms to adjust to costs and then change their prices. According to menu costs theory, firms may not be willing to frequently reset their prices below a set level of exchange rate changes. As a result, firms may absorb small movements in the exchange rate but adjust prices when the exchange rate volatility is heightened.[1] Such that transitory and less volatile exchange rate changes can be partially absorbed in the profit margin, resulting in a low degree of pass-through (Bache 2007).[2] This suggests that the degree and regime of the exchange rate volatility play a role in the exchange rate pass-through to inflation.

[1] This suggest that firms may postpone resetting their prices until profits increase, which occurs only when prices adjustments exceeds the adjustment costs (Murase 2013).

[2] This is particularly the case in monopolistic markets or producers.

To what extent does the exchange rate volatility lead to a non-linear response of inflation to exchange rate shocks? The most recent evidence in other countries, including Turkey, which is often compared to South Africa, suggests differential effects of inflation response to exchange rate depreciation depending on the exchange volatility regimes. For instance, Kal et al. (2015) found that both the standard deviation and mean core inflation were lower in periods of low (or tranquil) exchange rate volatility than in periods of high volatility. These results imply a higher pass-through during periods of high volatility in the nominal exchange rate.

We have established that the exchange rate volatility regimes induce a policy trade-off that maybe incompatible with the inflation targeting regime in an open economy. Literature shows that, inflation targeting in an open economy to some degree includes aspects of implied exchange rate stabilisation. However, this implied exchange rate stabilisation is derived from the objectives of stabilising inflation and the output gap (Chang 2007).

Price stability is the primary mandate of the South African Reserve Bank (the Bank) and understanding that supply side shock effects emanating from factors such as the exchange rate volatility, and their effects on the degree of the exchange rate pass-through to inflation can turn out to be welfare enhancing and support the objective of price stability. Evidence in this chapter will determine that the exchange rate matters for inflation dynamics via the exchange rate volatility and persistence of the rand depreciation shock. This means that within flexible inflation targeting, even if the exchange rate is not the ultimate target of policy, optimal monetary policy settings imply that policymakers have to respond to the information contained in exchange rate movements to the extent that it affects the attainment of inflation targets.[3] Hence, monetary policy may have to respond to exchange rate movements if their volatility induces a policy trade-off into a zone incompatible within flexible inflation targeting framework.

[3] Svensson (1999).

7.2 How Did the Exchange Rate Volatility Evolve?

The rand per US dollar (R/US$) exchange rate has depreciated along a continuous trend since 2011 as shown in Fig. 7.1. Given that some central banks, particularly those in Latin America and Asia, have accumulated foreign currency reserves, albeit with the objective of preventing financial crises, dealing with sudden stops and preventing excessive appreciations, what has been the South African experience?

The Bank's foreign exchange reserves grew significantly and peaked in 2012, moving sideways with a downward bias thereafter. Furthermore, the Bank states that the official foreign exchange operations are directed towards gradually building up the official foreign exchange reserves and it typically conducts this through spot purchases. However, in certain exceptional circumstances where there are considerable foreign direct investment inflows, the Bank directly purchases these flows as off-market transactions to accelerate the process of accumulating foreign exchange reserves. Is it possible that the accumulation of forex reserves and these opportunistic direct purchases influenced the rand exchange rate?

Fig. 7.2 suggests that periods of forex accumulation coincided with the appreciation in the R/US$ exchange rate. Similarly, post-2012, when the Bank slowed the rate of accumulation and the level of foreign reserves declined, the exchange rate depreciated. The scatterplots show negative association or correlation suggesting that increases in annual changes in forex reserves result in the appreciation of the R/US dollar exchange rate.

These suggest that the de-accumulation of foreign exchange rate reserves is possibly amongst the contributing factors to the depreciation of the exchange rate. This has not been intensively interrogated in the academic and policy discussions. Furthermore, evidence based on cross-correlations suggests that an increase in reserves accumulation leads to rand appreciations for nearly six months. On the other hand, the rand depreciation is associated with a persistent decrease in forex reserves.

The sustainability of the role of the accumulation of foreign reserves as a subordinate policy initiative to support price stability has to factor

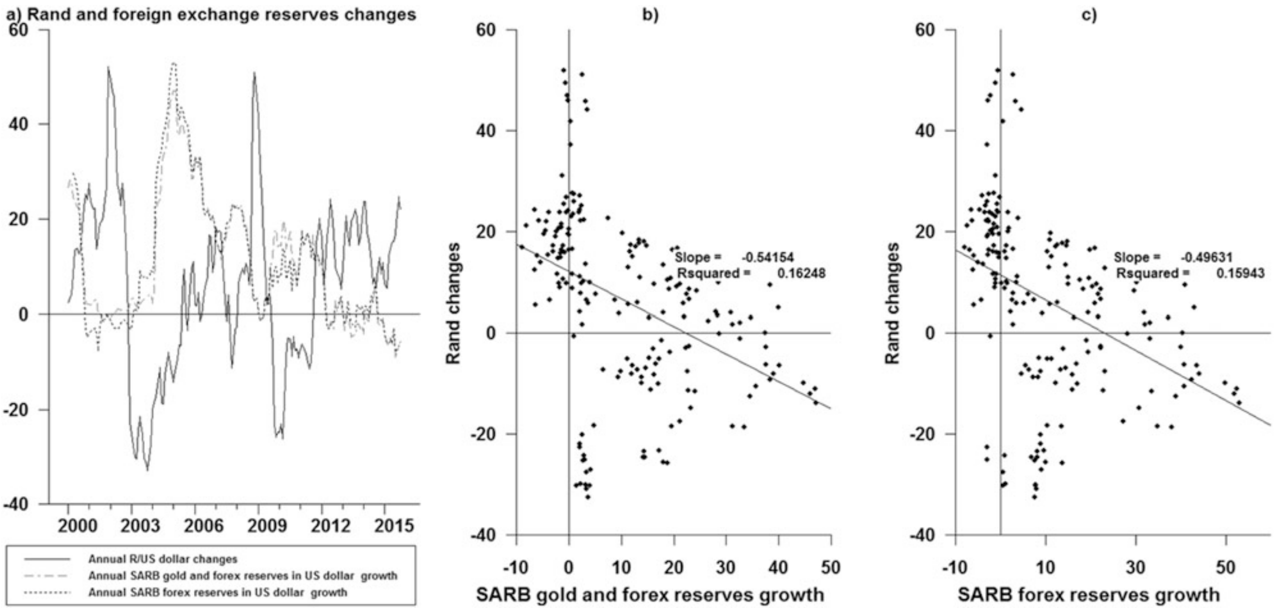

Fig. 7.2 Foreign currency reserves and the R/US$ exchange rate Changes. *Source*: South African Reserve Bank and authors' calculations

aspects ranging from the costs involved, the implications of the sterilisation costs on the Banks' balance sheet and the fiscus. However, it seems they could serve well as part of the tool kit that should be considered to deal with the exchange rate and its volatility.

7.3 Exchange Rate Volatility and Foreign Reserve Accumulation

The exchange rate volatilities are estimated using a component Garch(1,1) model to daily rand per US dollar exchange rate data from 1 January, 1990, to 15 December, 2015. The component Garch approach further decomposes volatility into permanent and transitory volatilities. Svensson (1999) states that in an optimal inflation targeting regime the policy instrument should respond to any variable that marginally helps predicting inflation possibly via interest rates. But the exchange rate and volatility are impacted by factors beyond interest rate differentials. Can foreign exchange reserves reduce overall and permanent exchange rate volatilities and inflation? How does the policy rate respond?

Fig. 7.3(b), (d) and (f) presents the impulse responses from a VAR model for the reaction of macroeconomic variables to unexpected one positive standard deviation of foreign reserves accumulation shocks. An increase in foreign reserve accumulation lowers inflation more than the repo rate in (f). In addition, increased foreign reserves accumulation lowers both exchange rate volatilities in (b).

This suggests that an increase in foreign reserves through (i) the appreciation in the rand, (ii) lowering overall and permanent exchange rate volatility, and (iii) lowering inflation, may lead to a lower repo rate over time than that would prevail in the absence of increased foreign reserves accumulation. This evidence indicates that foreign exchange reserves though not a primary monetary policy tool can offload the burden of adjustment on the repo rate as reserves can impact broadly the prevailing economic conditions.

While the costs of maintaining reserves have predominantly been highlighted in policy discussions, the analysis shows here that there are benefits accruing via lowering the exchange rate and its permanent volatility

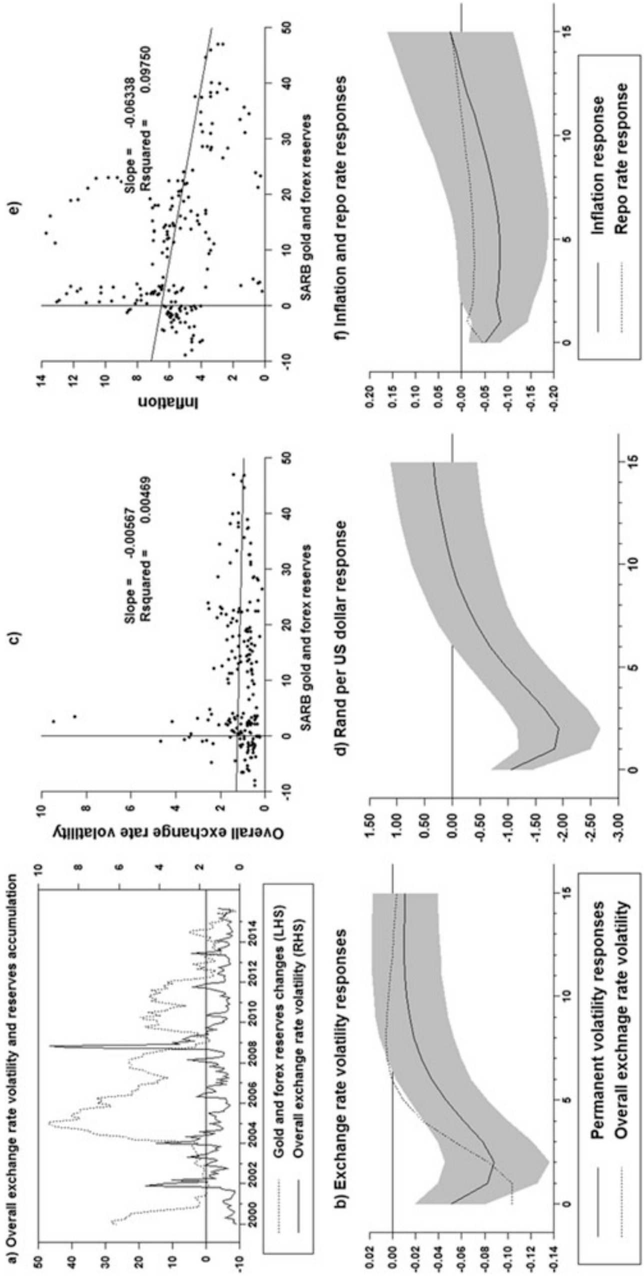

Fig. 7.3 Foreign reserves accumulation and macroeconomic dynamics. *Source*: Authors' calculations

with direct and indirect spillovers into mitigating inflationary pressures. It is ideal at certain times for policymakers to use complementary tools that help to achieve an inflation target through a direct and indirect impact on inflation.

7.4 Does the Threshold of the R/US$ Exchange Rate Volatility Matter?

We determine the exchange rate volatility threshold using the Balke (2000) multivariate approach. The model uses the annual rand changes, exchange rate volatility, inflation and the repo rate. The best threshold determined by the model is shown by the dotted line in Fig. 7.4 which shows a large of number of observations on each side of the threshold. We use the mean volatility rather than the estimated threshold volatility for robustness analysis. Fig. 7.4 shows that mean volatility is higher than the estimated threshold volatility in the model.

Based on this threshold the study determines the extent to which the estimated volatility threshold leads to different inflation responses to the rand depreciation shocks. Is there a difference in the rand reaction to own depreciation shocks based on the volatility regimes? Do inflation

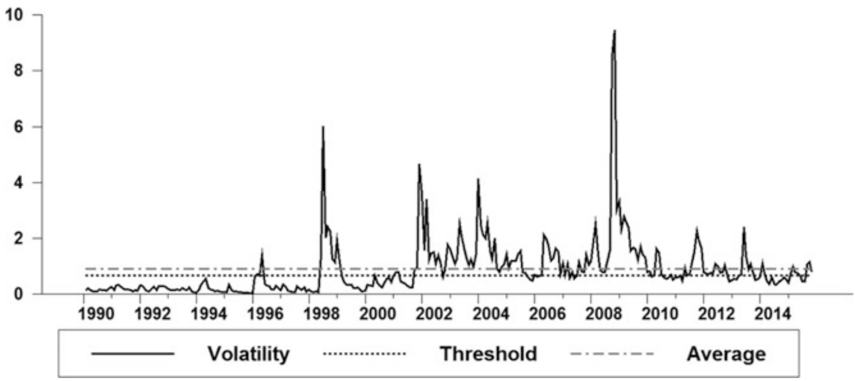

Fig. 7.4 Overall exchange rate volatility, mean and threshold. *Source*: Authors' calculations

fluctuations induced by rand depreciation shocks differ between the high and low volatility regimes? Does monetary policy react differently to inflation shocks in low and high rand exchange rate volatility regimes? The results are shown in Fig. 7.5, from which it can be seen that (i) inflation remains elevated for longer periods in the high volatility regime than in the low volatility regime, (ii) the rand remains more highly depreciated in the high volatility regime than in the low volatility regime, and (iii) inflation fluctuates very much in the high volatility regime.

The responses based on mean volatility threshold display little difference from those presented in Fig. 7.5 for the threshold volatility. In addition the rand depreciation shock induces more fluctuations in the inflation rate in the high volatility regime compared to the lower regime. Overall, the findings from mean volatility do not alter the main findings established in prior sections using threshold volatility. Furthermore, robustness analysis based on a three variable VAR model rather than four variables shows that the increase in inflation remains highly elevated for longer periods in the high volatility regime. In addition, the findings reveal that the rand depreciation shock in the high volatility regime leads to more fluctuations in inflation.

The last robustness test using the permanent volatility rather than overall volatility, which includes the transitory component of volatility, shows that inflation remains more elevated in the higher volatility regime than in the lower volatility regime. Rand depreciation shocks induce more movements in inflation in the high volatility regime and currency depreciation is more persistent in the high volatility regime. In addition, the repo rate is tightened to deal with inflationary pressures.

7.5 Does the Persistence of the Rand Depreciation Shock Matter in Different Exchange Rate Volatility Regimes?

The impact of persistent and non-persistent rand depreciation scenarios are assessed on inflation in the high, low and no exchange volatility regimes. The evidence in Fig. 7.6 shows that inflation increases more

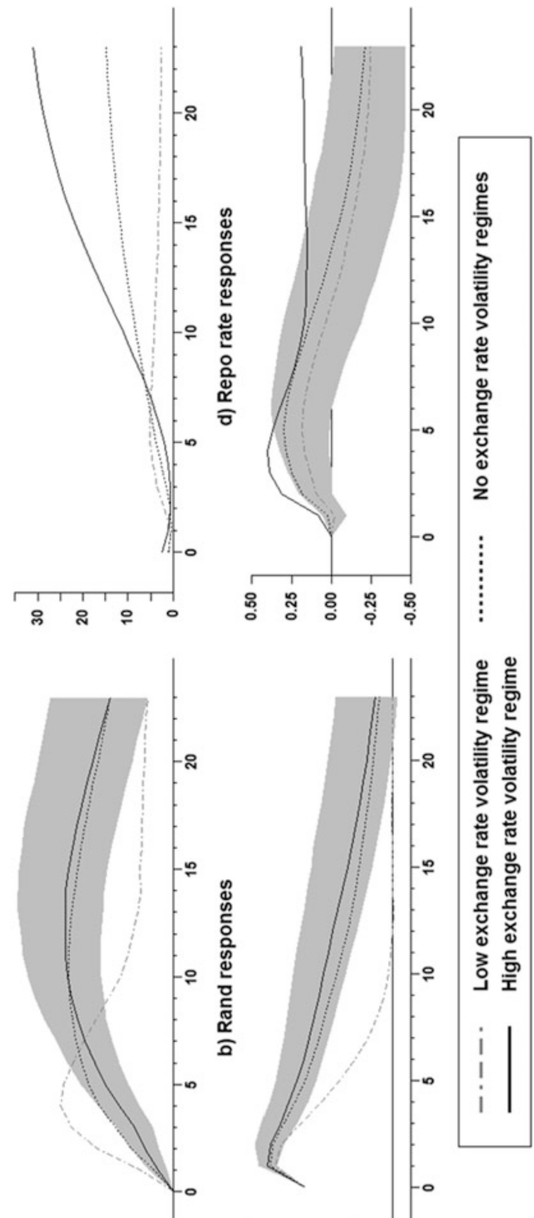

Fig. 7.5 Inflation and exchange rate response in high and low volatility regimes. *Source*: Authors' calculations

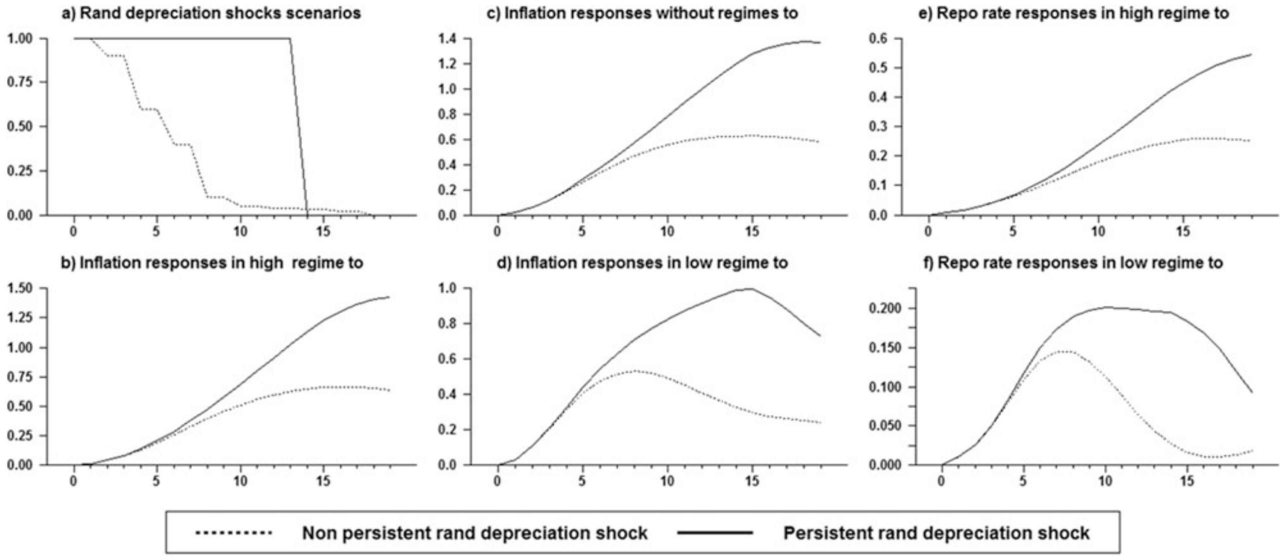

Fig. 7.6 Inflation responses to persistent and non-persistent shocks. *Source*: Authors' calculations

due to persistent rand depreciation shock irrespective of the exchange rate volatility regimes. This suggests that the persistence of the rand depreciation matters for inflation responses to rand depreciation shocks in low and high volatility regimes.

7.6 Conclusion and Policy Implications

This chapter estimated the exchange rate volatility threshold, explored non-linarities and introduced the role of permanent and overall exchange rate volatility in different volatility regimes on the exchange rate pass-through to inflation. Evidence indicates that inflation remains elevated for longer periods and fluctuates more in the high volatility regime. The rand exchange rate remains highly depreciated in the high volatility regime. Furthermore, the persistence of the rand depreciation shock matters as inflation rises to high levels for longer horizons due to persistent rand depreciation shock in both volatility regimes.

The accumulation of foreign exchange reserves plays a role in appreciating the exchange rate, lowering both the permanent and overall exchange rate volatility. At the same time it lowers inflation. The policy implication is that it lessens the burden of adjustment on the repo rate whilst supporting the price stability mandate. Thus the accumulation of foreign reserves should be seriously considered as a complementary policy tool. A reserves accumulation complementary policy approach can induce additional benefits of reduced welfare costs of elevated inflation, hence minimising the policy trade-off.

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8

Persistent and Non-Persistent Exchange Rate Depreciation Effects on Inflation

Learning Objectives

- Estimate the exchange rate thresholds via a number of approaches
- Show the policy implications of zero and nonzero thresholds of exchange rate depreciation for inflation
- Show the persistent and non persistent exchange depreciation effects on inflation

8.1 Introduction

Although the flexible exchange rate is a shock absorber, it is possible that beyond certain magnitudes of exchange rate depreciation, the depreciation becomes a source of shocks, which can lead to adverse implications for the country's growth plans and policies. Where is the threshold beyond which exchange rate depreciations are no longer beneficial to price and macroeconomic stability? What are the policy implications of zero and nonzero thresholds of exchange rate depreciation for the response of inflation to exchange rate shocks?

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The menu costs theory suggests that due to costs linked to changing prices, exporters may leave prices unchanged in importers' currency if the exchange rate changes are small. However, when exchange rate changes exceed some threshold then large exchange rate magnitudes lead firms to change their prices. This hypothesis suggests that exchange rate pass-through is asymmetric with respect to size of exchange rate shocks. This is because price adjustment is more frequent with large exchange rate changes than with small ones. So, is there a specific magnitude of the exchange rate changes that matters for the price adjustments?

8.2 Responses based on Zero and Nonzero Exchange Rate Thresholds

The analysis begins by using zero thresholds to classify the exchange rate changes into appreciation and depreciation regimes. We estimate a VAR model with annual rand per US dollar exchange rate changes, rand volatility and inflation using two lags as selected by the Akaike Information Criterion (AIC), thereafter estimating the regime dependent impulse responses.[1] The model is estimated using 10,000 Monte Carlo draws. The analysis uses monthly (M) data spanning 1990M1 to 2015M7. The depreciation (appreciation) regime refers to positive (negative) rand changes. How does the inflation rate respond to rand depreciation shock in each regime?

Fig. 8.1 shows that inflation rises significantly in both regimes but increases much faster in the depreciation regime than in the appreciation regime over all horizons.

Fig. 8.2 shows the distribution of annual rand exchange rate changes using the "box-and-whisker" plots.

The box plot provides a simple graphical representation of some of the key and basic statistical properties of rand changes. These include the median, the interquartile ranges, the maximum and minimum values, and

[1] The exchange rate volatility is estimated using Garch(1,1) model and satisfies the model diagnostics and model restrictions.

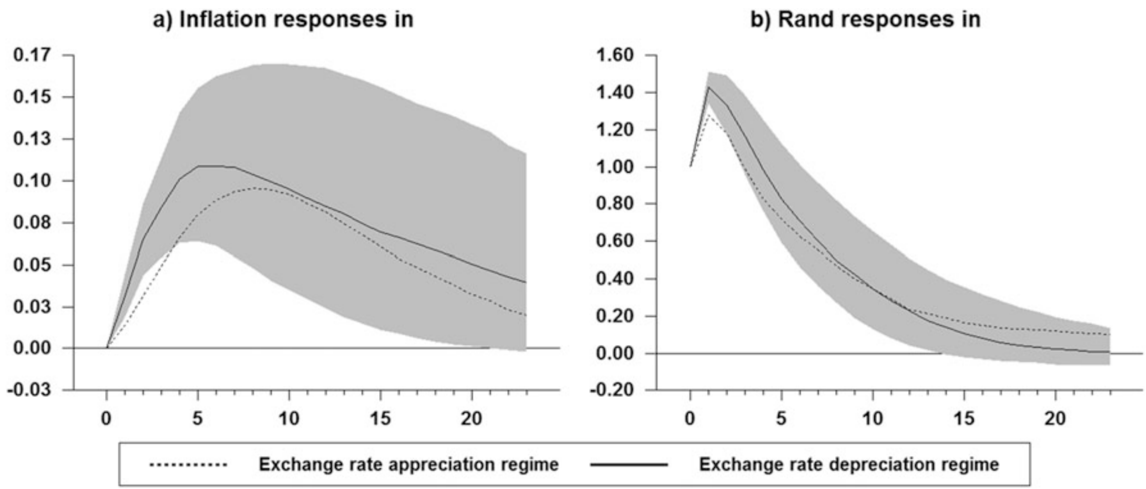

Fig. 8.1 Comparison of inflation and rand responses to rand depreciation shock. *Source*: Authors' calculations. *Note*: The grey shaded are denotes the 16th and 84th percentiles

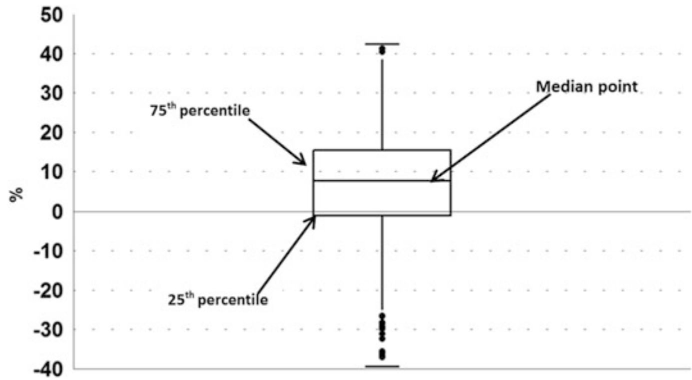

Fig. 8.2 The box-and-whisker plot. *Source*: Authors' calculations

significant outliers.[2] Using data that span 1990M1 to 2015M7, the median value for the annual rand exchange rate is nearly 9 per cent, the 75th percentile is nearly 15 per cent while 25th percentile is less than −1 per cent. These statistics can be shown in the box-and-whisker plot and the dots represent the outlying changes.

We also use the modified Balke (2000) threshold VAR approach to determine the threshold value of the rand exchange rate changes. The modified Balke (2000) threshold VAR approach estimates a 9 per cent threshold. Fig. 8.3 visualises the threshold determined by the Balke (2000) approach and the 75th percentile value suggested by the box plot.

The 9 per cent threshold is equivalent to a R1/US$ appreciation or depreciation and the 15 per cent median is equivalent to R1.65/US$ depreciation or appreciation. The two numbers will enable us to make comparisons and assess the validity of empirical papers referring to a nonzero estimated threshold as suggesting the presence of menu cost or some adjustment costs of prices.

Based on the threshold determined by the Balke (2000) approach the impulses show that inflation tends to be slightly higher in the depreciation

[2] Box plots plot include the following elements: (i) a line representing the median value, and (ii) a box representing the interquartile range (IQR). The top and bottom lines of the box correspond to the 75th and 25th percentiles, respectively. Vertical lines or "whiskers" indicate 1.5 times the IQR in either direction from the 75th and 25th percentiles. This is about a 2.7 standard deviation on either side of the median for a normal series. Short horizontal lines represent the maximum and minimum values. Dots representing outliers: values larger than or smaller than 1.5 times the IQR.

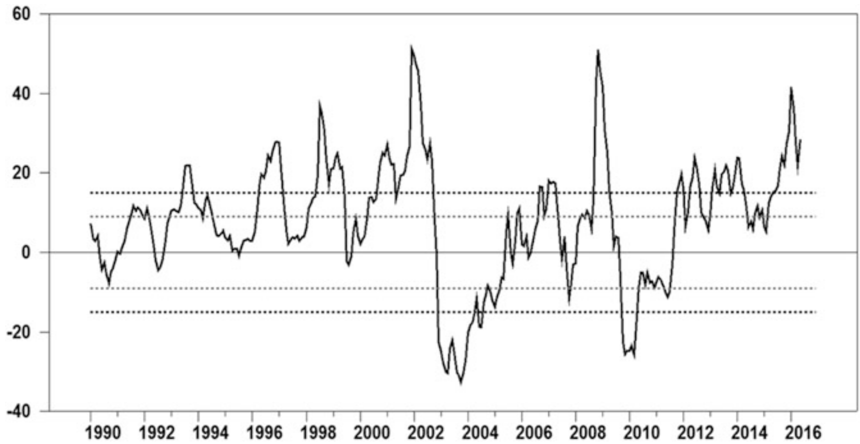

Fig. 8.3 The rand exchange rate, threshold and the 75th percentile box and whisker plot. *Source*: Authors' calculations

regime above the 9 percent threshold to rand depreciation shock in Fig. 8.4. The inflation responses are not significantly statistically different as they are within the same error bands. However, the rand response to a rand depreciation shock differs in both regimes in Fig. 8.4(b). Above 9 per cent, the rand depreciation is sharp in response to own depreciation shock in the first four months.

Fig. 8.5(a) shows that inflation increases more due to a persistently rising rand depreciation shock above the 9 per cent threshold. A persistently increasing rand depreciation shock leads to large inflation in the high exchange rate depreciation regime.

Furthermore, the analysis of the simple statistics suggest that even though the median and the threshold levels for the rand exchange rate occur at 9 per cent, the 75th percentile categorisation of depreciation episodes is 15 per cent. We use 15 per cent as a threshold and assess whether there are significantly differential inflation responses to rand depreciation shocks. Fig. 8.6 indicates that inflation increases more due to rand depreciation shock above the 15 per cent depreciation regime. Furthermore, persistently rising depreciations shock worsens the inflationary pressures.

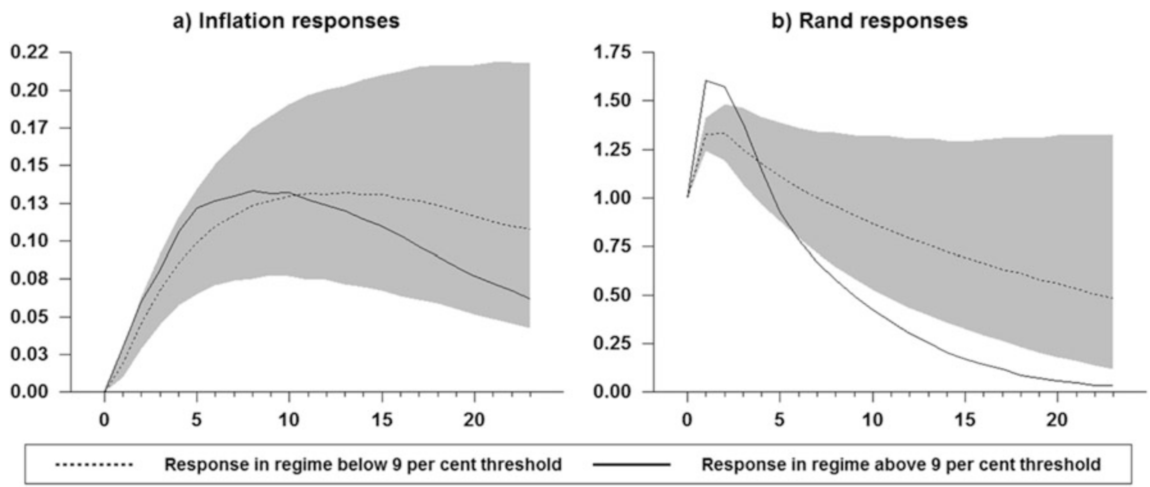

Fig. 8.4 Inflation and R/US$ responses based on the 9 per cent threshold. *Source*: Authors' calculations. *Note*: The grey shaded are denotes the 16th and 84th percentiles

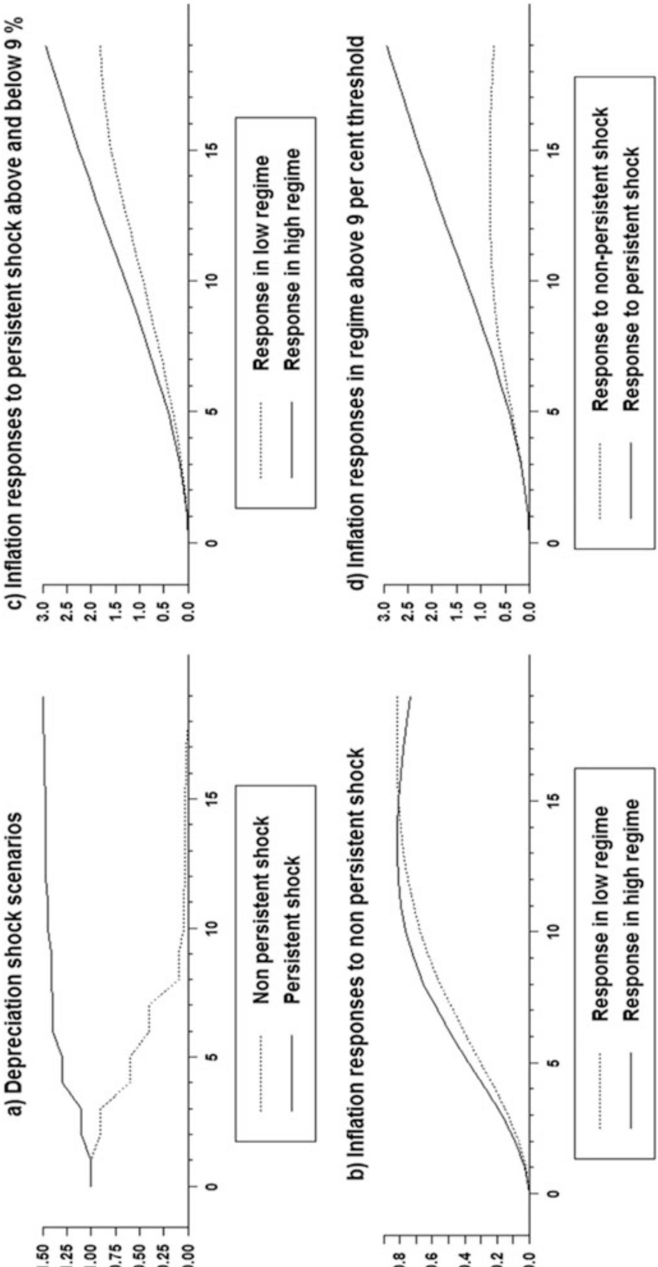

Fig. 8.5 Inflation response to non-persistent and persistent depreciation shocks. *Source*: Authors' calculations

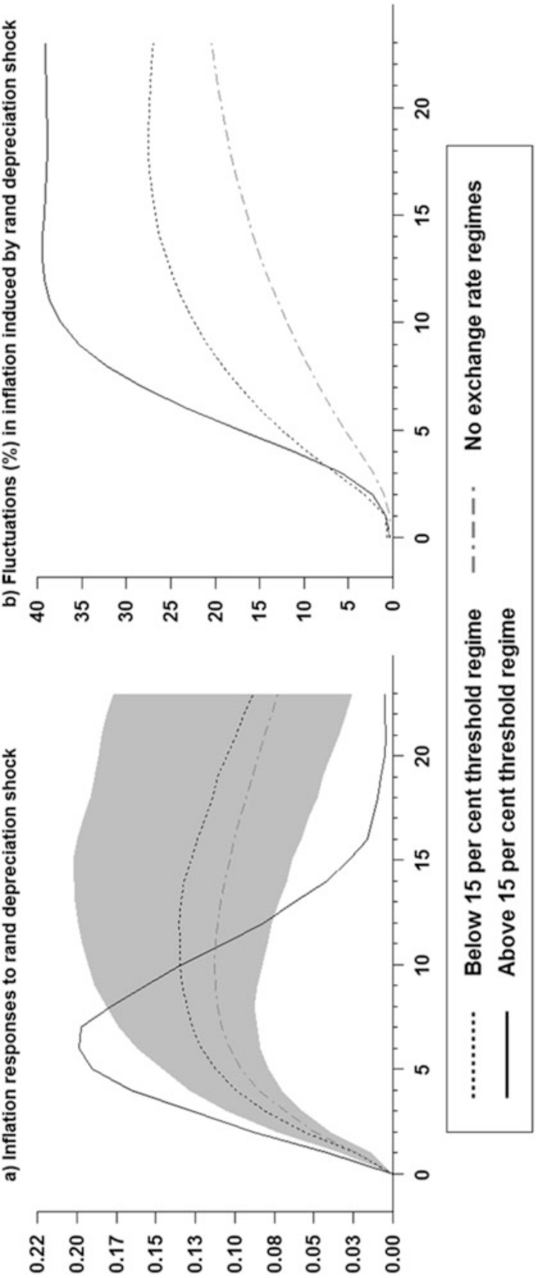

Fig. 8.6 Inflation responses to rand depreciation above and below 15 per cent rand depreciation. *Source*: Authors' calculations. *Note*: The grey shaded are denotes the 16th and 84th percentiles

8.3 Are There Asymmetric Exchange Rate Effects Above 15 per cent Rand Depreciation Threshold?

This section tests if there are asymmetries in the direction and size of exchange rate changes based on exchange rate as threshold variable in region exceeding 15 per cent depreciation. Evidence shown in Fig. 8.7 suggests that there are non-linear responses due to the size and sign of the exchange rate shocks. Peak inflation responses are bigger in absolute value to rand depreciation shock than to appreciation shock in Fig. 8.7(b). This shows that inflation responds asymmetrically to rand exchange rate shocks. Thus, policymakers should expect the inflation to remain slightly elevated in this regime due to depreciation shock compared to inflationary pressure subsiding due to an appreciation shock.

8.4 Conclusion and Policy Implications

This chapter extended the analysis of the exchange rate depreciation effects by considering (i) a zero threshold, (ii) the 9 per cent threshold equivalent to R1/US$ established by the modified Balke (2000) VAR approach and the median box-whisker-plot, and (iii) the 15 per cent equivalent to R1.65/US$ which is 75th percentile in box-whisker-plot annual rand changes. The percentage depreciation thresholds and the associated absolute values lend perspective to discussion about the exchange rate depreciation regimes and magnitudes involved. We find differential responses on how the inflation rate responds to exchange rate depreciation shock in different exchange rate changes states. Evidence shows that inflation rises very much to rand depreciation shock in depreciation regimes than in an appreciation regime. The rand depreciation shock leads to elevated inflation pressures. In addition, persistently rising rand depreciation shock leads to more highly elevated inflation pressures than non-persistent rand depreciation shock.

There are asymmetric exchange rate effects above 15 per cent rand depreciation threshold. Peak inflation responses are bigger in absolute

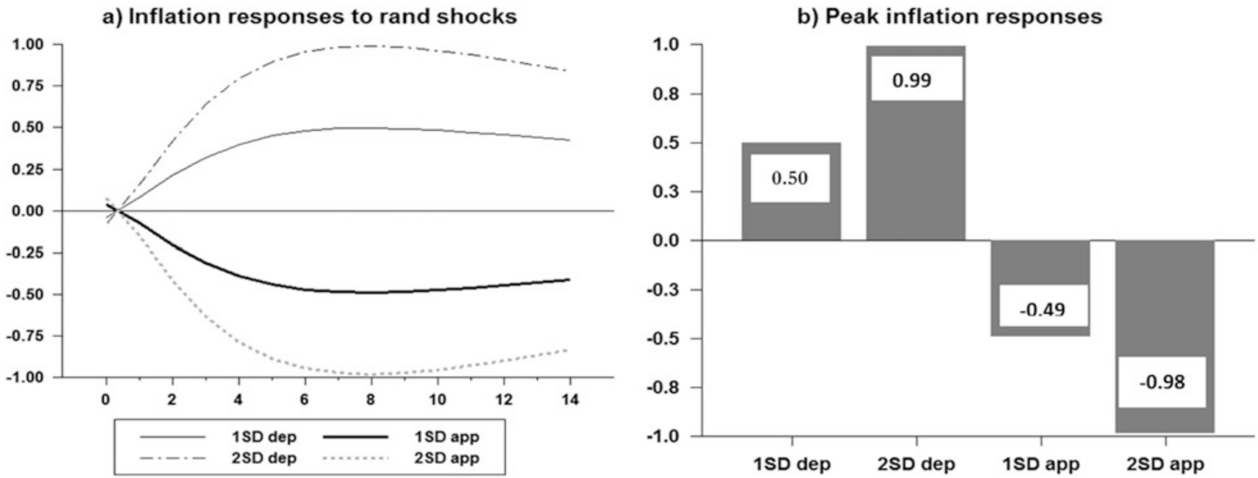

Fig. 8.7 Inflation responses to asymmetric exchange rate shocks in the region above 15 per cent rand depreciation.
Source: Authors' calculations

value to rand depreciation shock than to an appreciation shock. This shows that inflation responds asymmetrically to rand exchange rate shocks. Thus, policymakers should expect the inflation to remain slightly elevated in this regime to depreciation shock compared to inflationary pressure subsiding to an appreciation shock.

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9

Relative Services Price Dispersion, Trend Inflation and Inflation Volatility

Learning Objectives

- The relationship between relative services price dispersion and the various aspects of inflation dynamics
- The extent to which relative service price dispersion is influenced by a rising trend or expected inflation, unexpected inflation and inflation volatility
- The direct effects of electricity prices on the price dispersion, the indirect effects via trend inflation and the inflation volatility channels
- Establish the inflation threshold level which minimises the relative price dispersion and asymmetries it introduces

9.1 Introduction

Earlier chapters showed that supply-side shocks and the exchange rate are drivers of overall inflation and feature strongly in the monetary policy decision-making process. This chapter looks at the relationship between relative services price dispersion and the various aspects of inflation dynamics. The weight of services within the consumer price basket is slightly more than 50 per cent and a majority of the components of

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services prices display persistent trends that are normally above the inflation target band. The electricity price increases in recent years are also seen as a key contributor to the degree of persistence and the trajectory of overall inflation. So what is the relationship between relative services price dispersion and the various aspects of inflation dynamics?

9.2 What Does Theory Say About the Nature of the Relationship Between Inflation and Relative Price Dispersion?

Theoretical and empirical literature asserts that higher inflation increases not only inflation volatility, but also the relative price dispersion. Furthermore, inflation affects the economy through its impact on relative price dispersion (RPD).[1] Woodford (2003) states that the impact of expected inflation on RPD is a major channel of the real effects of inflation. Therefore, what does a positive relationship or link between RPD and inflation indicate? It indicates that inflation increases RPD, hence decreasing the information content of prices. This can lead to a decrease of welfare gains due to the misallocation of resources, through less competitive markets, and less efficient pricing by firms as they find it difficult to interpret price signals.

Theoretically, the relationship between inflation and the RPD is explained by models based on information asymmetry and menu costs that are associated with price adjustments. Literature suggests that relative prices tend to be more dispersed in times when prices fall, relative to periods characterised by price increases. Such behaviour also confirms the asymmetric effects of inflation on relative prices (Park 1978; Reinsdorf 1994).[2] On the other hand, the signal extraction model postulates that inflation is not always anticipated correctly. Hence, unexpected inflation and increases in inflation volatility will raise the RPD.[3]

[1] For further reading on the conflicting views on the nexus between inflation and inflation volatility, see Valdovinos and Gerling (2011), Friedman (1977), Ball (1992), Cuckierman (1992).

[2] The existences of nominal rigidities has been linked to asymmetric price responses, in which prices are more flexible when going up than when going down (Ball and Mankiw 1994).

[3] See, Lucas (1973); Barro (1976); and Hercowitz (1981).

How is it possible that there exists a positive relationship between inflation and RPD? In the menu costs argument, RPD is positively linked to trend or expected inflation.[4] Given that firms' price adjustments are heterogeneous, depending on the size of menu costs, firm-specific menu costs can lead to staggered price setting. This can distort the information content of prices, distort relative prices by inefficiently increasing RPD and impede the efficient allocation of resources (Becker and Nautz 2012).

This chapter assesses whether relative service price dispersion is influenced by a rising trend or expected inflation. This involves exploring the relationships between various aspects of inflation; namely, expected inflation, unexpected inflation, inflation volatility, positive and negative unexpected inflation and relative services price dispersion in South Africa. Furthermore, is services price dispersion influenced by inflation volatility and unexpected inflation? What are the direct effects of electricity prices on the price dispersion? Are there any indirect effects via trend inflation and the inflation volatility channels? In view of the fact that it is not only the direction of the impact that matters, the analysis establishes where the inflation threshold level which minimises the relative price dispersion lies. The threshold is further determined to ascertain if it differs between the pre- and post-inflation targeting periods. This threshold will help determine if the asymmetric impact of inflation on RPD depends on whether the inflation threshold is either zero or nonzero inflation rate, and we discuss the associated implications for monetary policy.

9.3 What Do Simulations Depict the Shape of the Relationship Between Inflation, Price Dispersion and Welfare to Be?

The link between inflation, relative price dispersion and welfare as simulated in Becker and Nautz (2012) illustrates the impact of expected inflation on price dispersion and welfare. The shapes of the relationships

[4] According to Becker and Nautsz (2012) increases in expected inflation amplify the distorting effects of menu costs on relative prices.

indicates that the expected relationship between inflation and price dispersion can be captured by a U-shaped or quadratic specification with a turning point occurring at positive levels of inflation. The positive turning point denotes that the welfare maximising inflation rate is determined by the minimum of the welfare cost curve. Furthermore, it is located very close to the vertex of the inflation–relative price dispersion nexus. This vertex can also serve as a proxy for threshold inflation. The shapes of the curves capture the fact that the relationship between inflation and price dispersion is not linear. Such evidence suggests that the relationship between inflation and RPD is non-monotonic. This means that above a certain inflation threshold, the welfare distorting effects of inflation become significantly magnified.

9.4 What Is the Relationship Between Relative Price Dispersion and Inflation?

The RPD variable is calculated as the absolute value of the difference between the component price change ($p_{ser,t}$) and inflation (π_t) using Eq. (9.1):[5]

$$RPD_t = \left|p_{ser,t} - \pi_t\right| \tag{9.1}$$

where $p_{ser,t} = \ln P_{ser,t} - \ln P_{ser,t-1}$ with $P_{ser,t}$ as the price index level of the services component at time t. Inflation is defined as the month-on-month log difference of the CPI level. Monthly data spanning from March 1980 to December 2011 is used. The Granger causality test identifies unidirectional causality from inflation to relative services price dispersion in Table 9.1.

Fig. 9.1 shows that the relationship between relative service price dispersion and inflation is captured by a quadratic relationship, with the majority of the observations scattered around the turning point. This

[5] See Ndou and Redford (2013).

Table 9.1 Granger causality tests

	F-statistic	*P*-value
RPD does not Granger-cause Inflation	0.815	0.443
Inflation does not Granger-cause RPD	6.419	0.002

Source: South Africa Reserve Bank and authors' calculations

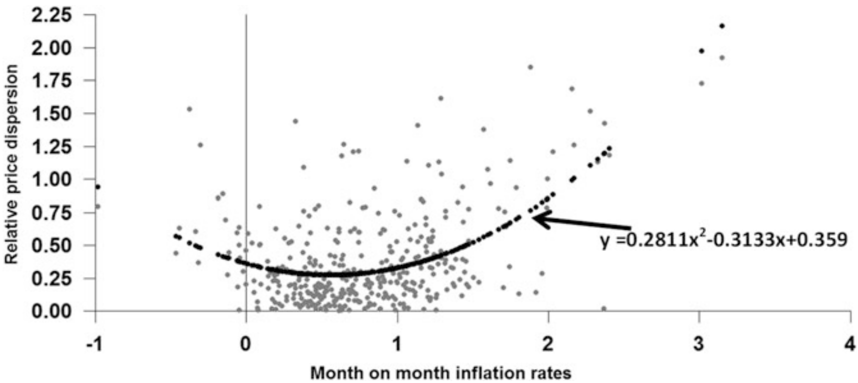

Fig. 9.1 Relative services price dispersion and aggregate inflation rate. *Source*: South Africa Reserve Bank and authors' calculations

turning point is the point at which inflation minimises relative services price dispersion.

Is the relationship between the relative service prices dispersion and inflation proportionate on either side of the turning point? No, it is clear from Fig. 9.1 that the relative prices dispersion increases more as the rate of inflation increases. The relationship tends to be more disproportionate when moving up on the positive side, suggesting that during higher inflationary outbreaks the relative service price structure is highly distorted.[6] Therefore, to minimise associated welfare costs a different policy response might be required.

Given that this estimated annualised inflation rate suggests that the inflation rate in Fig. 9.1 that minimises the relative services price variability is outside the inflation targeting band, is this still the case after

[6] The minimum is bounded between −1 and −0.5 and the maximum is between 1.7 and 3.2 for the two graphs in Fig. 9.2.

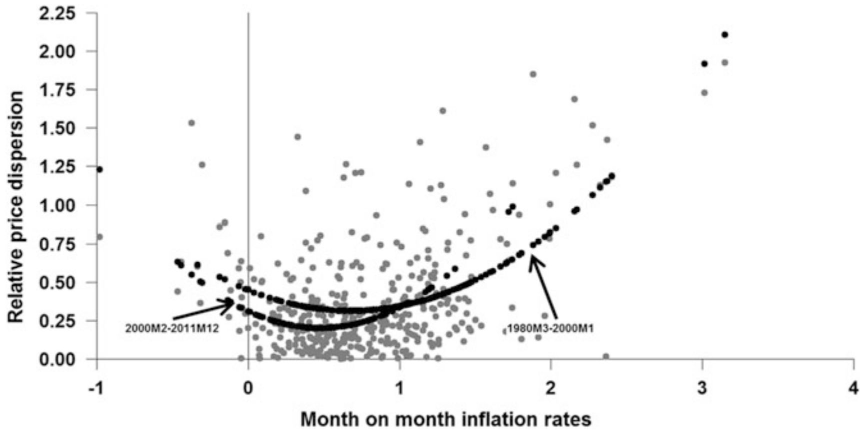

Fig. 9.2 Relative services price dispersion and inflation pre- and post-inflation targeting. *Source*: South Africa Reserve Bank and authors' calculations

subdividing the sample size into pre- and post-inflation targeting periods? The two graphs for the subsamples are shown in Fig. 9.2. It is evident that the turning points are different. The RPD rises as the rate of inflation increases in subsamples.

Figs. 9.1 and 9.2 confirm that price increase and decreases from the estimated threshold level result in large variability in relative price changes. This suggests that the RPD cannot be lowered monotonically by maintaining lower rates of inflation. What do the turning points tell us about the inflation rate that minimises the relative services price dispersion? Does this turning point lie within the inflation target band?

The estimated results for the different samples shown in Fig. 9.3 indicate that for the period 1980M3 to 2000M1, relative services price dispersion is minimised at a monthly inflation rate of 0.666 per cent or annual inflation rate of 8.3 per cent. This is in contrast to the monthly inflation rate around 0.5575 per cent, which is equivalent to an annualised 6,687 per cent for the period 1980M3 to 2011M12 and the monthly inflation rate of 0.473 per cent or annual inflation of 5.8 per cent for the period 2000M2 to 2011M12.

The results of the thresholds suggest that the period of inflation targeting contributed to the decline in the inflation threshold. The

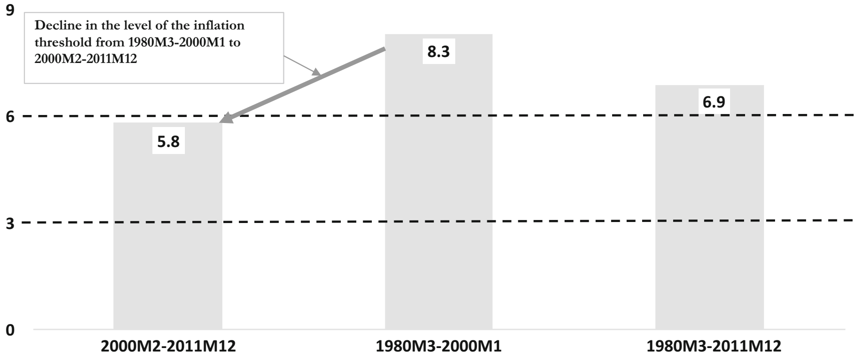

Fig. 9.3 Points at which the inflation rate minimises relative service price dispersion. *Source*: Authors' calculations

inflation rate that minimises the relative services goods dispersion lies within the inflation target band in the post inflation targeting period, although it is very close to the upper band of the target. Furthermore, these results suggest that relative services price dispersion is minimised around a nonzero inflation rate. The implication is that the asymmetry about price increases and decreases should focus on the deviations from the nonzero inflation threshold.

9.5 Which Aspect of Inflation Dynamics Impacts Relative Services Price Dispersion?

The analysis in this section uses Eqs. (9.1, 9.2, and 9.3) to test for the effects of inflation volatility, trend inflation, unexpected inflation, and positive and negative unexpected inflation on relative service price dispersion.[7] The various equations suggest that relative services price dispersion depends on its first lag, the first lag of trend inflation $\left(\pi_{t-1}^2\right)$ and the conditional variance of inflation at time t. We also included various

[7] These are estimated together with the variance equations; see Becker and Nautsz (2012) for details.

measures of unexpected and expected inflation. Inflation volatility $\left(\sigma_t^2\right)$ is estimated using the conditional inflation variance.

$$RPD_t = \eta_0 + \eta_1 RPD_{t\text{-}1} + \eta_2 \sigma_{\pi,t}^2 + \eta_3 \pi_{t\text{-}1}^2 + \sum\nolimits_{z=1}^{w} \omega_z v_{t\text{-}i} + \eta_5 UNEXPsq + \upsilon_t \tag{9.2}$$

$$RPD_t = \eta_0 + \eta_1 RPD_{t\text{-}1} + \eta_2 \sigma_{\pi,t}^2 + \eta_3 \pi_{t\text{-}1}^2 + \sum\nolimits_{z=1}^{w} \omega_z v_{t\text{-}i} + \eta_6 UIPsq + \eta_7 UINsq + \upsilon_t \tag{9.3}$$

$$RPD_t = \eta_0 + \eta_1 RPD_{t\text{-}1} + \eta_2 \sigma_{\pi,t}^2 + \eta_4 EXPINF + \sum\nolimits_{z=1}^{w} \omega_z v_{t\text{-}i} + \eta_8 UIPsq + \eta_9 UINsq + \upsilon_t \tag{9.4}$$

The expected inflation (EXPINFL) is defined as the one-period-ahead inflation forecast. Unexpected inflation (UNEXPsq) is the difference between the actual inflation rate and forecast errors. In order to control for the fact that the effect of unexpected inflation on the RPD varies with the sign of the inflation forecast error, the analysis defines unexpected positive inflation (UIPsq) as positive inflation forecast errors and zero otherwise. In addition, the unexpected negative inflation (UINsq) is defined as negative inflation forecast errors and zero otherwise. Following literature specification, these variables will be used as squared terms. These include the expected and unexpected inflation, and unexpected positive and negative inflation.

The effects of menu costs and signal extraction in Eqs. (9.1), (9.2), and (9.3) are captured by η_2 and η_3, respectively, in the above equations. If the menu cost hypothesis holds, then trend inflation η_3 or expected inflation η_4 should exert a positive and significant effect, indicating that trend inflation increases RPD. When the signal extraction prediction holds, then inflation volatility η_2 should have a positive and significant sign, suggesting that inflation volatility raises RPD.[8] The hypotheses examined are:

[8] See, Aarstol (1999); Parks (1978); Becker and Nautsz (2012).

Hypothesis 1: The menu costs suggest expected or trend inflation increases relative services price dispersion, that is $\eta_4 > 0$ or $\eta_3 > 0$, respectively.

Hypothesis 2: The signal extraction model suggests that inflation volatility raises the relative services price dispersion, that is $\eta_2 > 0$.

Hypothesis 3: The extended signal extraction model[9] suggests that unexpected inflation, that is $\eta_5 > 0$ as well as both unexpected positive inflation, that is $\eta_6, \eta_8 > 0$ and unexpected negative inflation, that is $\eta_7, \eta_9 > 0$ increase the relative services price dispersion.

Hypothesis 4: The extended signal extraction model suggests that there should be no significant difference between the unexpected positive and unexpected negative inflation on relative services price dispersion.

The evidence shown in Table 9.2 indicates that trend inflation and expected inflation have a positive and significant effect on relative services price dispersion; hence, the failure to reject Hypothesis 1, which relates to the menu costs assumptions. Unexpected inflation and its unexpected positive and negative inflation rates increase relative services price dispersion significantly. However, unexpected inflation is more important than trend inflation.[10] This supports evidence that it is the amount of unexpected inflation rather than the inflation rate itself that has a large impact in raising relative services price variability.

Both components of unexpected inflation raise relative services price dispersion more than expected inflation. On the contrary, inflation volatility does not raise relative services price dispersion significantly, indicating the rejection of the hypothesis of the signal extraction model.

Does Hypothesis 4 hold? No, it does not, indicating the rejection of the Hercowitz–Cukierman version of extended signal extraction that predicts equal coefficients on positive and negative unexpected inflation.[11] The

[9] See the Hercowitz-Cukierman model.

[10] This is similar to the results obtained by Aarstol (1999) for the United States.

[11] We find evidence similar to that in Aarstol (1999).

Table 9.2 The effects of inflation categories

Inflation variable in model	Size of impact of inflation component according to model						Conclusion on the effects of price dispersion
	Model A		Model C		Model D		
Trend inflation	0.061	(0.00)*	0.035	(0.04)**			Raise price dispersion
Unexpected inflation	0.288	(0.00)*					Raise price dispersion
Unexpected positive inflation			0.415	(0.00)*	0.519	(0.00)*	Raise price dispersion
Unexpected negative inflation			0.247	(0.00)*	0.295	(0.00)*	Raise price dispersion
Inflation volatility	*0.021*	*(0.8)*	*0.101*	*(0.58)*	*0.002*	*(0.99)*	No effect
Expected inflation					0.100	(0.01)**	Raise price dispersion

Source: Authors' calculations

Note: The paper estimates the conditional variance as the dynamic conditional covariance (dcc) model which is time varying rather than assuming a constant correlation across time. The letters A, C and D denote three models estimated. The variables with letters A, C and D show the variable included in the model. The expanded model is shown in Table A7.2.

*Significant at 1 per cent **significant at 5 per cent coefficient on unexpected positive inflation is larger relative to unexpected negative inflation pointing to asymmetric effects.[12] Based on the identified effects of expected inflation and trend inflation, evidence reveals that the menu costs model is better at explaining how inflation increases raise relative services price dispersion. To make appropriate policy recommendations these relationships or the hypotheses are tested within a VAR framework in the next section.

9.6 What Are the Effects of the Shocks of Various Inflation Aspects on Relative Services Price Dispersion?

The four hypotheses in the preceding section are further tested using a bivariate VAR model to determine the relationship between relative services price dispersion and various inflation dynamics.[13] The VAR approach does not have strong prior expectations firmly grounded on theoretical models to inform the ordering of the variables. Therefore, without theoretical prior economic ordering of the variables, the analysis uses a one positive standard deviation generalised impulse response function shock. The disadvantage of this approach is being very atheoretic; nonetheless, it still provides useful insights into the relationships. Fig. 9.4 shows the results based on 10,000 Monte Carlo draws.

Evidence indicates that inflation volatility has no positive significant effect on relative services price dispersion in Fig. 9.4(d). In addition, evidence indicates that a negative unexpected inflation shock tends to increase relative services price dispersion. But, the effects are not significant in Fig. 9.4(f). In addition the trend inflation, expected inflation, unanticipated inflation and positive unexpected inflation shocks increase relative services price dispersion in Fig. 9.4(a), (b), (c) and (e).

Furthermore, there is no significant difference in the reaction of relative services price dispersion to unanticipated inflation and positive

[12] Similar to that reported in both Aarstol (1999) and Fischer (1982).

[13] We estimate a bilateral VAR model using two or one lag(s) selected by AIC, SBC and HQ statistics.

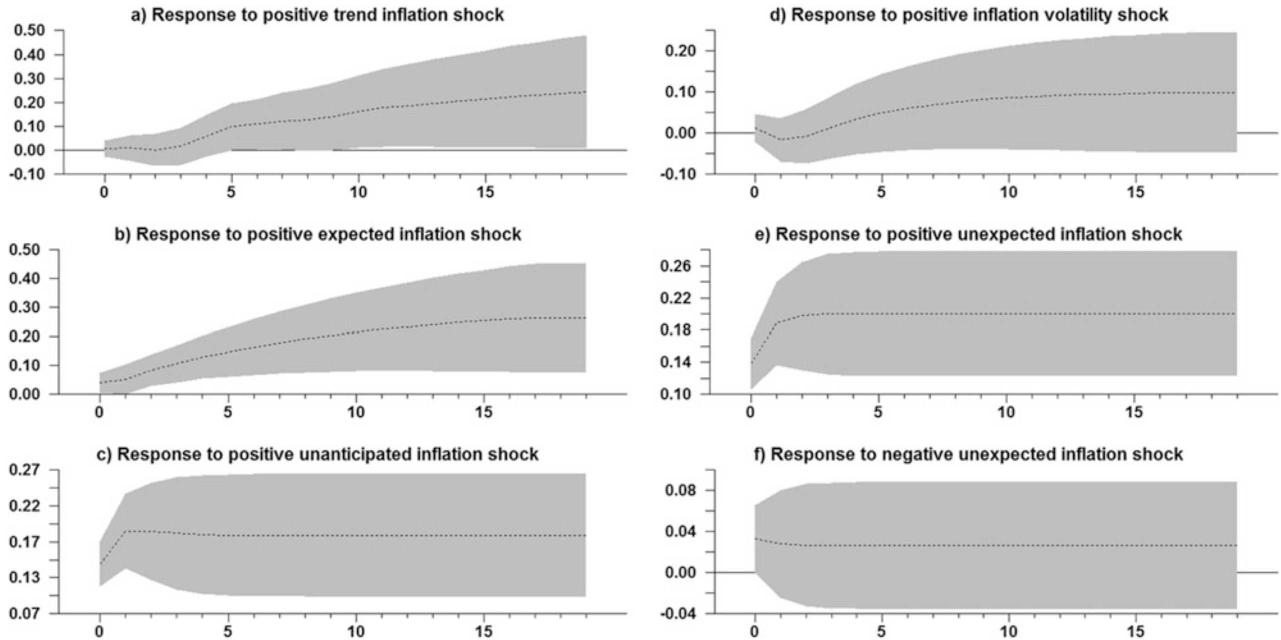

Fig. 9.4 Responses of relative services price dispersion to various inflation shocks. *Source*: Authors' calculations. *Note*: The shaded areas denote the 16th and 84th percentile error bands. The dotted lines denote the impulse responses. The shock is a positive generalised one standard deviation shock

unexpected inflation shocks. Evidence concludes that positive expected inflation shock has the biggest impact, followed by positive unexpected inflation shock. Negative unexpected inflation shock has the least effect on service price RPD and this supports the findings in Table 9.2.

However, the response of relative services price dispersion to negative unexpected inflation shock indicates that the effect of negative unexpected inflation differs from those of both an unexpected inflation and positive unexpected inflation shock. But these results show the same conclusion as those in Table 9.2. Unexpected inflation has a larger effect relative to positive expected inflation and trend inflation between 7 and 10 months. These responses are significantly different on impact up until 3 months.

9.7 Does an Unexpected Positive Electricity Price Shock Impact Relative Services Price Dispersion?

Given the importance of electricity and energy prices on the trajectory of inflation and the forecast, this section examines the effects of a positive electricity shock on relative services price dispersion to determine whether the electricity price shocks have a direct or indirect impact on services price dispersion. In addition, the electricity price shock can indirectly affect other inflation dynamics already explored above. Fig. 9.5(a), (b) and (c) shows the responses of relative service prices dispersion, trend inflation and inflation volatility, respectively, to a positive electricity price shock.

Fig. 9.5(a) reveals that a positive electricity price shock increases relative services price dispersion but the response is not significant. This suggests that an unexpected positive electricity price shock does raise relative services price dispersion but the effects are insignificant. The inability to find a significant direct impact of a positive electricity price shock on relative service price dispersion may suggest the effects are indirect via trend inflation and inflation volatility as in Fig. 9.5(b). Thus, trend inflation rises significantly for over six months in response to a positive electricity price shock. Furthermore, in Fig. 9.5(c) inflation volatility increases significantly for 10 months. In Fig. 9.5(d), the trend inflation

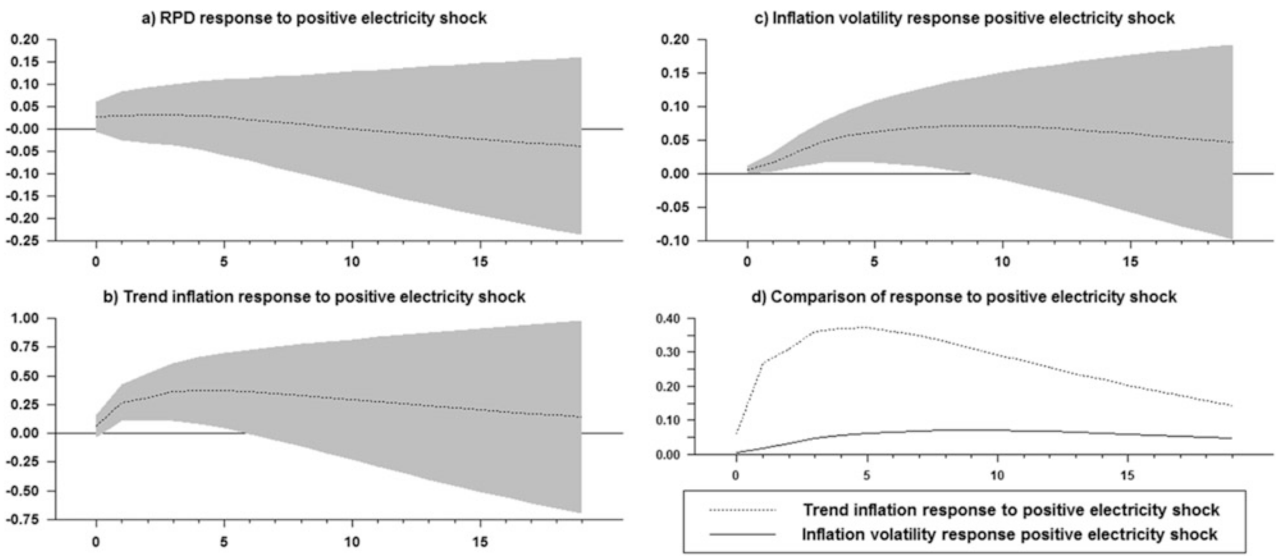

Fig. 9.5 Cumulative impulse responses to a positive electricity price shock. *Source*: Authors' calculations. *Note*: The shaded areas denote the 16th and 84th percentile error bands. The lines denote the impulse responses. The shock is a positive generalised one standard deviation shock

is very responsive and remains at high levels over all horizons relative to the response of inflation volatility.

9.8 What Does a Nonzero Inflation Threshold Which Minimises Relative Services Price Dispersion Mean for Policy?

How useful is the positive inflation threshold determined in the earlier sections in shaping the thinking of the policymakers relative to when the threshold is at zero? To determine the relevance and usefulness of the threshold, the analysis examines the asymmetric effects of inflation on relative services price dispersion during the inflation targeting period. This follows the Ball and Mankiw (1994) argument that the asymmetric price adjustment related to negative inflation shocks lead to slower adjustment of firms' desired price level, which leads to huge price dispersion relative to those of positive shocks of a similar magnitude.[14] The analysis further determines whether this is prevalent in South Africa and ascertains if policy responses will vary between the zero and nonzero inflation threshold. The zero and nonzero thresholds are consistent with the "grease" and "sand" arguments of inflation rates.[15]

Results in Table 9.3 based on the Choi and Kim (2010) methodology confirm evidence of asymmetric responses based on the zero inflation thresholds. However, the finding based on a zero inflation threshold seems to overstate the response of relative services price dispersion to price decreases and understate the response to price increases as this asymmetry no longer holds when using a positive inflation threshold of 0.473 per cent inflation.

The results based on the positive inflation threshold of 0.473[16] per cent for the inflation targeting period suggest rejection of asymmetry. Thus a nonzero inflation rate supports the U-shape established earlier in Figs. 9.1

[14] See Ball and Mankiw (1994).
[15] See Rotemberg (1996).
[16] This is based on month on month inflation changes.

Table 9.3 Results based on 2000M2 to 2011M12

Impact of inflation deviation	Model with inflation deviating from zero inflation threshold[a]		Model with inflation deviating from positive inflation threshold[b]	
Impact of positive deviation from threshold	0.19	(0.023)**	0.51	(0.00)*
Impact of negative deviation from threshold	1.16	(0.001)*	0.54	(0.00)*
Asymmetry	0.97	(0.005)*	0.03	(0.231)
Is there asymmetry		*Yes*		*No*

Source: Authors' calculations

Note: [a]Use $T = 0$ and [b]use $T = 0.473$. *P* values indicating significance are shown in brackets. The thresholds are month on month inflation. The equation is $RPD_t = \phi_0 + RPD_{t-1} + \varphi|\pi_t - T|^+ + \gamma|\pi_t - T|^- + \upsilon_t$. The specification includes both increases $|\pi_t - T|^+$ and decreases $|\pi_t - T|^-$ in inflation (π_t) as deviation from threshold value (T)

and 9.2. This shape implies that what matters is not the direction of price changes but their deviations from inflation threshold. Therefore, relative services price dispersion increases when inflation rises and deviates from the threshold. Furthermore, there are welfare costs associated with inflation deviating from the threshold as the welfare distorting effects of inflation eventually dominate. This is further evidence pointing to the benefits of stabilising the inflation rate within the inflation target band.

9.9 Conclusion and Policy Implications

The analysis conducted in this chapter found that the relationship between relative services price dispersion and inflation is captured by a quadratic relationship. There is unidirectional causality from inflation to relative services price dispersion. The turning point and threshold at which relative services price dispersion is minimised has systematically declined from high levels in the pre-inflation targeting period to within the inflation target band.

The hypothesis of asymmetry is rejected when we using the nonzero inflation rate as the threshold in support of the U-shape between inflation and relative services price dispersion. This shape implies that the direction of price changes matters but the deviations from inflation threshold matter even more. Therefore, relative services price dispersion increases when inflation increases and deviates further from the threshold. The relative price dispersion increases more as rate of inflation increases and the relationship becomes more disproportionate, suggesting that during higher inflationary outbreaks the relative service price structure is highly distorted. And so, a slightly aggressive disinflationary policy approach to minimise welfare costs associated with increases of inflation above the threshold may be required.

Evidence indicates that relative services price dispersion is driven by trend (expected) inflation supporting the menu costs theory. Thus, firm-specific menu costs lead to staggered price setting, thereby distorting the relative prices and inefficiently increasing services price RPD. There is lack of evidence to indicate that inflation volatility is a big driver of relative services price dispersion. Thus rejecting the Lucas-Barro signal extraction theory.

On a comparison basis, evidence shows that both unanticipated inflation and unexpected positive inflation dominate the impact of negative unexpected inflation. Unexpected inflation has a bigger impact relative to expected and trend inflation. Regarding the role of supply-side shocks such as electricity prices on relative services price dynamics, we found that positive supply-side shocks impact trend inflation and inflation volatility. There is weak evidence that a positive electricity shock directly raises relative services price dispersion. A positive electricity price shock works indirectly via trend inflation and inflation volatility to raise relative services price dispersion. As a result, trend inflation is very responsive to a positive electricity shock and remains at high levels over all horizons compared to the reaction of inflation volatility.

The policy implication is that monetary policy can affect relative service price dispersion by lowering trend or expected inflation to within the target range. Policy initiatives that reduce unexpected inflation will minimise the distortionary effects of high realised inflation in allocating resources and welfare. Furthermore, the results based on the threshold show that the objective of lowering and minimising the marginal effects of inflation on expected inflation, inflation volatility and relative services price dispersion does not imply keeping inflation close to zero per cent.

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Part II

The Terms-of-Trade, Fiscal Policy, Labour Market Conditions and Inflation in South Africa

10

Negative Terms-of-Trade Shock, the Real Effective Exchange Rate and Repo Rate Adjustments

Learning Objectives

- The adjustment of the trade account to a positive terms-of-trade shock and the Harberger-Laursen-Metzler (HLM) effect
- The net effects of oil prices and terms-of-trade shocks
- Terms-of-trade threshold and whether negative terms-of-trade shocks constrain monetary policy

10.1 Introduction

This chapter explores the impact of a negative shock to terms-of-trade on the real effective exchange rate (REER) and the pace of repo rate adjustments. Rather than focus on the temporary or persistent nature of these shocks, this chapter assesses the net effects of the concurrence of such shocks on inflation. In light of a negative shock to terms-of-trade and negative oil price shock, what are the net effects on inflation and economic activity? If these two shocks matter for the exchange rate, inflation and growth, how should monetary policy react?

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Understanding the impact of terms-of-trade shocks is further complicated by the fact that it is difficult to determine whether shocks are transitory or permanent (Funke et al. 2008). In view of the data trends that are volatile, this chapter takes the route of establishing the threshold for terms-of-trade growth and estimating the non-linearity effects based on the estimated threshold. We use the estimated threshold to assist in determining whether terms-of-trade growth is a binding constraint in any significant way to repo rate responses to inflation developments. Does the terms-of-trade threshold constrain how the repo rate should be adjusted in response to inflation developments? This exercise assists us in our attempt to derive meaningful policy implications of terms-of-trade shocks. Furthermore, terms-of-trade shocks tend to induce excessive REER volatility, affect competitiveness and can destabilise economic ativity; the analysis shows the contributions of the shocks to macroeconomic variables.[1]

10.2 What Are Some of the Implications of Negative Terms-of-Trade Shocks?

Funke et al. (2008) offers an explanation of the transmission of terms-of-trade shocks and why the adjustments to the terms-of-trade shocks are seldom smooth. They show that in order to grow following a terms-of-trade shock, the economy needs to be flexible, resources need to be reallocated rapidly to reflect the new relative prices. However, the existence of frictions within the private sector, the banking and financial system and the public sector make the quick adjustment difficult.

Terms-of-trade shocks affect the actions of the private sector, particularly those in the export sector. The assessment of investment ventures following a negative terms-of-trade shock can render some of them no longer profitable enough to continue and may have to be postponed

[1] Becker and Mauro (2006) attest that for developing countries, an adverse change in the terms-of-trade is the most costly type of shock as it reduces income growth. Furthermore, in most instances positive terms-of-trade shocks are accompanied by a surge in capital inflows. The combined effects of capital inflows surges, REER appreciation and increases in export prices can result in the crowding out of non-commodities tradable industries (Aizenman 2012).

(or even scrapped) with adverse effects on capital formation and growth. Furthermore, during negative shocks, revenues fall, thereby constraining governments' ability to borrow and this leads to a slowdown in spending. Fornero and Kirchner (2014) establish that the patterns of the trade account adjustments of commodity exporting countries have differed. Some countries have conformed to the predictions of the Harberger-Laursen-Metzler (HLM) effect, while the adjustments of some countries' trade balances have been best described by the intertemporal approach to the current account, or the so-called Obstfeld-Razin-Svenson effect.

Fig. 10.1 shows that the strength of the co-movement between terms-of-trade and the trade balance as a percentage of GDP has varied over the entire sample period as shown by the scatterplots for the two subsamples 2000Q1 to 2015Q1 and 2004Q1 to 2015Q1. The scatterplots show a positive relationship for the period 2004Q1 to 2015Q1 and a negative relationship for the period 2000Q1 to 2015Q1. The relationship is explored further in the later sections in the chapter.

10.3 Is There Evidence of Harberger-Laursen-Metzler Effect?

On the other hand, there is an inverse relationship between terms-of-trade and the repo rate and the cross correlations indicate that the repo rate declines when it is preceded by terms-of-trade. This suggests that an increase in the terms-of-trade should lead to a reduction in the repo rate, or alternatively, policy tightening when the economy experiences a negative terms-of-trade shock.

Furthermore, the relationship between terms-of-trade and the REER is positive, suggesting that a rise in the terms-of-trade leads to REER appreciation. The cross-correlations indicate that the REER appreciates transitorily when it is preceded by the terms-of-trade. In addition, the relationship between inflation and the terms-of-trade is positive, suggesting that an increase in the terms-of-trade tends to leads to inflationary pressures. However, the lack of a perfect one-to-one movement in the variables indicates that

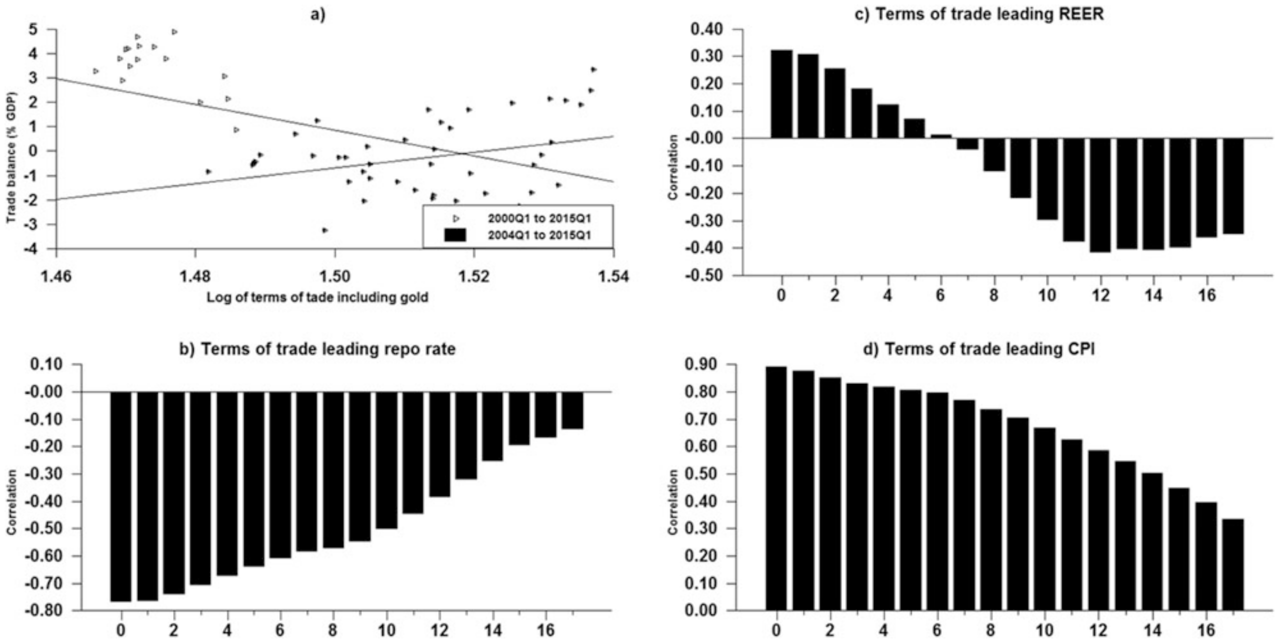

Fig. 10.1 Trade balance and terms-of-trade relationship and cross correlations. *Source*: South African Reserve Bank and authors' calculations. *Note*: All points show the scatterplot in period 2000Q1 to 2015Q1. The black dots show the scatterplot in period 2004Q1 to 2015Q1

there are other drivers of inflation. The cross correlations show a positive relationship, suggesting that a rise in the terms-of-trade is often associated with inflationary pressures. Last, the relationship between terms-of-trade, GDP growth and private consumption expenditure is positive.

The empirical analysis starts with the extension of the Grohé and Uribe (2015) VAR model by incorporating the policy rate and inflation. The analysis uses quarterly data spanning 2000Q1 to 2015Q1. The variables in the model include terms-of-trade, the trade balance as percentage of GDP, GDP, consumption expenditure, consumer price index, the repo rate, oil prices expressed in rand and the REER. All the variables excluding the repo rate and the trade balance enter the model in log levels. The model is estimated using one lag as selected by the Akaike Information criterion (AIC). The model is estimated using 10,000 Monte Carlo draws. In later estimations of the differential impact of terms-of-trade and oil price shocks, we replace terms-of-trade with oil prices expressed in rand. The terms-of-trade and oil prices are exogenous and South Africa is a small player in the world commodity markets. Furthermore, variations in the terms-of-trade and oil prices can be regarded as exogenous sources of aggregated fluctuations.

Is there evidence that supports the Harberger-Laursen-Metzler (HLM) hypothesis or the Obstfeld-Razin-Svenson effect in the South African data? Fig. 10.1 indicates that the nature of the relationship has been unstable. Therefore, an understanding of the extent to which a positive terms-of-trade shocks impacts the trade balance and the current account can indeed prove to be helpful. Fig. 10.2 shows the impulse responses to a 10 per cent unexpected increase in the terms-of-trade. The impulse responses show that a 10 per cent increase in the terms-of-trade leads to nearly 1.5 per cent increase in the trade balance, shown in Fig. 10.2(a).

However, the results show that on impact there are marginal differences in the responses of the trade balance when considering the inclusion or exclusion of gold in the terms-of-trade. Fig. 10.2(b) shows that the terms-of-trade shock takes two years to die off, irrespective of whether gold is included or excluded. This suggests that the shock is fairly transitory. The data supports the HLM effect.[2] Furthermore, the

[2] Otto (2003) and Grohé and Uribe (2015) also find a positive response in the trade balance to an improvement in the terms-of-trade.

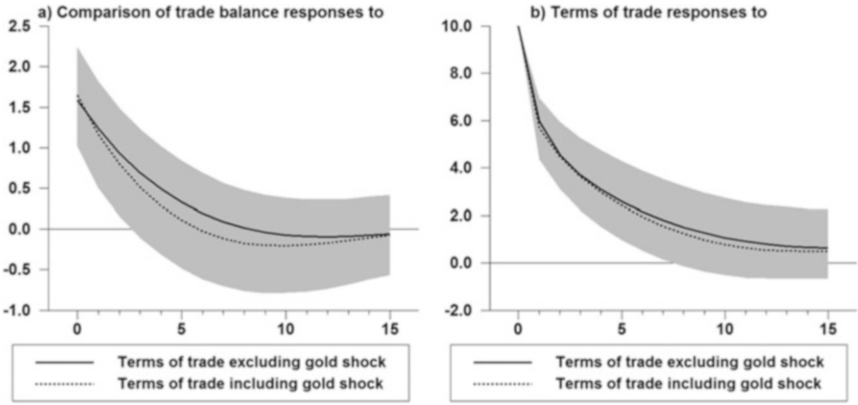

Fig. 10.2 Trade balance responses to a positive 10 per cent terms-of-trade shock. *Source*: Authors' calculations

responses suggest that the adjustment of the trade account is characterised by the dominance of the consumption-smoothing effect over the investment effect. This is consistent with the view that agents largely perceive the positive terms-of-trade shock as transitory and it therefore does not incentivise them to alter the capital stock (Kent 1997). An improvement in savings leads to an increase in the trade balance. Secondly, it may also reflect the dominance of the income effect due to high export prices over the substitution-effect induced by lower import prices. Hence, the improvement in terms-of-trade leads to an increase in trade balance.

10.4 Do Oil Price Declines Offset Negative Terms-of-Trade Shocks on Economic Growth?

Fig. 10.3 show the responses to a negative terms-of-trade shock. A 10 per cent decline in the terms-of-trade results in a decline in GDP of nearly 1.5 per cent after 10 quarters. Consumption expenditure declines sharply and reaches a peak of nearly 2.5 per cent around the eighth quarter. In both

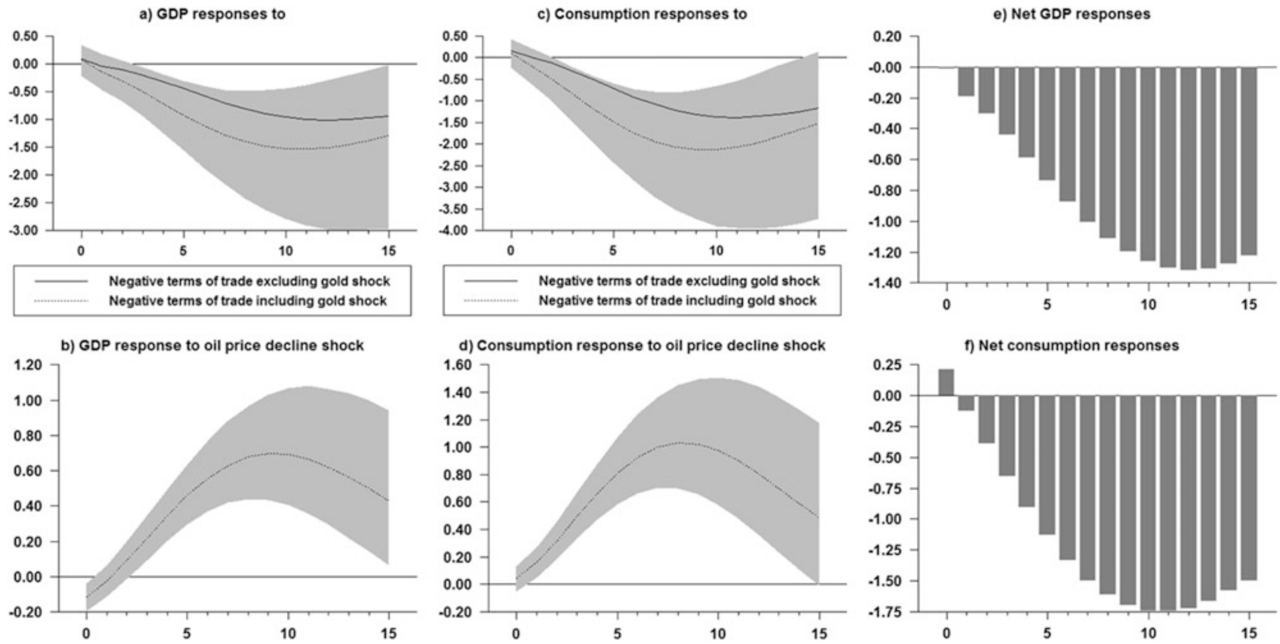

Fig. 10.3 GDP and consumption expenditure responses to a 10 per cent decrease in terms-of-trade. *Source*: Authors' calculations

cases the decline in GDP and consumption is more pronounced when the terms-of-trade include gold. Fig. 10.3(b) and (d) shows that an unexpected 10 per cent reduction in oil prices leads to increases in GDP and consumption expenditure over longer horizons.

What are the net effects of a negative terms-of-trade including gold shock and an unexpected decline in oil price on GDP and consumption expenditure? To arrive at an estimate of the net effects, the analysis adds the responses of GDP and consumption expenditure separately to both shocks. In net terms[3] GDP and consumption decline less than they would have in the absence of an unexpected decline in oil prices. This means that a decline in oil prices does indeed cushion GDP and consumption expenditure to adverse effects of negative terms-of-trade shocks. At peak, the decline in GDP is less than that when considering the terms-of-trade including gold effects only.

The net effects on consumption expenditure are positive in the first quarter, as the benefits of the lower oil prices more than neutralise the negative effects of the decline in the terms-of-trade including gold. However, the net benefits of the oil prices die off.

10.5 Negative Terms-of-Trade Shock, Unexpected Decline in Oil Prices, Inflation and Policy Rate Adjustments

As Fig. 10.4(a) shows, a negative terms-of-trade shock results in the depreciation of the REER by nearly 2.5 per cent on impact and reaches peak depreciation of 7.5 per cent in the first quarter. The REER depreciation lasts nearly five quarters, which is long enough to lead to highly persistent inflationary pressures. The repo rate is tightened and remains tight for nearly eight quarters and inflation responds to the decline in the terms-of-trade in line with weak income effects, as well as the decline in demand for non-traded goods. Hence, there are weak inflationary

[3] The net effects shown in this section are based of the impulse responses of the terms-of-trade including gold. The net effects based on the terms of trade excluding gold follow a similar trajectory and the magnitudes. However, they are not included in this analysis but can be made available to the reader upon request.

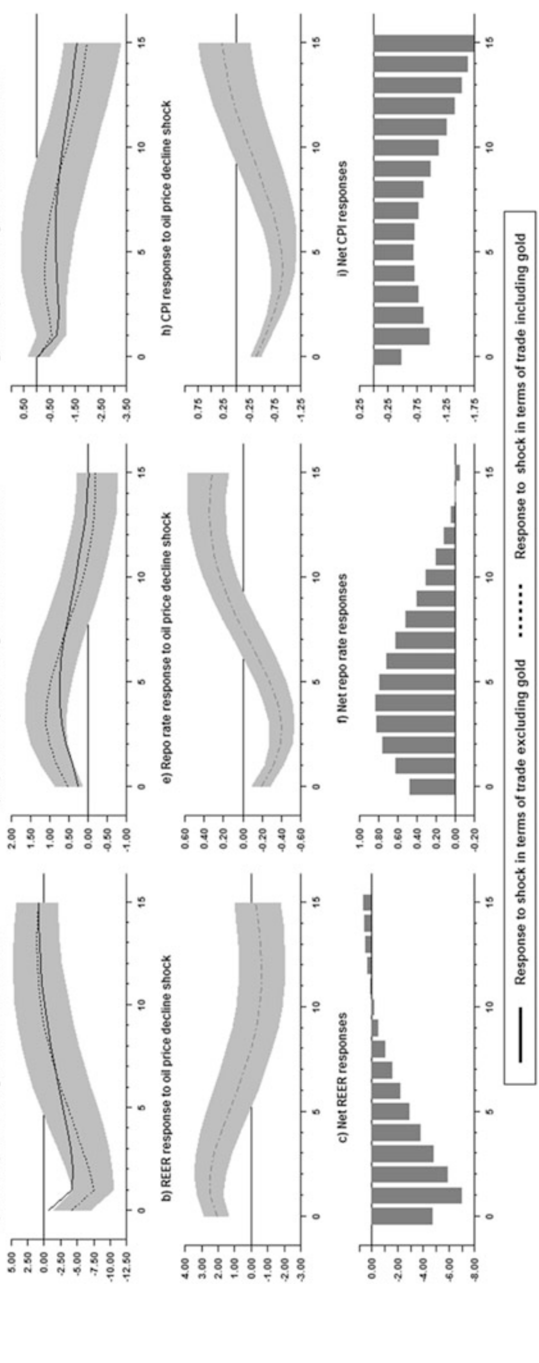

Fig. 10.4 REER, inflation and repo rate responses to negative terms-of-trade and oil prices shock. *Source*: Authors' calculations

pressures after eight quarters. The REER appreciates insignificantly whilst inflation and the repo rate declines. However, policymakers do not observe the isolated responses; they respond to the net effects of these shocks on inflation.

In net terms,[4] the terms-of-trade effects dominate the outcomes as the REER depreciates significantly. The repo rate is tightened and inflation declines. This suggests that the tightening in the repo rate due to the REER depreciation, in net terms leads to a decline in inflation.

10.6 How Important Are Terms-of-Trade and Oil Price Shocks in Inducing Business Cycle Fluctuations?

The fraction of the variance induced by the terms-of-trade shock in Fig. 10.5 shows that the terms-of-trade, excluding gold, explain high fluctuation in the repo rate of 22 per cent compared to less than 10 per cent due to terms-of-trade with gold. A similar pattern is observed in REER fluctuations, trade balance and GDP as these fluctuate by at most by 22 and 40 per cent, respectively. In addition, inflation fluctuates by at most 18 per cent in the long term due to terms-of-trade shocks. This suggests that terms-of-trade are important for the business cycle. It also matters which definition of the terms-of-trade is used.

Furthermore, the historical contributions in Fig. 10.6 suggest that terms-of-trade shock contributed to the REER appreciation for a long period between 2009 and 2013. During this period the terms-of-trade contributions to the repo rate were negative.

This suggests that there is a close relationship between terms-of-trade dynamics and the business cycles, which are transmitted via the exchange rate to impact the policy rate. Furthermore, the contributions of terms-of-trade in increasing the repo rate coincided with periods in which the

[4] The net effects shown in this section are based of the impulse responses of the terms-of-trade including gold. The net effects based on the terms of trade excluding gold follow a similar trajectory and the magnitudes. However, they are not included in this analysis is available to the reader upon request.

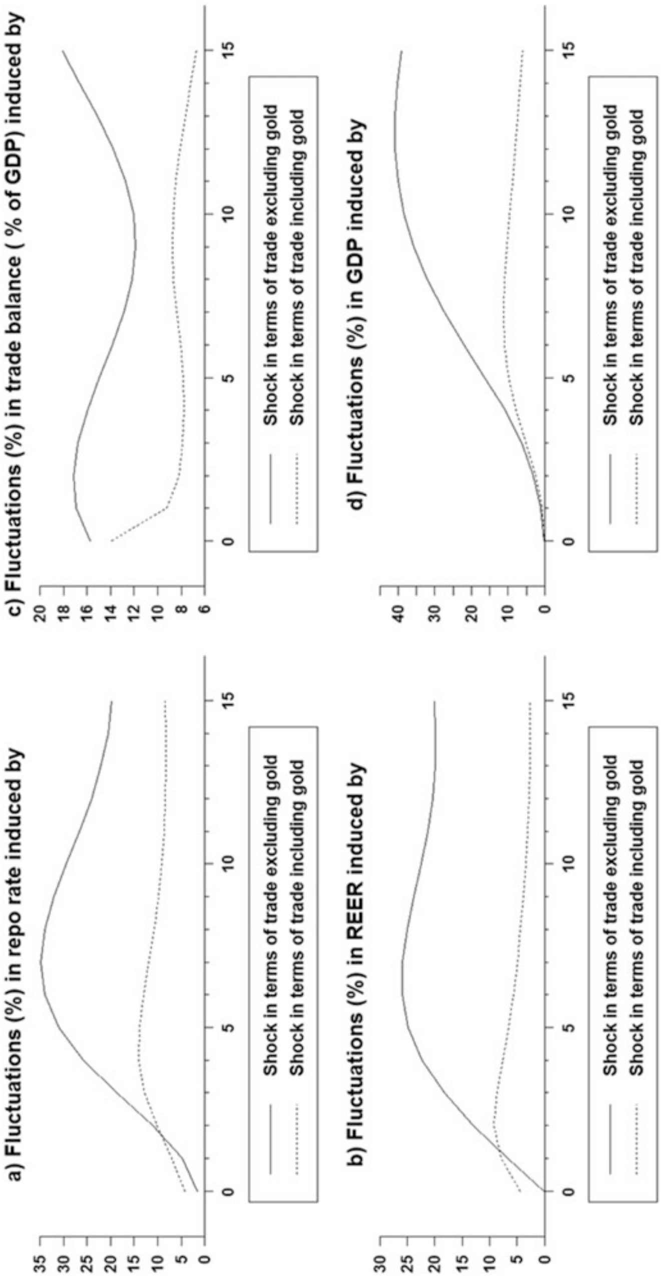

Fig. 10.5 The proportions of fluctuations due to terms-of-trade shock. *Source*: Authors' calculations

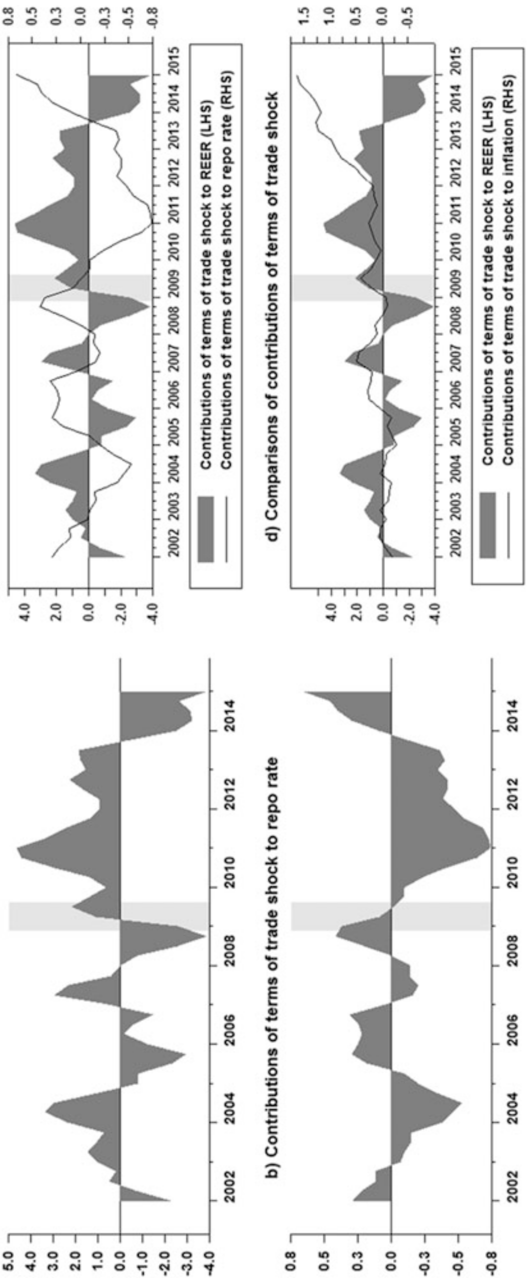

Fig. 10.6 Terms-of-trade contributions to CPI, REER and repo rate. *Source*: Authors' calculations

terms-of-trade and the REER depreciated. The depreciation in the REER in end of sample coincided with increasing inflationary pressures. However, evidence suggests that the exchange rate is a stabilising mechanism. The depreciation of the REER coincides with positive contributions to GDP and consumption. This means that a depreciation of exchange rate due to negative terms-of-trade shocks is likely to stabilise economic growth and it will have a positive effect on income growth. Nonetheless, this depends on whether domestic prices are sticky. Funke et al. (2008) show that if prices are sticky, then the relative prices will adjust faster through changes in the real exchange rate.

10.7 Do the Terms-of-Trade Growth Regimes Pose a Policy Dilemma?

Does the deterioration of terms-of-trade pose a policy dilemma? Alternatively stated, in pursuing monetary policy within the flexible inflation targeting framework, do the terms-of-trade regimes constrain the ability of policymakers to respond to inflationary pressures? We use the modified Balke (2000) threshold VAR approach to establish the threshold value of 1.363 per cent on quarter-to-quarter changes in terms-of-trade. To get enough degrees of freedom the threshold VAR model is estimated using data spanning 1990Q1 to 2015Q1. The VAR is estimated with the repo rate, inflation and terms-of-trade inflation to assess their responses in different regimes subject to the estimated threshold.

Figure 10.7 shows that in low and high terms-of-trade growth regimes monetary policy responds to inflationary pressures. The repo rate is tightened in response to positive inflation shocks. In contrast, the repo rate is loosened to unexpected negative inflation shocks. However, evidence shows that the repo rate responds more aggressively to large inflation shocks than to small inflation shocks, which points to the presence of asymmetry. The magnitude of the repo rate tightening is slightly larger than the magnitudes during loosening episodes. Monetary policy is tightened to curb inflationary pressures in both low and high terms-of-trade inflation regimes.

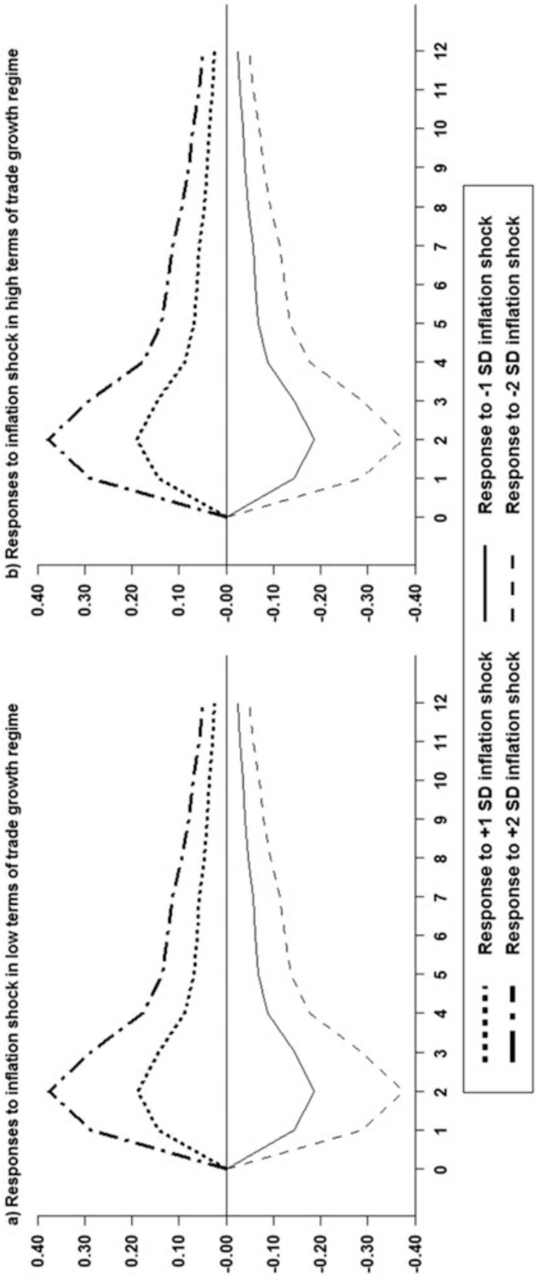

Fig. 10.7 Repo rate response to one and two standard deviation inflation shocks according to terms-of-trade regimes. *Source*: Authors' calculations. *Note*: SD means standard deviation

Thus the terms-of-trade inflation regimes do not constrain the monetary policy response to curb inflationary pressures. Terms-of-trade regimes are not a binding constraint on the policymakers' mandate of maintaining the price stability.

10.8 Conclusion and Policy Implications

In view of the fact that policymakers do not observe shocks individually, we assessed the net effects of the concurrence of negative terms-of-trade and oil price shocks on inflation and the response of the policy rate. First, we established that the adjustment of the South African trade balance to positive terms-of-trade shock is consistent with the Harberger-Laursen-Metzler (HLM) effect. Furthermore, the responses suggest that the adjustment of the trade account is characterised by the dominance of the consumption-smoothing effect over the investment effect. Such behaviour is consistent with the view that agents largely perceive the positive terms-of-trade shock as transitory. Therefore, growth in terms-of-trade does not necessarily induce agents to significantly alter the capital stock.

The net effects of negative terms-of-trade and oil prices shocks indicate that a decline in oil price cushions GDP and consumption. But the positive net benefits of the oil prices on consumption are very transitory. Furthermore, in most instances the depreciation of the REER coincides with positive contributions to GDP and consumption. But the REER depreciates for more than a year, which is long enough to lead to highly persistent inflationary pressures. The repo rate tightens in response to the expected inflationary pressures associated with the depreciation in the REER.

Is monetary policy constrained by terms-of-trade shock? No. Evidence assessing the policy responses subject to growth in the terms-of-trade thresholds shows that monetary policy responds to inflationary pressures. The repo rate is tightened in response to positive inflation shocks to curb inflationary pressures in both low and high terms-of-trade inflation regimes. However, the slowdown in income and demand due to the negative terms-of-trade shock could depress inflation for a longer period. The policy implication of the evidence is that the terms-of-trade regimes are not a binding constraint on monetary policy. Policymakers are able to execute their mandate in pursuit of price stability, irrespective of terms-of-trade regimes.

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11

Do Fiscal Policy Variables Drive Inflation in the Same Direction?

Learning Objectives

- How fiscal policy variables drive inflation dynamics
- Whether the monetary policy response to positive inflation shocks is affected by different tax components and government consumption

11.1 Introduction

Do fiscal policy variables drive inflation dynamics? Do these shocks impact the response of GDP and inflation growth to positive repo rate shocks? Theory predicts different price level reactions due to changes in fiscal policy effect via (i) cutting government spending, and (ii) increasing tax rates, resulting in an increase in tax revenues. In this case, a restrictive fiscal policy stance by reducing government spending lowers inflation but the extent of the price decline may be offset by increased taxes. On the

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other hand, it is possible that via "expansionary fiscal contraction effects" cuts to government spending can lead to economic expansions.[1]

The lack of a clear price level response based on theory prompts us to embark on an empirical analysis and ask: To what extent do positive tax revenue and government spending shocks amplify or neutralise the impact of repo rate adjustments to positive inflation shocks? In which periods did tax revenue and government spending uplift and drag inflation? What are the combined effects of the increase in tax and spending reduction on inflation dynamics in 2015?

It is possible that fiscal policy can propagate (reinforce) or neutralise monetary policy efforts by lowering (increasing) inflation under certain circumstances. In Fig. 11.1 based on Arnold (2004) monetary policymakers would benefit from restrictive fiscal policy shocks when fiscal policy lowers output (Y) from Y_0 to Y_2 rather than to potential output denoted by Y_D. When the short-run (SRAS) and long-run (LRAS) supply curves are important and operational in the economy's adjustment towards shocks, then fiscal policy action which reduce government spending will shift the short-run supply curve upwards. Due to lags in the transmission and legislative processes, policymakers implementing restrictive fiscal policy may end up with aggregate demand (AD) AD_2 intersecting $SRAS_2$ at point ***b*** rather at point ***a***.

While the preceding effects are plausible, not all economic theories allude to fact that fiscal policy can impact the price level. This divergence and inconclusiveness of the final effects of fiscal policy on the price level is not limited to economic theory only but also extends to empirical studies. For instance, the Keynesian theories highlight that restrictive fiscal policy impacts the price level as shown in Fig. 11.2(a) but the extent of the price level response depends on whether it was anticipated on not.[2] In contrast, fiscal policy does not impact the price level in the new classical economics in Fig. 11.2(b) and the Ricardian theories.

[1] The effect comes into play as the private sector fills the output decline due to improvement in confidence and possible lower cost of borrowing.

[2] As shown in Fig. 11.2(a), the simple Keynesian theory based on assumptions such as price rigidity postulate that aggregate demand impacts output. According to this model, consumption responds to current income and fiscal expansion has a multiplier effect on growth.

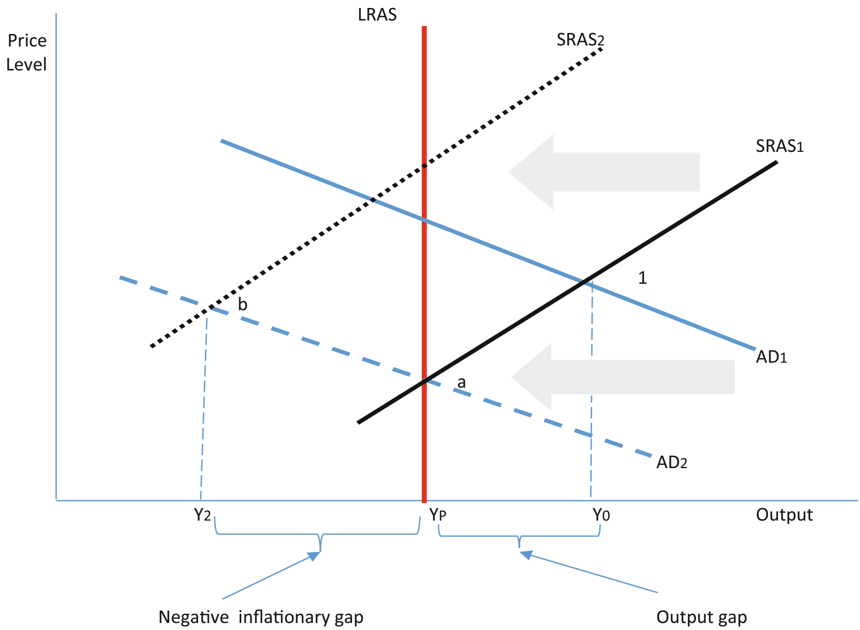

Fig. 11.1 Reduction in inflation due to decrease in government spending. *Source*: Authors' drawing and adapted from Arnold (2004)

The Ricardian equivalence suggests that consumers are forward-looking and fully aware of the government's intertemporal budget constraint. Consumers know that a tax cut today will be financed by higher taxes in the future. Hence, their consumption does not change because their permanent income is unaffected. The knowledge that increasing government spending by borrowing today will be offset by future spending cuts and tax increases leaves output unchanged.

The current policy landscape is dominated, and rightfully so, by the discussion of what are the policy interventions to deal with persistent low GDP growth. The realisation that monetary policy expansion has limits and that it has carried a disproportionate burden post-crisis has brought the debate about fiscal and monetary co-operation and structural reforms into sharp focus. If monetary policy is overburdened, fiscal policy needs to play a more active role.

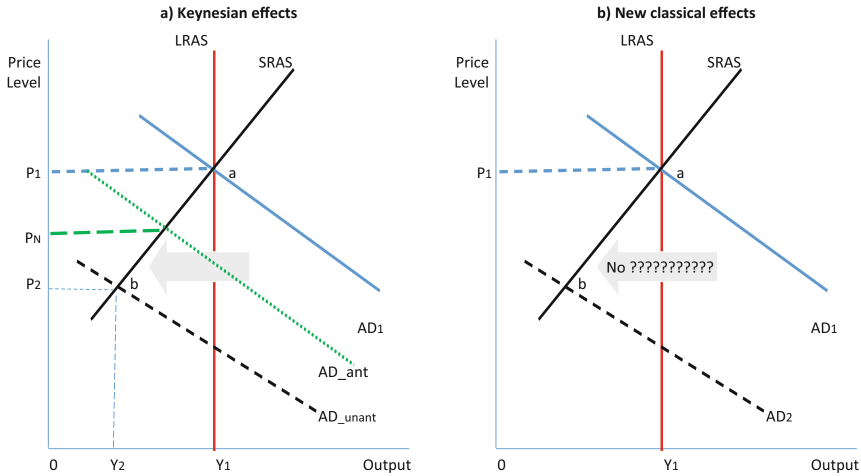

Fig. 11.2 Price level predictions by Keynesian and new classical models. *Source*: Authors' drawing and adapted from Arnold (2004). *Note*: "ant" refers to anticipated and "unant" means unanticipated effects

11.2 To What Extent Do Fiscal Variables Amplify Economic Responses?

To enable policy evaluation the analysis applies a counterfactual approach to determine the extent to which total tax revenue and final consumption by general government amplify and neutralise repo rate responses to positive inflation shocks. The counterfactual approach determines what the inflation rate would be if the fiscal variables are shut off in the model. This demonstrates whether fiscal policy as measured by these variables propagates or neutralises the monetary policy adjustment and the enforcement of the price stability mandate. Furthermore, a counterfactual analysis to determine the extent to which tax revenue amplifies or neutralises GDP growth responses to tight monetary policy shocks is performed. The gap between the counterfactual and actual responses measures the dampening or amplifying effects exerted by tax revenue from different sources and final consumption expenditure by government.

The empirical analysis uses quarterly (Q) data starting in 2000Q1 and ending in 2015Q4. The estimated VAR model includes annual headline

CPI inflation, GDP growth, tax revenues growth, final consumption expenditure by government growth and repo rate. The VAR is estimated using two lags selected by AIC and using 10,000 Monte Carlo draws to calculate the average impulse responses and 16th and 84th percentile confidence bands.[3] Fig. 11.3(c) and (d) shows the roles of taxes on income and taxes on goods and services on amplifying GDP responses to monetary policy tightening shocks.

There are similar effects between taxes on income and tax on goods and services. The GDP growth decline is sharp when total taxes are not shut off than when they are shut off.

What is the role of the fuel levy and VAT on GDP growth during monetary policy tightening shocks? Fig. 11.4 shows similar effects between the fuel levy and VAT. GDP growth declines more when the fuel levy and VAT are not shut off than when they are shut off. This suggests that increased fuel levy and VAT accentuates the effects on monetary policy tightening shocks on the decline in GDP growth.

11.3 The Impact of the Tax Components on Repo Rate Responses to Positive Inflation

Fig. 11.5 indicates that actual repo rate increases more than the counterfactual repo rate when total tax revenue and final consumption by government are not shut-off. This suggests that cumulative expansionary fiscal policy which increases government spending magnifies the repo rate responses to positive inflation shocks. However, total tax revenue has a bigger magnifying effect than that exerted by final consumption expenditure by government. Given the symmetric nature of the responses, this

[3] We tested the robustness of the evidence to different ordering and the results did not change, indicating they were robust. This included placing the final consumption expenditure by government before total tax revenue growth and placing GDP growth before headline inflation. In other estimations, we replaced final consumption by government by other government expenditure component while tax revenues were replaced with tax components and non-tax revenues growth.

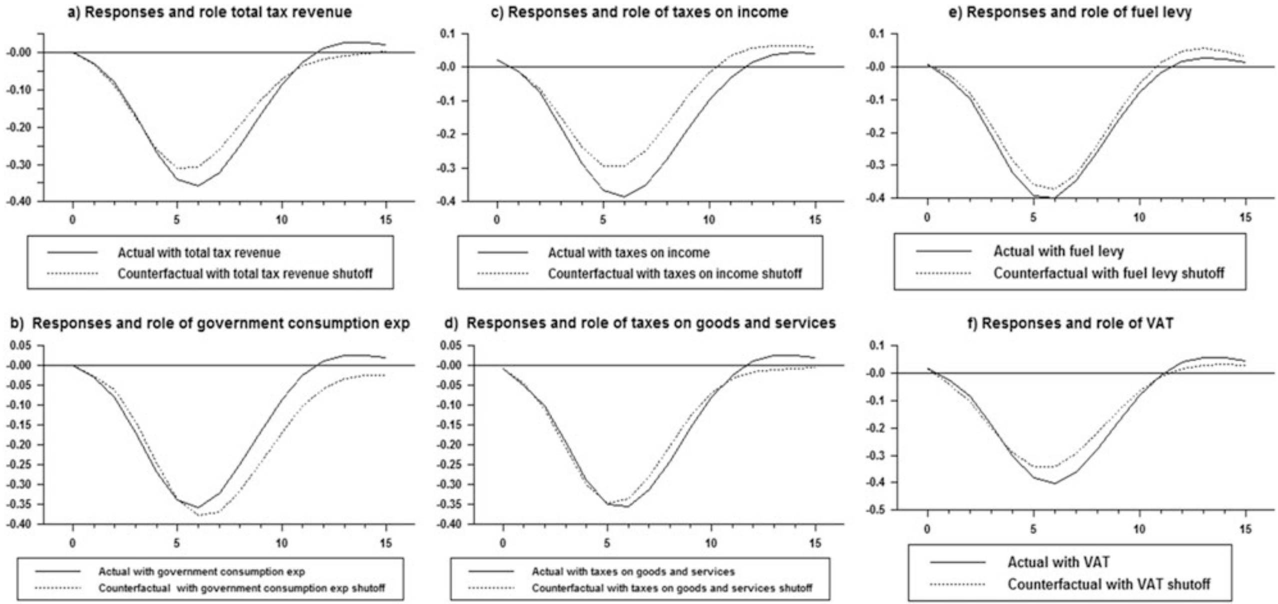

Fig. 11.3 GDP responses to repo shocks and the role of taxes and final consumption expenditure by general government. *Source*: Authors' calculations

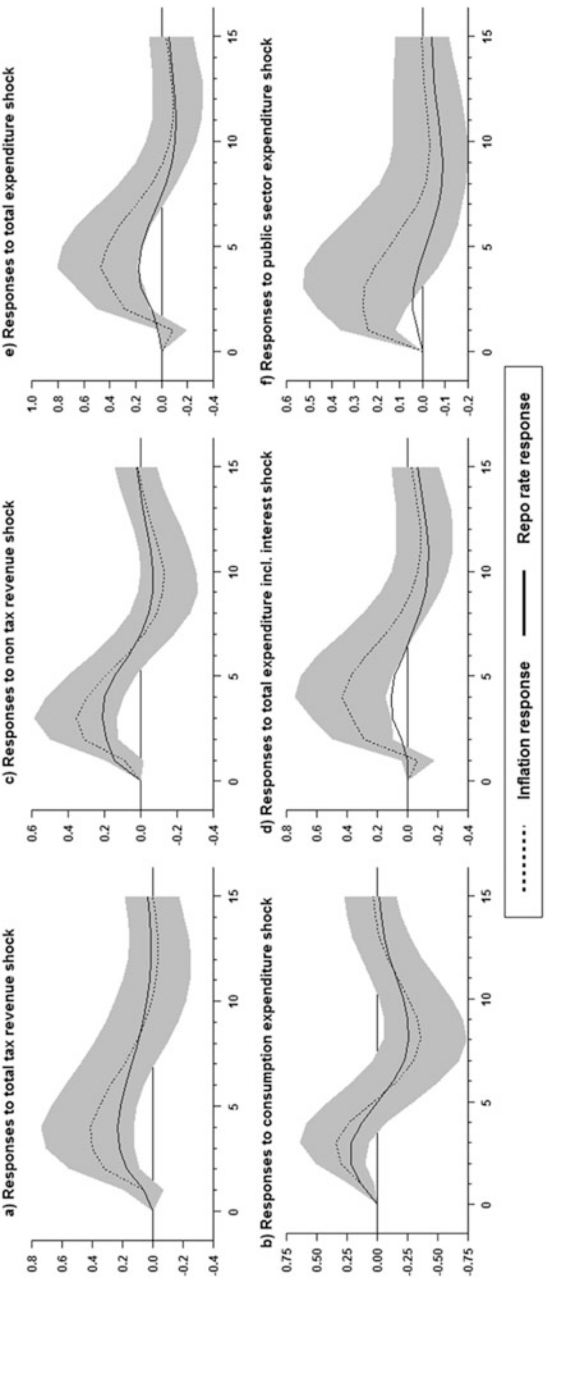

Fig. 11.4 Inflation and repo rate responses to tax and spending shocks. *Source*: Authors' calculations

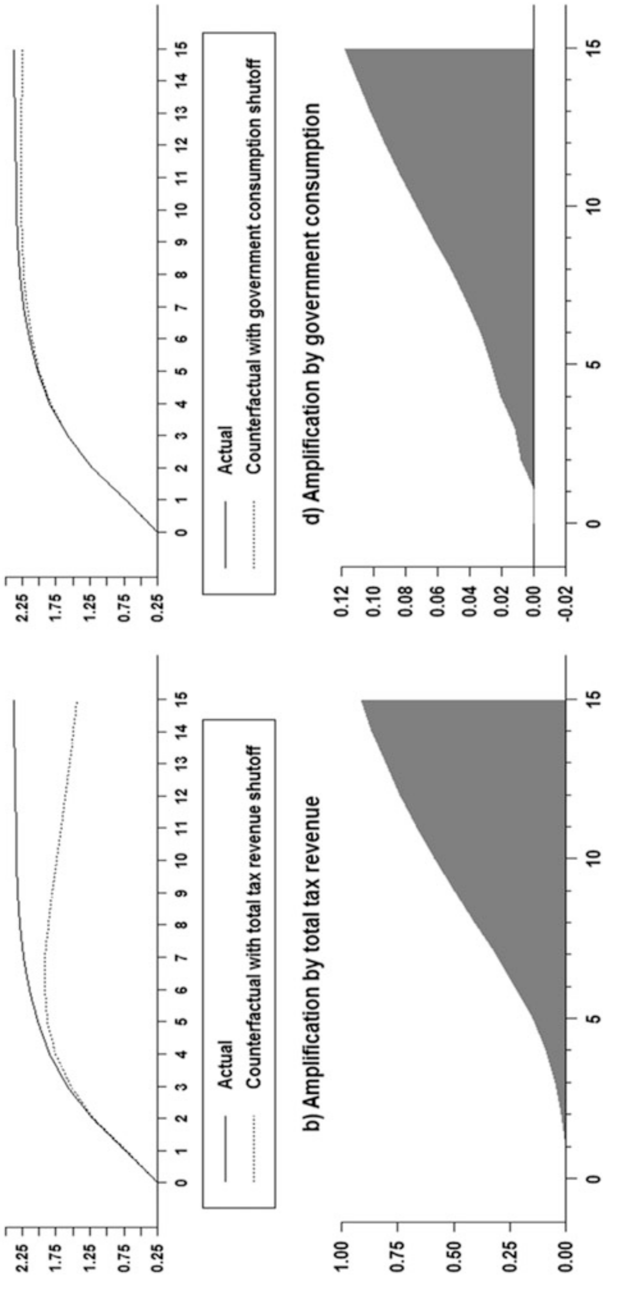

Fig. 11.5 Repo rate responses to positive inflation shocks and role of fiscal variables. *Source*: Authors' calculations

suggest that cuts in government spending lower inflation but this may be neutralised by the effects on increased taxes.

What about the components of taxes which include company income tax (CIT), personal income tax (PIT), taxes on income, taxes on goods and services, VAT and fuel levy? Fig. 11.6 shows that there are heterogeneous results as expected. The repo rate increases more in the presence of company income tax, taxes on income and taxes on goods and services. The actual repo rate would be much lower than the counterfactual repo rate when VAT and the fuel levy are not shut off relative to when they are shut off.

Overall, evidence shows that monetary policy is tightened by raising the repo rate to curb inflationary pressures irrespective of developments in the tax components. However, the degree to which the repo rate rises varies given differing amplifying abilities of the tax components. In this regard, evidence indicates that VAT and the fuel levy induce muted increases in the repo rate than when these variables are not shut off in the model.

11.4 Counterfactual Evidence from Historical Decomposition

How have the contributions on inflation evolved over time? We complement the previous analysis by applying a historical decomposition approach, which decomposes a variable into its trend, own contributions and contributions from other variables. Thereafter, we shut off the variables of contributions of selected fiscal policy contributions from actual inflation to determine the counterfactual inflation rate. The actual and counterfactual inflation rates are plotted together and the comparison begins from 2009Q1 until 2015Q4. Fig. 11.7 shows that the contributions from final consumption expenditure by government were negative since 2013Q3, suggesting that these fiscal variables contributed to the decline in inflation. However, on an individual basis evidence indicates the dominance of final consumption by government over total tax revenue contributions.

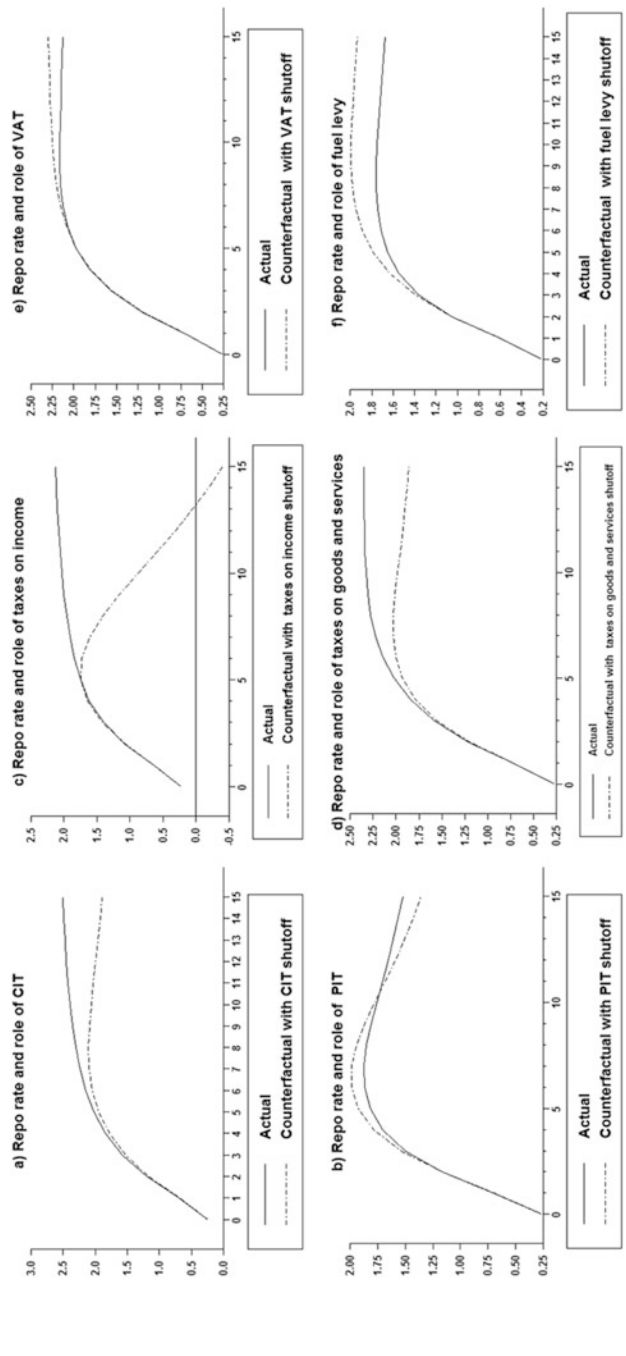

Fig. 11.6 Cumulative responses of repo rate to positive inflation shocks and role of tax components. *Source*: Authors' calculations

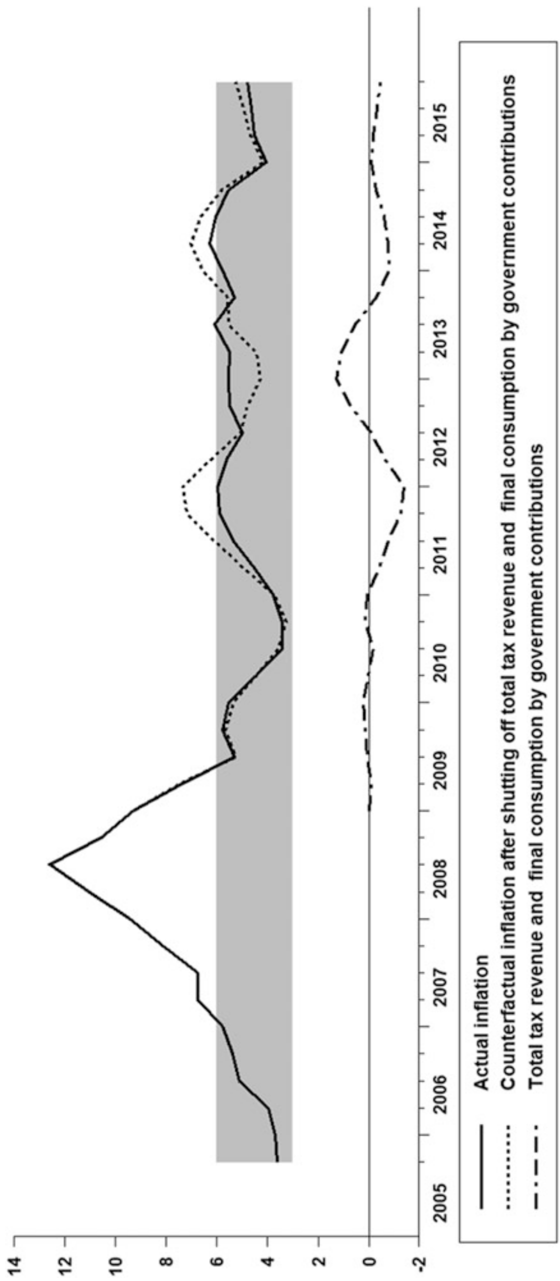

Fig. 11.7 Actual and counterfactual inflation and combined role of total tax revenue and final consumption by government. *Source*: Authors' calculations

Furthermore, the counterfactual inflation rate suggests that total tax revenue made positive contributions to actual inflation rate. Similarly, changes in income tax and company income tax made more positive contributions to actual inflation as suggested by the counterfactual inflation rate.

11.5 Conclusion and Policy Implications

Despite the theoretical diverging views on the fiscal policy effects on the price level, evidence in this chapter establishes different effects between total tax revenue and final consumption expenditure by government. Do fiscal variables accentuate the effects of tight repo rate on GDP growth? Yes, we find similar effects between taxes on income and tax on goods and services indicating that GDP growth declines very much when total taxes are not shut off than when they are shut off. What about the role of the fuel levy and VAT on GDP growth and monetary policy tightening shocks? GDP declines more when the fuel levy and VAT are not shut off than when they are shut off. This evidence suggests that taxes on income, tax on goods and services, increased fuel levy and VAT accentuates the effects on monetary policy tightening shocks on the decline in GDP growth.

Overall, evidence shows that monetary policy is tightened by increasing the repo rate to curb inflationary pressures irrespective of developments in the tax components. However, the degree to which the repo rate rises varies given differing amplifying abilities of the tax components. Evidence indicates that since 2013 the counterfactual inflation rate exceeded the actual inflation, suggesting the dominance of final consumption by government over total tax revenue in lowering inflationary pressures.

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12

What Would Inflation and Repo Rate Be in the Absence of Increased Government Expenditure?

Learning Objectives

- The direct and indirect roles of government expenditure on the pass-through of the rand depreciation shock to inflation
- Inflation rate responses to rand depreciation shock and the amplifying role of total government expenditure

12.1 Introduction

This chapter extends the analysis in the preceding chapter by focusing on the direct and indirect roles of government expenditure on the impact of the rand depreciation shock on inflation. We assess the amplification or dampening abilities of government expenditure. Would the inflation rate respond differently to rand depreciation shock in the presence or absence of growth in total government expenditure? These questions are investigated using the counterfactual analysis which shuts-off this variable as well, based on historical decompositions.

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12.2 Impact of Government Expenditure on Inflation and GDP Growth

We start by estimating a VAR model using quarterly (Q) data from 2000Q1 to 2015Q4. The model includes the annual inflation rate, GDP growth, total government revenue and expenditure excluding or including interest payments and the repo rate. Government expenditure excluding or including interest payments are included separately in the model. The model is estimated using two lags selected by AIC and 10,000 Monte Carlo draws to calculate the 16th and 84th percentile confidence bands. The responses to positive expenditure shock are separated into expenditure including and excluding interest rate payments, are shown in Fig. 12.1. The distinction in the expenditure components acts as a further test for the robustness of the effects of positive total expenditure shocks.

In Fig. 12.1 positive expenditure shock increases inflation for nearly two years and the peak increase of 0.5 per cent occurs in the fourth quarter. In contrast, the positive expenditure shock reduces GDP growth between 5 and 12 quarters and the maximum decline of nearly 0.3 per cent occurs in the two years after the shock. In addition, the policy rate tends to rise by about 20 basis points in the fourth quarter although the effect is insignificant. The results are invariant to the definition of the expenditure shock. This suggests that the results are robust as to whether interest rate payments are included or excluded from total expenditure.

12.3 Does Increased fiscal Expenditure Amplify Inflation Response to Rand Depreciation Shock?

This section applies a counterfactual approach to determine the extent to which growth in total expenditure amplifies or neutralises (i) the inflation responses to rand depreciation shocks, and (ii) the repo rate response to positive inflation shock. The counterfactual responses are determined by shutting off the influence of growth in total government expenditure (total exp) on the annual rand/US dollar exchange rate changes and

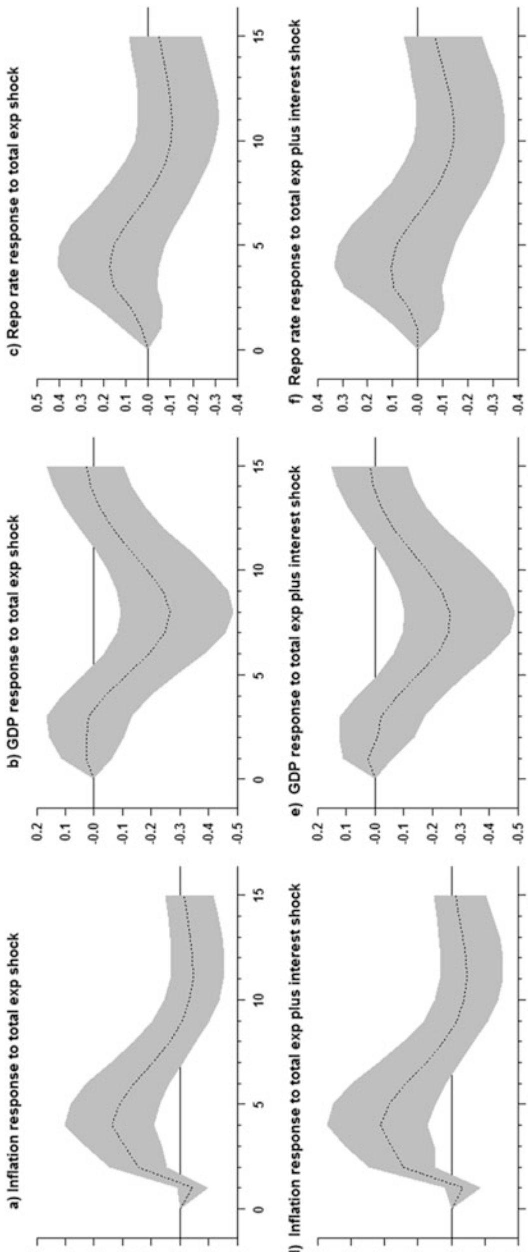

Fig. 12.1 Inflation and GDP responses to positive expenditure shocks. *Source*: Authors' calculations

repo rate equations in the VAR model. The two models are estimated by replacing the repo rate with annual rand/US dollar changes to determine the effects of the rand depreciation shock on inflation.

Fig. 12.2 shows that inflation increase due to rand depreciation shock irrespective of whether growth in expenditure is shut off or not. However, the actual inflation rate exceeds the counterfactual inflation by a slight margin when growth in expenditure is shut off in the model. In addition, the amplification displayed by expenditure including interest payments in Fig. 12.2(d) differs to those in (b) for expenditure as a ratio of GDP. The amplification due to expenditure as ratio of GDP occurs immediately but is smaller in comparison to those of expenditure including interest payment, which are larger but delayed and occur after the second quarter.

Is monetary policy impacted by total public expenditure (public exp)? The responses in Fig. 12.2(e) and (f) show that the repo rate increases due to positive inflation shocks. However, the actual repo rate trajectory remains lower than that suggested by the counterfactual repo rate path. The dampening effect is bigger when considering the role of public expenditure as a percentage of GDP rather than growth in total expenditure including interest payments.

Is the ability of monetary policy to enforce price stability impacted by public expenditure dynamics? No, the repo rate responses indicate the policy rate is tightened but the pace of tightening is slightly less aggressive when expenditure variables are not shut off than when they are active in the model.

12.4 Counterfactual Evidence from Contributions

The historical decomposition approach for 2009Q1 to 2015Q4 in Fig. 12.3 shows that the actual inflation rate has been lower than the counterfactual inflation since 2013Q2. This suggests that developments in total expenditure exerted downward pressure on inflation.

The contributions of growth in total expenditure including interest rate payments in Fig 12.3(b) shows that the contributions were positive for

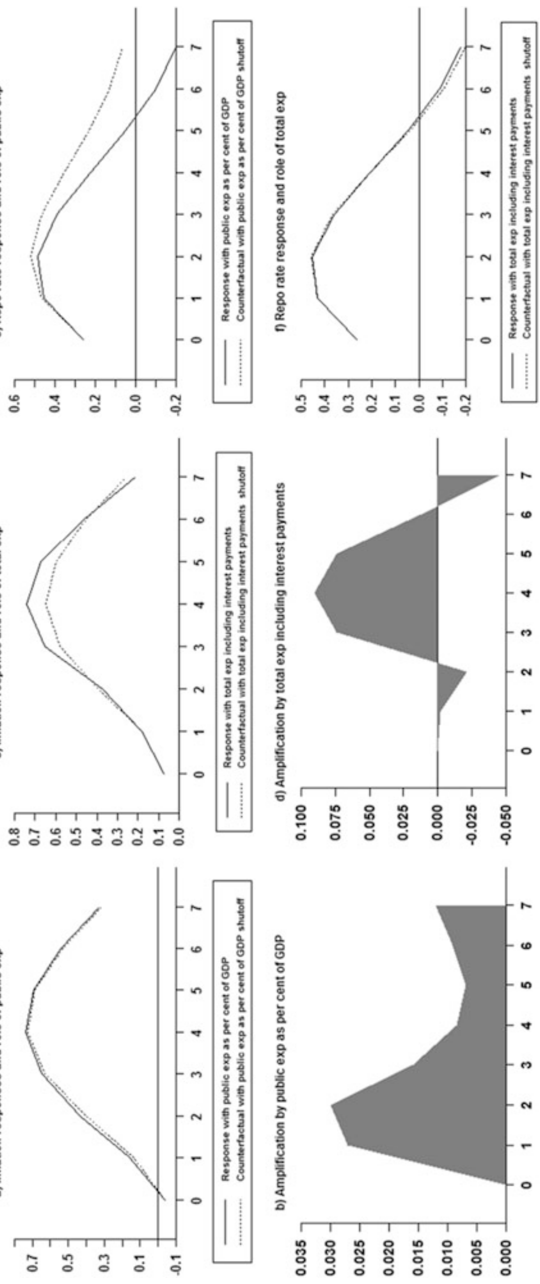

Fig. 12.2 Responses to rand depreciation shock, amplification by total expenditure and repo rate responses. *Source*: Authors' calculations

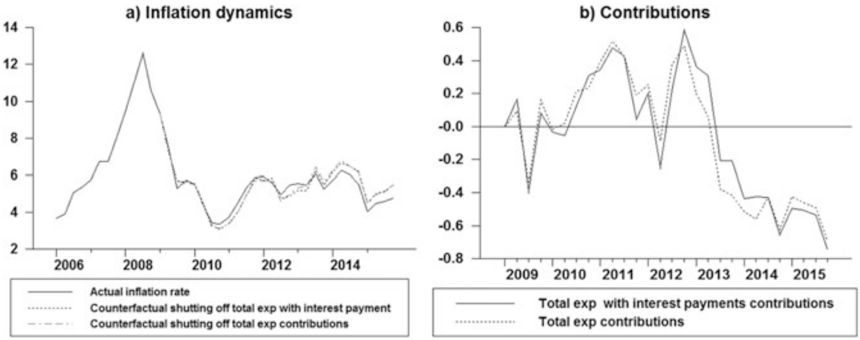

Fig. 12.3 Actual and counterfactual inflation and total expenditure contributions. *Source*: Authors' calculations

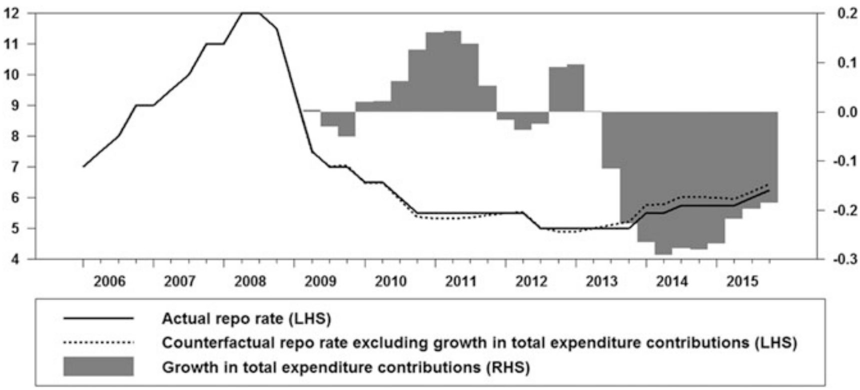

Fig. 12.4 Actual and counterfactual repo rate and the role of total expenditure. *Source*: Authors' calculations

most periods prior to 2013 and became more negative after 2013Q2. Since 2014Q3 growth in expenditure including interest rate payments contributed more to dampening inflationary pressures.

The analysis concludes by examining the extent to which growth in expenditure impacted the actual repo rate in Fig. 12.4. The counterfactual repo rate excluding growth in expenditure suggests that the actual repo rate has been lower than the counterfactual repo rate. The size of the contributions shown in bars indicate that the repo was, in certain periods, was about 0.3 percentage points lower, but the gap is closing at the 2015Q4.

12.5 Conclusion and Policy Implications

This chapter assessed the extent to which public expenditure impacts the exchange rate pass-through to inflation and the response of the repo rate. Evidence suggests that the inflation rate would increase more due to rand depreciation shock in the presence of growth in public expenditure than when it is shut off. The repo rate increases due to positive inflationary pressures but the increase is slightly lower than what it would be when growth in public expenditure is shut off. These findings indicate that monetary policy is tightened in response to inflationary pressures. Historical decompositions show that growth in public expenditure had a dampening effect on the repo rate tightening since the beginning of 2015 due to the effects of expected fiscal consolidation.

13

Labour Productivity and Unit Labour Costs Impact on Inflation: What Are the Implications for Monetary Policy?

Learning Objectives

- How unit labour costs (ULC) and labour productivity the impact of transmission of shocks to inflation
- Persistent and non-persistent ULC and labour productivity shocks effects

13.1 Introduction

Labour market conditions, unit labour costs and labour productivity contain information about the inflationary pressures. Hence the Monetary Policy Committee (MPC) pays particular attention on wage pressures. In particular, the emphasis put forward by the MPC is that unit labour costs and labour productivity should rise together to neutralise inflationary pressures. Fig. 13.1 shows that labour productivity and unit labour costs have diverged since the recession. Labour productivity has persistently declined while unit labour costs have risen. What are the implications of this divergence on inflation and the repo rate responses to inflationary pressures? What are the effects of labour productivity and unit

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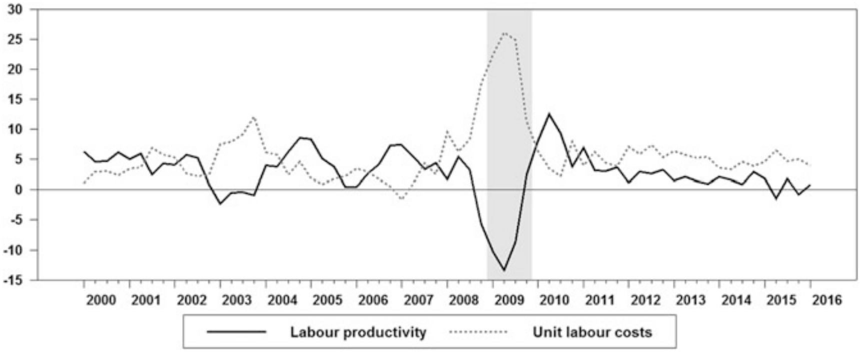

Fig. 13.1 Labour productivity and unit labour costs. *Source*: SARB

labour cost shocks to inflation when inflation exceeds 6 per cent? Does the labour productivity shock prevent monetary policy from enforcing price stability? Is there an indirect impact on the pace of policy adjustments?

We apply the counterfactual VAR analysis and the robustness tests by assessing whether the evidence changes when labour productivity is endogenous or exogenous. In the model, the endogenous assumption implies that we allow for feedback effects in contrasts to exogenous assumptions.

13.2 Inflation Responses to Positive Unit Labour Costs and Productivity Shocks

The analysis begins by examining the role of growth in labour productivity on the monetary policy responses to positive inflation shocks. A three and four variable VAR models using quarterly (Q) data from 2000Q1 to 2016Q1 is estimated. The initial analysis is based on a three variable VAR model which includes annual growth in unit labour costs (ULC), annual growth in labour productivity and inflation. The extended four variable model in the later sections include annual inflation, annual ULC growth, repo rate and labour productivity growth. The models are estimated using two lags as selected by Schwarz Bayesian Criterion (SBC) and 10,000 Monte Carlo draws.

Do unit labour costs neutralize the transmission of positive labour productivity shocks to inflation? Fig. 13.2(a) and (b) compare actual

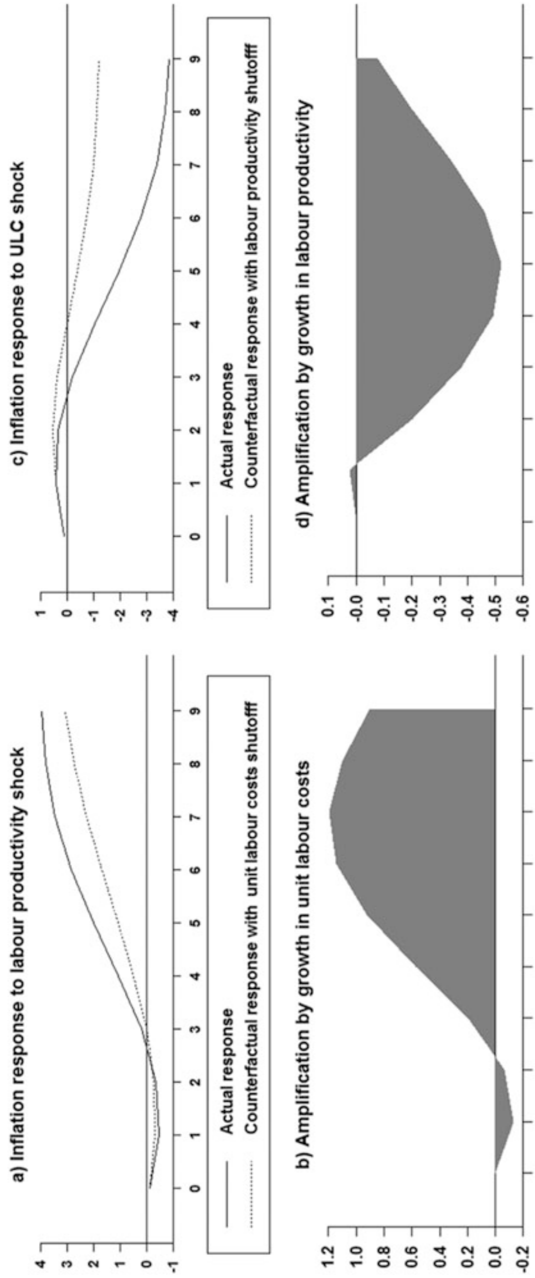

Fig. 13.2 Inflation responses to positive ULC shock and labour productivity and amplification. *Source*: Authors' calculations

and counterfactual inflation responses to a positive labour productivity shock on inflation and the role of ULC in the transmission of the labour productivity shock to inflation; whereas Fig. 13.2(c) compare actual and counterfactual inflation responses to a positive ULC shock. The role of labour productivity in the transmission of the ULC shock to inflation is shown in Fig. 13.2(d).

Evidence shows that positive unit labour productivity shock lowers inflation transitorily. This is because ULC leads to a quick recovery in inflation as shown by the counterfactual response, which remains lower than the actual inflation reaction after two quarters. This suggests that ULC exert more influence on inflation in Fig. 13.2(b) as the peak cumulative inflation increases by 0.6 percentage points in the fifth quarter.

The counterfactual inflation rate in which the role of labour productivity is shut off in Fig. 13.2(c) shows that positive ULC result in transitory increase in inflation. However, growth in labour productivity dampens inflation pressures in Fig. 13.2(d), resulting in actual inflation rising less than the counterfactual response. This shows that improved labour productivity plays an important role in neutralising inflationary pressures emanating from increased labour market costs.

What about the persistence of these shock effects? We distinguish between persistent and non-persistent shock effects. Furthermore, does the persistence of ULC shock matter when inflation exceeds 6 per cent? The responses depicted above are due to once-off shocks. We use a dummy which equals the value of inflation above 6 per cent and zero otherwise. Fig. 13.3(b) shows that persistent positive ULC increase inflation more than the non-persistent shocks when inflation exceeds 6 per cent. On the other hand, persistent labour productivity shocks lower inflation for prolonged periods in Fig. 13.3 (c). This means that inflationary pressures would subside more when there are persistent improvements in labour productivity.

13.3 The Role of Labour Productivity on Policy Rate Reaction Function

We have established that ULC and labour productivity exert differential influences on inflation. What about the repo rate responses to inflationary shocks in a model with ULC and labour productivity? Fig. 13.4 shows

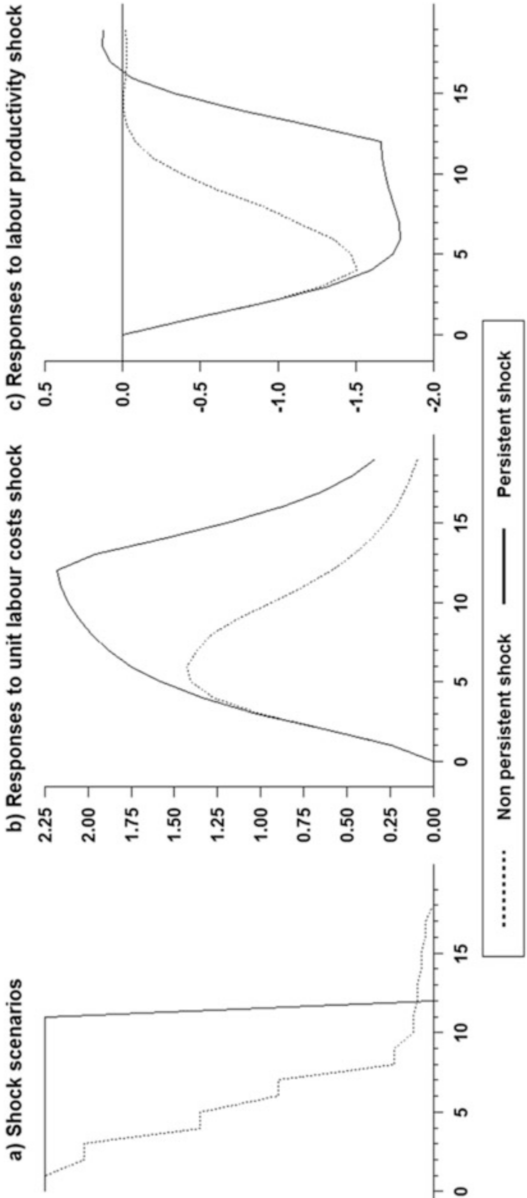

Fig. 13.3 Inflation responses to positive growth in unit labour costs and labour productivity shocks in high regime.
Source: Authors' calculations

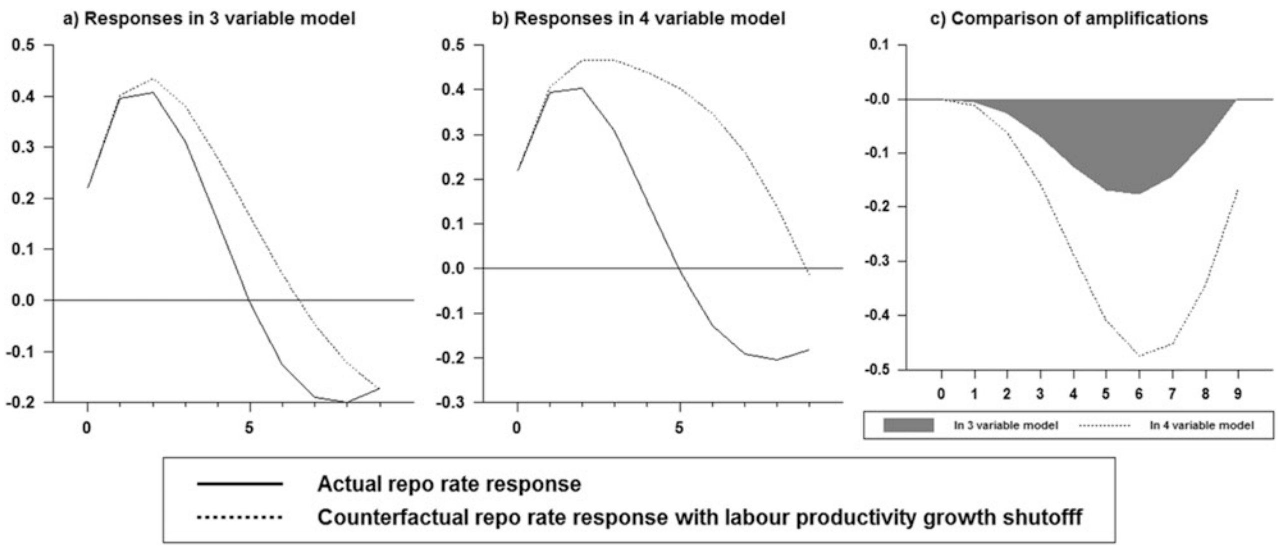

Fig. 13.4 Repo rate responses to positive inflation shocks and the role of labour productivity. *Source*: Authors' calculations

that the repo rate is tightened to positive inflation shocks but the actual repo rate responses is tightened less than the counterfactual repo rate.

This implies that high labour productivity growth dampens the rate at which the repo rate is tightened. The dampening effect at peak indicates that the repo rate can be lower by as much as 0.5 percentage points in the extended model due to labour productivity compared to 0.25 percentage points in the three variable model. This evidence shows the robustness of the role of labour productivity in the inflation process and the policy rate reaction function. Furthermore, the dampening effect in inflationary pressures due to labour productivity growth implies that it plays a role in lowering the burden of adjustment on the repo rate and assists in attaining the price stability mandate.

How do the effects of labour productivity compare to those of ULC in the policy reaction function? Do these effects have similar effects on repo rate reaction to positive inflation shocks? Fig. 13.5(a) shows that labour productivity exerts a dampening effect whilst Fig. 13.5(b) shows that ULC amplify the repo rate increase to positive inflation shocks.

Fig. 13.5(c) shows the size of the amplification magnitudes and it is evident that the peak decline due to labour productivity is nearly twice the peak increase due to ULC. Would the effects differ after including the wage variable? We adjust the VAR model to include private sector wage growth in Fig. 13.6(a) and the repo rate responses to positive inflation shocks indicate that labour productivity dampens the repo rate responses. In contrast, the repo rate increases more in the presence of ULC meaning that weak labour productivity growth does not mitigate inflationary pressures.

13.4 Does the Evidence Change When Labour Productivity Is Endogenous or Exogenous?

Does the assumption of exogeneity or endogeneity of growth in labour productivity affect the results? The models in the earlier sections are estimated with ULC as an endogenous variable. Fig. 13.7 shows that the repo rate increases to curb positive inflationary pressures but is more

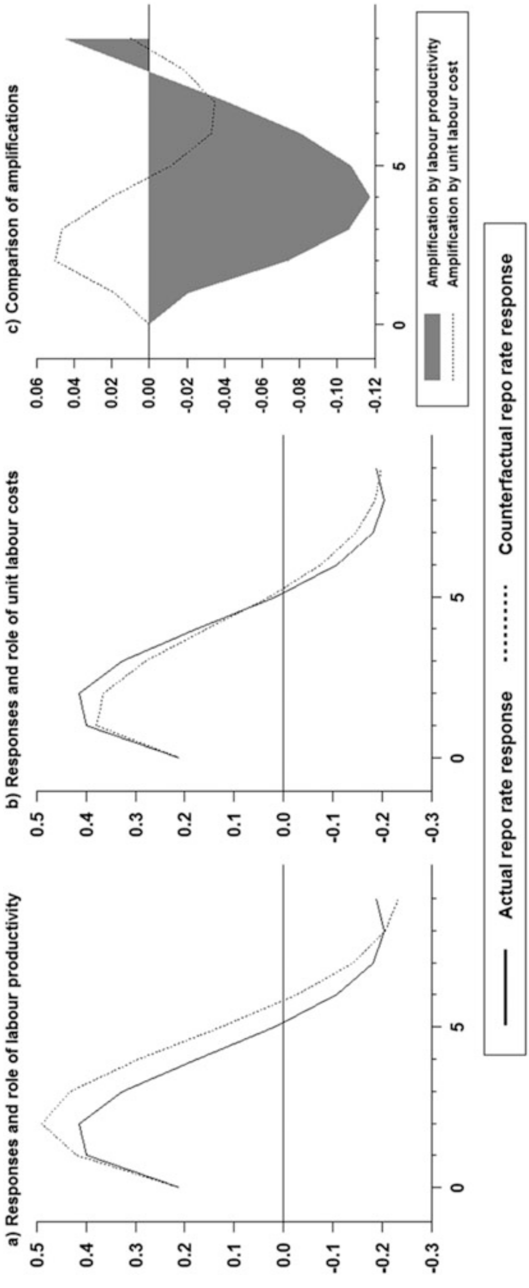

Fig. 13.5 Repo rate responses to ULC and labour productivity. *Source*: Authors' calculations

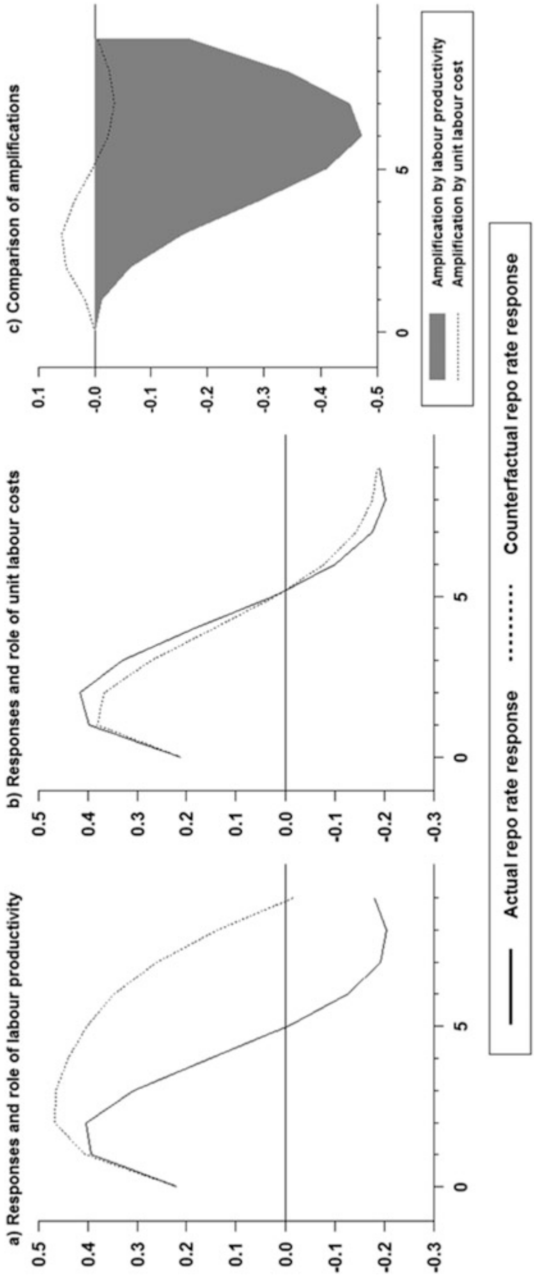

Fig. 13.6 Repo rate responses to positive inflation shock in the presence of wages growth. *Source*: Authors' calculations

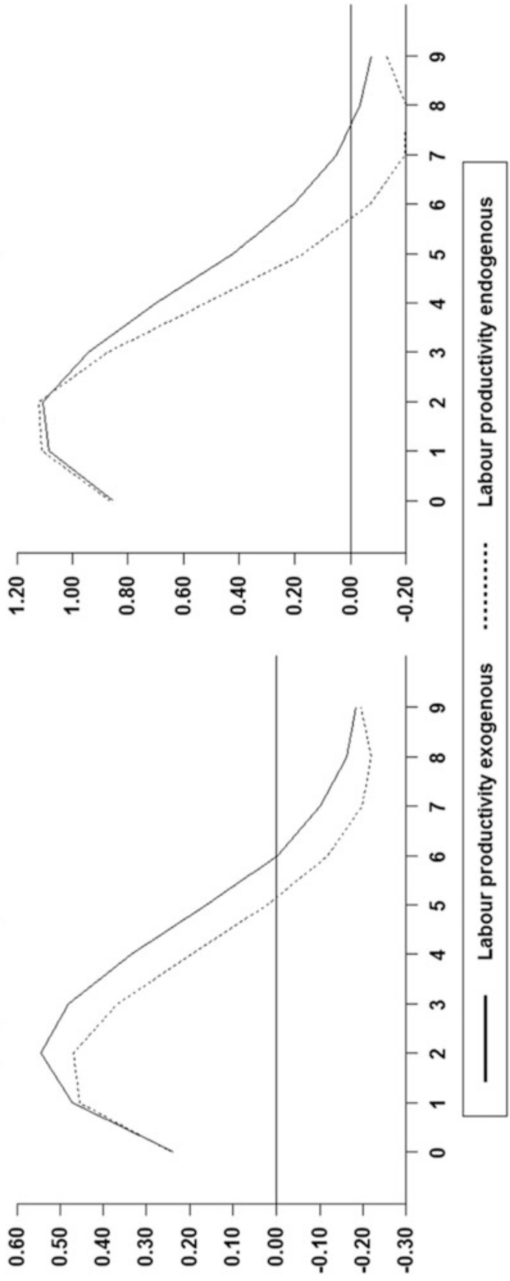

Fig. 13.7 Repo rate responses to positive inflation shocks. *Source*: Authors' calculations

tightened when labour productivity is exogenous relative to when it is endogenous.

This means that shutting off the feedback effects between labour productivity and ULC leads to stronger policy reaction to inflationary pressures.

13.5 Conclusion and Policy Implications

This chapter explored the role of labour productivity and ULC in impacting inflationary pressures and repo rate responses to inflation. Evidence shows that increases in labour productivity play an important role in dampening inflationary pressures directly and indirectly via the propagation effects. Labour productivity and ULC exert opposite effects on size of the adjustments of the repo rate to positive inflation shocks. Positive labour productivity shock lowers inflation and the increase in ULC results in a quick recovery in inflation. Furthermore, persistent labour productivity shocks lower inflation for prolonged periods. The implication is that inflationary pressures would subside more when there are persistent improvements in labour productivity.

However, in the presence of positive inflation shocks a weak labour productivity growth does not mitigate inflationary pressures. The degree to which improved labour productivity neutralizes inflationary pressures reduces the pace and magnitude of the repo rate adjustment to positive inflation shocks.

14

Labour Market Conditions, Positive Inflation Shocks and Policy Rate Responses

Learning Objectives

- The rationale for the construction of labour market conditions indices
- The information content of various measures of labour market conditions indices
- Financial and macroeconomic stability matters for labour market conditions

14.1 Introduction

The previous chapter assessed the role of labour productivity and unit labour costs on the policy rate responses to positive inflation shocks. But these two labour market variables do not comprehensively represent labour market conditions. Hence we estimate various labour market conditions indices (LMCI) to complement the two indicators in answering the key questions posed in this chapter. We construct a number of LMCIs which include a broad range of labour market indicators such as the unemployment rate (official and expanded definitions), job adverts, sectorial employment and compensation of employees to comprehensively capture labour market developments. What is the role of tight

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labour market conditions in the transmission of inflation shocks to the repo rate? To what extent do the labour market conditions impact the policy rate response to positive inflation shocks? Does the upper band of the inflation target matter for inflationary shocks on labour market conditions? Furthermore, what role do labour market conditions play in transmitting positive inflation expectations shocks on the economy?

Chung et al. (2014) show that the LMCI is a useful tool for gauging the changes in labour market conditions. The LMCI provides an organised way of extracting valuable information from different labour market indicators, particularly when they are conveying diverging signals to policymakers. We use the estimated LMCIs in the empirical analysis to assess what tight and loose conditions imply for the inflation and the repo rate responses to inflationary shocks.

14.2 The Construction of Labour Market Conditions Indices

Quarterly (Q) data spanning from 1980Q1 to 2016Q2 is used to estimate the labour market conditions and the sample size is adjusted in cases where the data starts in 1994Q1. We use the principal component analysis to extract the common factors in the data. All the variables are log changes and are demeaned prior to the extraction of the factors. The data and variables used for the factors are presented in Table 14.1.

We constructed a diverse number of factors given that the aim of the paper is to derive a credible link between labour markets conditions and inflation, the primary mandate of the South African Reserve Bank. Second, we further disaggregate the estimated LMCIs based on whether they include unit labour costs (non-agriculture and manufacturing) or compensation of employees (total and disaggregated based on different sectors). A diverse number of labour market conditions indices also assist in dealing with uncertainty surrounding the estimation of the gaps or measures of slack. However, the task is not to compare the estimated indices but rather to assess the information they convey about the current state of the labour market. In cases where there is divergence in the LMCI,

Table 14.1 Variables included in the various labour market conditions indices

Variable	F1 ULC	F1 Comp	F2 ULC	F2 Comp	F3 ULC	F3 Comp	F4 ULC	F4 Comp
QES employment			Y	Y				
Employment: expanded definition					Y	Y		
Public sector employment	Y	Y						
Private sector employment	Y	Y						
Construction							Y	Y
Finance							Y	Y
Electricity							Y	Y
Manufacturing							Y	Y
Mining							Y	Y
Public sector							Y	Y
Transport							Y	Y
Trade and catering							Y	Y
Unemployment rate: official	Y	Y	Y	Y			Y	Y
Unemployment rate expanded					Y	Y		
Labour participation rate: official	Y	Y	Y	Y			Y	Y
Labour participation rate: expanded					Y	Y		
Labour absorption rate: official	Y	Y	Y	Y			Y	Y
Labour absorption rate: expanded					Y	Y		
Manufacturing unit labour costs	Y		Y				Y	
Unit labour costs: non agriculture					Y			
Labour productivity: manufacturing	Y		Y				Y	Y
Labour productivity: non-agriculture		Y		Y	Y	Y		
Compensation of employees: Total		Y		Y		Y	Y	Y
Construction							Y	Y
Finance							Y	Y
Electricity							Y	Y
Manufacturing							Y	Y

(*continued*)

Table 14.1 (continued)

Variable	F1 ULC	F1 Comp	F2 ULC	F2 Comp	F3 ULC	F3 Comp	F4 ULC	F4 Comp
Mining							Y	Y
Public sector							Y	Y
Transport							Y	Y
Trade and catering							Y	Y
Job advertisements in the Sunday times	Y	Y	Y	Y	Y	Y	Y	Y

Source: Authors' calculations

the components of the index assist in what the sources of the differences are.

It is well established that the unemployment rate has serious limitations as a measure of the state of the labour market and how it relates to the inflation rate. Hence a number of studies explore a variety of ways in which the state of the labour market conditions can be measured. For instance, Blanchard and Diamond (1990), Davis and Haltiwanger (1992) and Davis et al. (1996) show that the labour market is characterised by a high level of flows between employed and unemployed people in and out of the labour force. Hence the flow approach to the labour market provides a theoretically more appropriate measure of labour market conditions than the unemployment rate alone. In addition, changes in unemployment and employment do not match one-for-one in the opposite direction. It is for this reason that unemployment, employment, labour absorption and participation rates are included in LMCIs to address aspects related to flows in the labour market.

Furthermore, Chung et al. (2014) argue that the inclusion of job adverts (vacancies) and unemployment to capture aspects related to the Beveridge curve.[1] On the other hand, the inclusion of the sectorial employment and compensation of employees can assist in the assessment of labour market interventions and their effects in loosening or tightening labour market conditions. This can help not only in the assessment of policy interventions but the design of future policy interventions as well.

[1] A Beveridge curve, is a graphical representation of the relationship between unemployment and the job vacancy rate.

14.3 The Constructed Labour Market Conditions Indices

Fig. 14.1 graphically presents the estimated LMCIs including unit labour costs. The interpretation of the estimated LMCIs is that they signal loose or tight or neutral labour market conditions when they are positive or negative or around the zero line. The trends displayed in Fig. 14.1 indicate that all the estimated LMCIs suggest that labour market conditions have tightened considerably since 2012Q1.

Furthermore the trends displayed by the various factors are comparable. For the analysis in this chapter to be focused and manageable, we use the labour market conditions indices as captured by factor in Fig. 14.1(d) to conduct the empirical analysis. The choice does not imply that we think it is superior but rather that it may contain more information about the labour market due to the granularity of the data contained in the factor. We will refer to the factor as the labour market conditions index (LMCI).

The stylised facts in Fig. 14.2 show the relationship between the LMCI and GDP growth is positive whilst it is negative relationship with inflation. In addition, labour market conditions loosen when preceded by an increase in GDP growth but an increase in inflation tightens labour market conditions. The implication is that the labour market conditions present similar characteristics to the two variables in the monetary policy loss function.

14.4 Are There Differences in the Responses of LMCI to GDP Growth and Inflation Shocks?

We begin the empirical analysis by showing that macroeconomic stability matters by establishing the effects positive GDP growth and inflation shocks on labour market conditions. We estimate a VAR model which includes GDP growth, inflation and the LMCI with two lags for the period 1995Q1 to 2016Q1 and subsample 2000Q1 to 2016Q1. The model is estimated with 10,000 Monte Carlo draws. We separate the

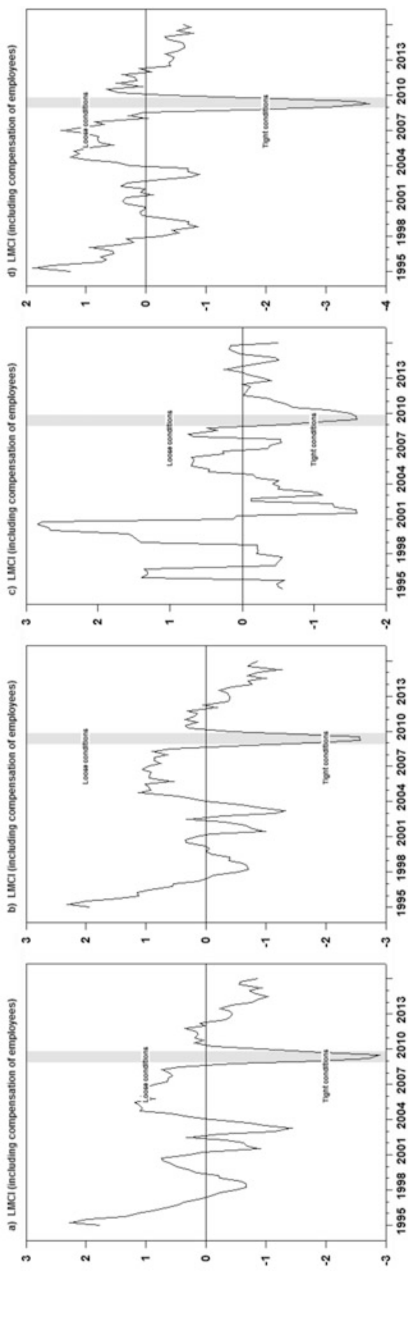

Fig. 14.1 Estimated labour market conditions indices (LMCIs). *Source*: Authors' calculations

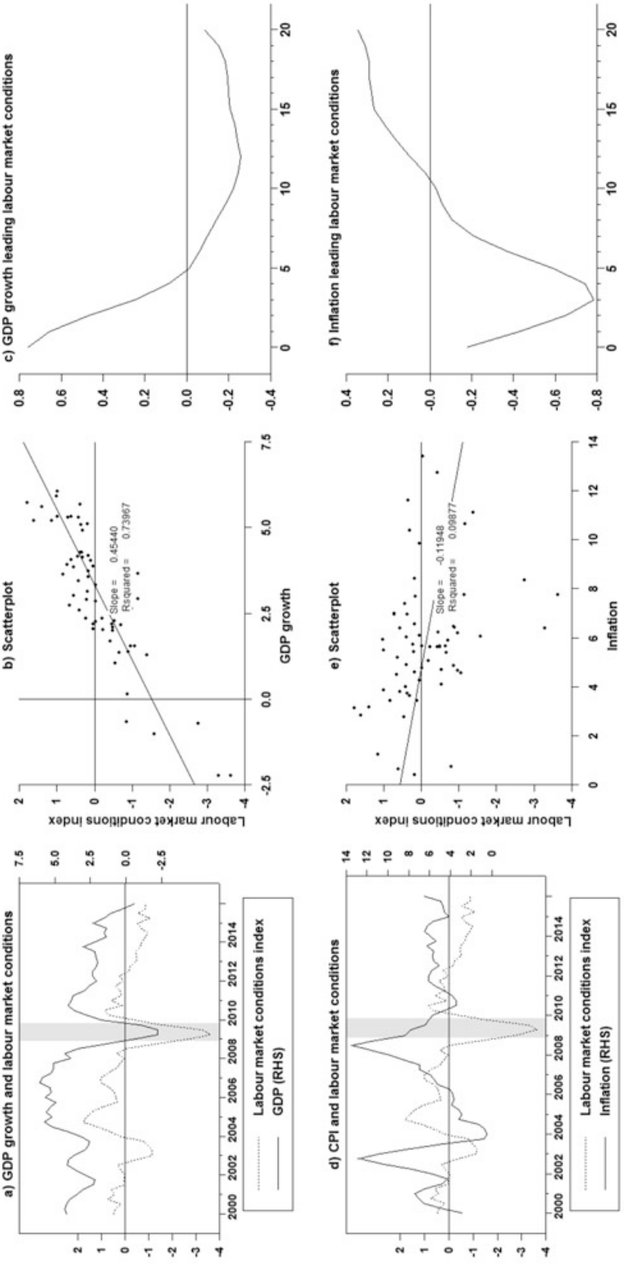

Fig. 14.2 Labour market conditions, inflation and GDP growth. *Source*: SARB and authors' calculations

LMCI into loose and tight conditions as indicated in Fig. 14.1. We use a dummy VAR approach to define these two conditions, where loose labour market conditions are equal to positive values of the LMCI when it is positive and zero otherwise. All shocks refer to one standard deviation shock.

Fig. 14.4(a) and (b) shows that a positive shock to GDP growth loosens the labour market conditions for nearly six and five quarters in both sample sizes, respectively. However, tight labour conditions increase more than the loose labour conditions index. This means that GDP growth shocks lead to a pronounced impact in loosening tight labour market conditions than accentuating already loose labour market conditions. This shows that GDP growth plays an important role in changing labour market conditions. In addition, Fig. 14.3(b) and (d) shows that positive inflation shocks leads to tightening of labour market conditions but the impact is pronounced when the labour market conditions are already tight. These findings are robust to both sample sizes.

14.5 Does the Upper Band of the Inflation Target Matter for Inflationary Shocks on Labour Market Conditions?

We show the role of price stability on labour market conditions by focusing on inflation shocks relative to the upper part of target band. We focus on inflation shocks especially when inflation exceeds the 6 per cent. Fig. 14.4 shows that labour conditions decline following positive inflation shocks suggesting tightening in labour market conditions. The decline is more pronounced in regard to a tight labour conditions index. This means that an inflation shock occurring when inflation exceeds the 6 per cent has more severe adverse effects on already tight labour market conditions than on loose conditions. The results are robust to changes in the sample size.

This means that price stability matters for labour market conditions especially when inflation exceeds 6 per cent. Furthermore, there are asymmetries in the responses of labour market conditions to negative

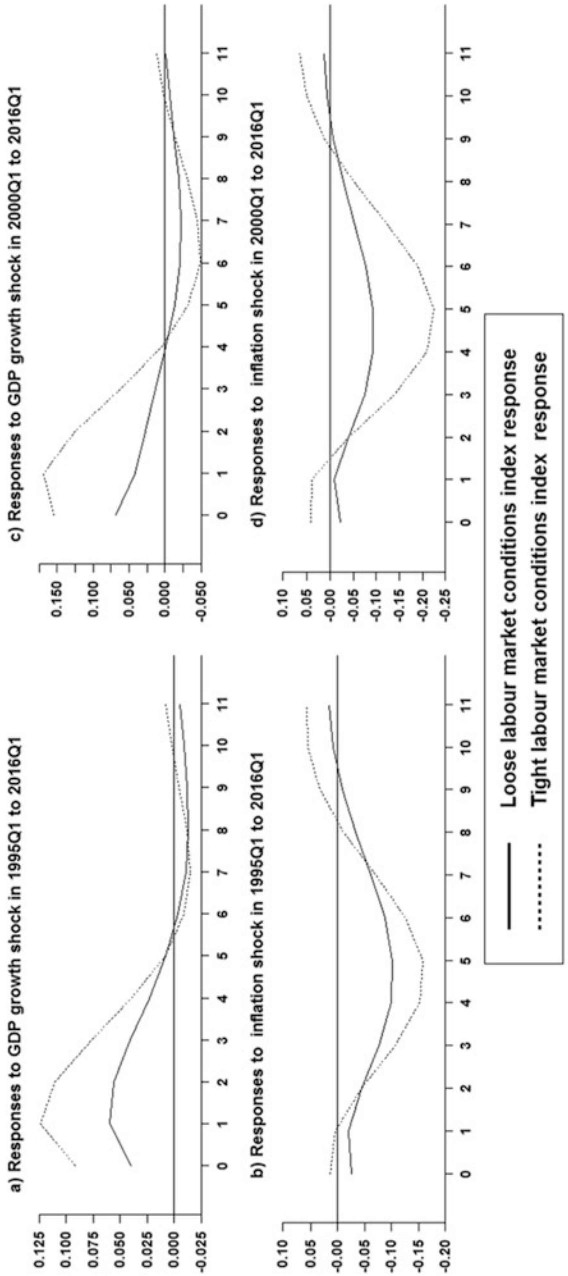

Fig. 14.3 Labour market conditions responses to positive GDP growth and inflation shocks. *Source*: Authors' calculations

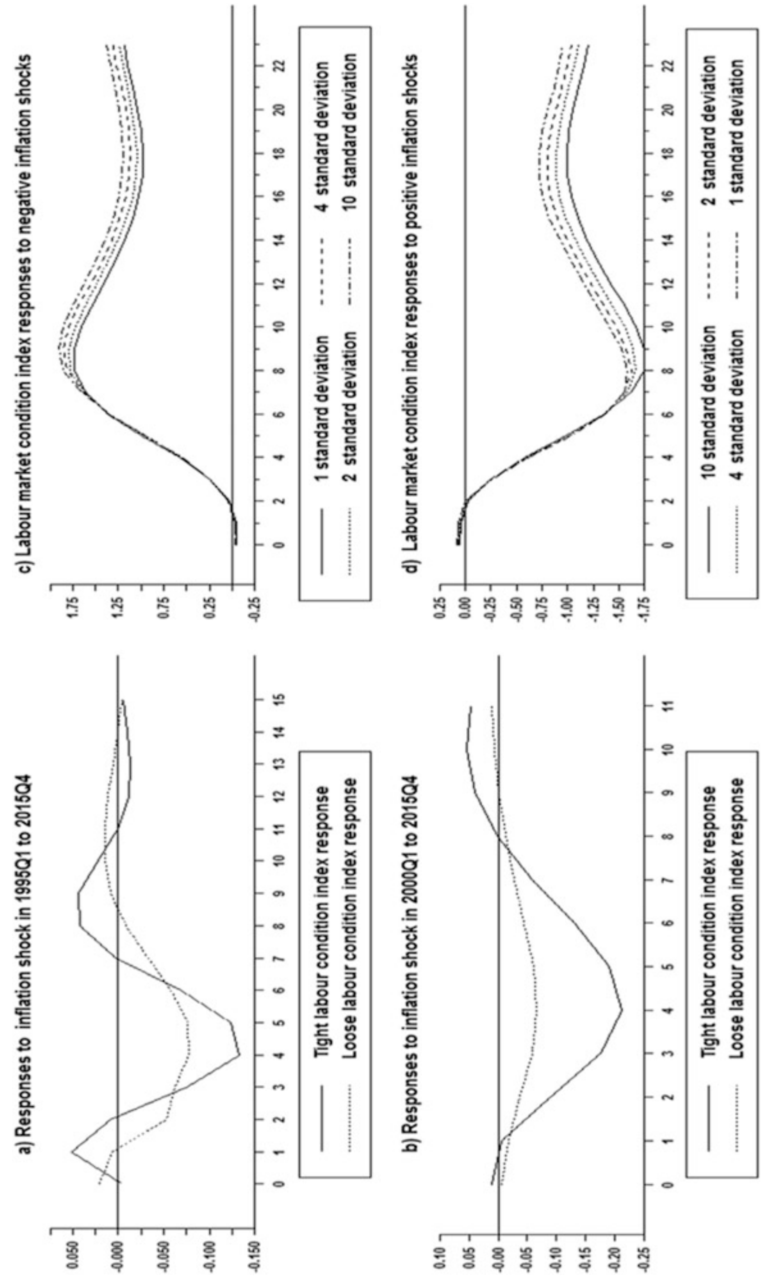

Fig. 14.4 Labour market conditions responses to inflation in the high inflation regime. *Source*: Authors' calculations. *Note*: the shocks are based on deviation from 6 per cent inflation rate.

and positive inflation shocks. Evidence in Fig. 14.4(c) and (d) shows that negative (decline) inflation shocks loosen labour market conditions which are in contrast to positive inflation shocks. The size of the negative and positive shocks induce asymmetric effects as labour market conditions loosen more when there is a large decline in inflation below 6 per cent. This means that labour market conditions benefit more from low levels of inflation and price stability.

14.6 Does the Reverse Hold: Are There Asymmetric Effects of Labour Market Conditions Index on Inflation?

We show the effects of tight labour market conditions shock on inflation in Fig. 14.5 and evidence suggests that tight labour market conditions shocks lower inflation. But the tight labour market conditions shock effects on inflation differ depending on whether inflation exceeds 6 per cent (i.e. high inflation regime). Tight labour market conditions result in a large decline in inflationary pressures depending on the degree of tightness in labour market conditions. Substantially tight labour market conditions exert more downward pressure on inflation.

14.7 What are the Implications for Policy Rate Adjustment Towards Inflation Shocks?

We assess the responses of the policy rate to positive inflation shocks for the period 2000Q1 to 2016Q1 and control for the influence of loose labour market conditions. First, evidence suggests that that actual repo rate increases more than the counterfactual repo rate. This means that loose labour market conditions lead to a slightly aggressive policy tightening stance than that would prevail in their absence.[2] Furthermore,

[2] This holds irrespective of the inclusion of the labour market conditions index including unit labour costs or compensation of employees.

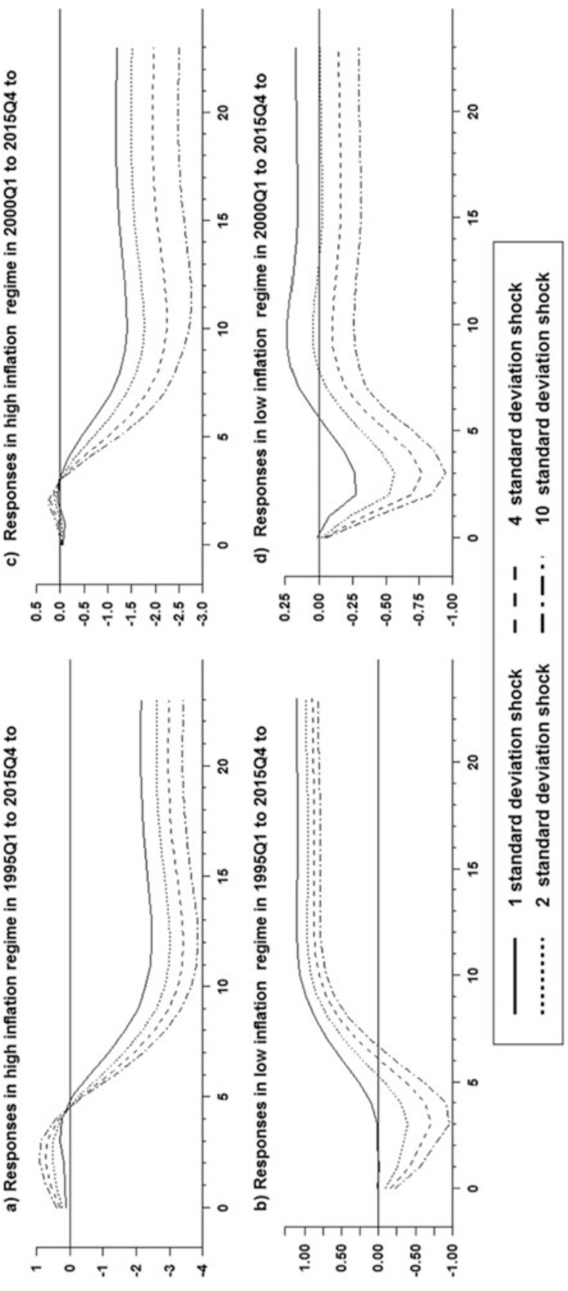

Fig. 14.5 Inflation responses to tight labour market conditions. *Source*: Authors' calculations

during tight labour market conditions, the repo rate is tightened less than what the counterfactual suggests. The implication is that tight labour market conditions via their impact on inflationary pressures influence the size and pace of the policy rate adjustment to inflation. This evidence shows that tight and loose labour market conditions impact the transmission of inflationary shocks to the repo rate.

What about the impact of labour market conditions on the repo rate when inflation exceeds 6 per cent? Fig. 14.6 shows that the repo rate increases more than the counterfactual repo rate in the presence of loose labour market conditions. This means that loose labour market conditions amplify the policy rate responses to inflationary pressures. In contrast, tight labour market conditions result in a policy rate increase that is lower than the counterfactual, meaning that tight labour market conditions dampen the size and pace of the repo rate adjustment inflation.

14.8 Labour Market Conditions and the Propagation Effects via Inflation Expectations

Anchored inflation expectations imply price stability. What is the role of labour market conditions in transmitting positive shocks to inflation expectations? We extend the analysis in this section and examine the role of labour market conditions in transmitting positive shocks to all current, one-year-ahead and two-years-ahead inflation expectation shocks. The gap between the actual and counterfactual inflation expectations measures the amplification role of labour market conditions in transmitting these inflation expectation shocks. Evidence in Fig. 14.7 shows that loose labour market condition leads to higher repo rate responses than would prevail if labour market conditions are shut off. In addition, current and one-year-ahead inflation expectations would rise by about 1.2 percentage points at the peak during periods of loose labour market conditions.

On the other hand, tight labour market conditions result in lower repo rate increases, implying that even when labour markets tighten, they

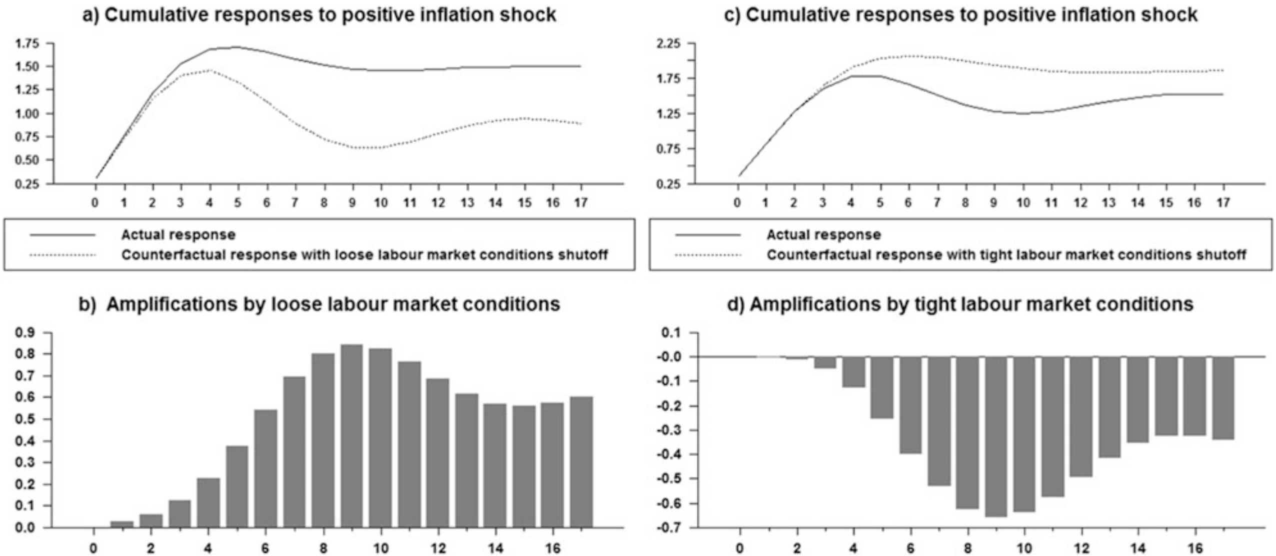

Fig. 14.6 Repo rate responses to positive inflation above 6 per cent and the propagation role of labour market conditions. *Source*: Authors' calculations

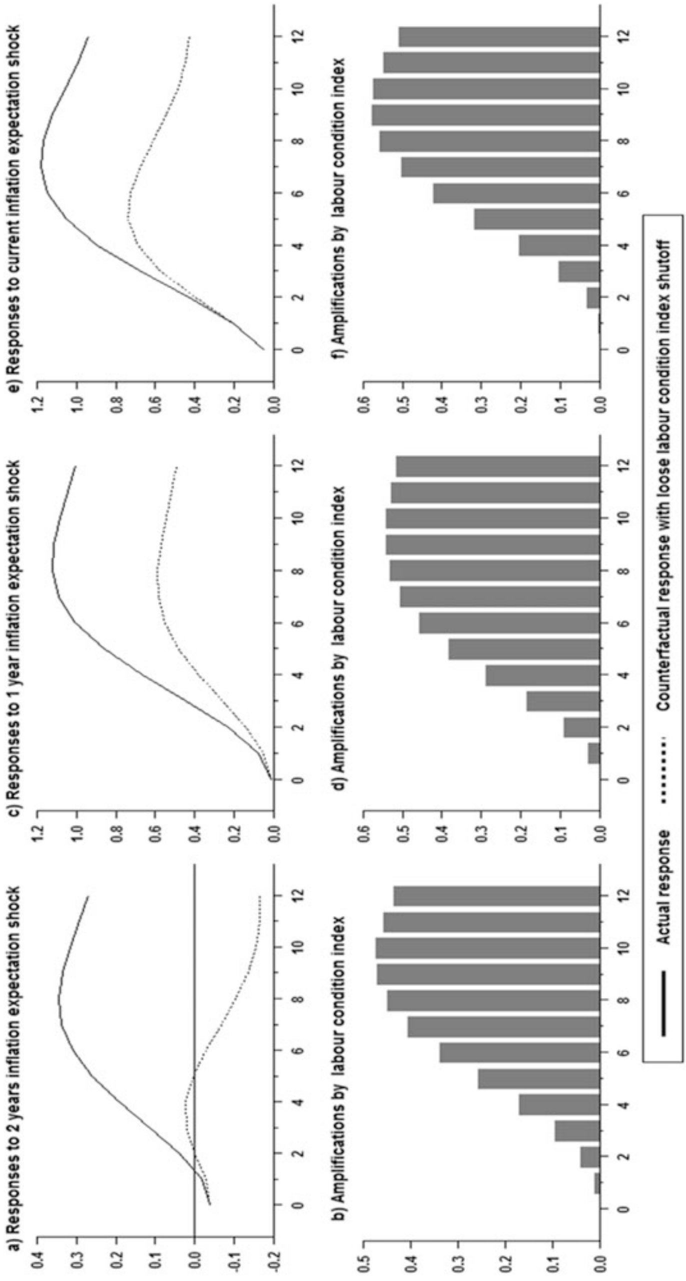

Fig. 14.7 Repo rate responses and the role of loose labour market conditions in propagating inflation expectations shocks. *Source*: Authors' calculations

dampen the inflationary pressures implied by inflation expectations but the repo rate adjustments are not as aggressive. This is consistent with a forward-looking monetary policy conduct.

14.9 Conclusion and Policy Implications

This chapter extended the analysis of labour market indicators on inflation and repo rate adjustments by estimating various LMCI. Evidence shows that labour market conditions play an important role in the transmission and propagation of inflationary pressures and inflation expectations. The propagation role of labour market conditions is potent when labour market conditions are loose and inflation is above 6 per cent. As a result, the policy rate is tightened aggressively when inflation is above 6 per cent and labour market conditions are loose. In contrast, the policy rate adjustments are more when the labour market conditions are tight.

Evidence shown suggests that labour market conditions benefit from price stability and vice versa. Tight labour market conditions shocks lower inflationary pressures and more so when inflation exceeds 6 per cent. In turn, the pace of the repo rate adjustments to inflationary shocks is slower and muted. This is consistent with the mandate of flexible inflation targeting.

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Part III

The First Stage of the Exchange Rate Pass-through

15

Does World Import Growth Amplify Domestic Inflation Responses to Inflationary Shocks?

Learning Objectives

- The extent to which world imports dynamics amplify (propagate) inflation shocks and the repo rate responses
- The role of the R/US$ exchange rate, oil prices, other commodity prices and break-even inflation expectations in amplifying the global import growth shocks
- Counterfactual inflation rate in the absence of global imports growth
- The cyclical influence of global demand on domestic inflation in relation to target band.

15.1 Introduction

The recurring theme of "secular stagnation" underpinned by weakness in investment growth and the global import-trade growth nexus remains at the centre of weak GDP growth. It is an undeniable fact in that post-2009 the slump in trade volumes and prices explains much of the low global inflation. Domestically, these global trends have been accompanied by a confluence of persistent exchange rate depreciation, inflationary pressures

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and anaemic growth. Indeed, recent evidence suggests that the exchange rate pass-through (ERPT) to inflation has declined. However, little attention has been given to the role of global imports dynamics in the ERPT. So, to what extent do developments in global imports impact domestic inflation and in turn, the repo rate responses? Do world imports dynamics amplify (propagate) inflation shocks and the repo rate responses?

To contextualise the role of global import growth dynamics, domestic imports according to stages of production increased post-2012, as shown in Fig. 15.1. In addition, there is a positive relationship between domestic imports and inflation. However, this relationship has changed since 2000. The degree of the sensitivity between inflation and domestic imports has become less sensitive and flatter post-2008, despite the severe and persistent depreciation in the exchange rate. Changes in trade volume trends across various types of goods convey valuable information about the possible explanatory factors to the slowdown in trade and the ERPT.[1] It is possible that weak growth in imports of capital goods signals weak investment. On the other hand, imports of intermediate goods might be informative about the changes in global value chains. Changes in the importation of consumption goods may signal a shift to goods with lower pass-through elasticities.

The contributions of different categories to total imports are largely unchanged since 1998. However, the average annual growth rates of imports of capital goods have increased relatively faster compared to other categories post-2010. Is it possible that the change in the relationship conveys more information about the role of the global import demand cycle and its spillover into the domestic economy and the ERPT from imports to domestic inflation?

These observations motivate the exploration of the stability of the ERPT to inflation subject to global import demand shocks. It is possible that the relatively stable trends in the composition of domestic imports and imports growth on its own contains limited information about sensitivity to inflation, shown in Fig. 15.1. In addition, this chapter shows that it is not only the degree of the ERPT that matters but the

[1] See for instance IMF WEO April 2016, Campa et al. (2005).

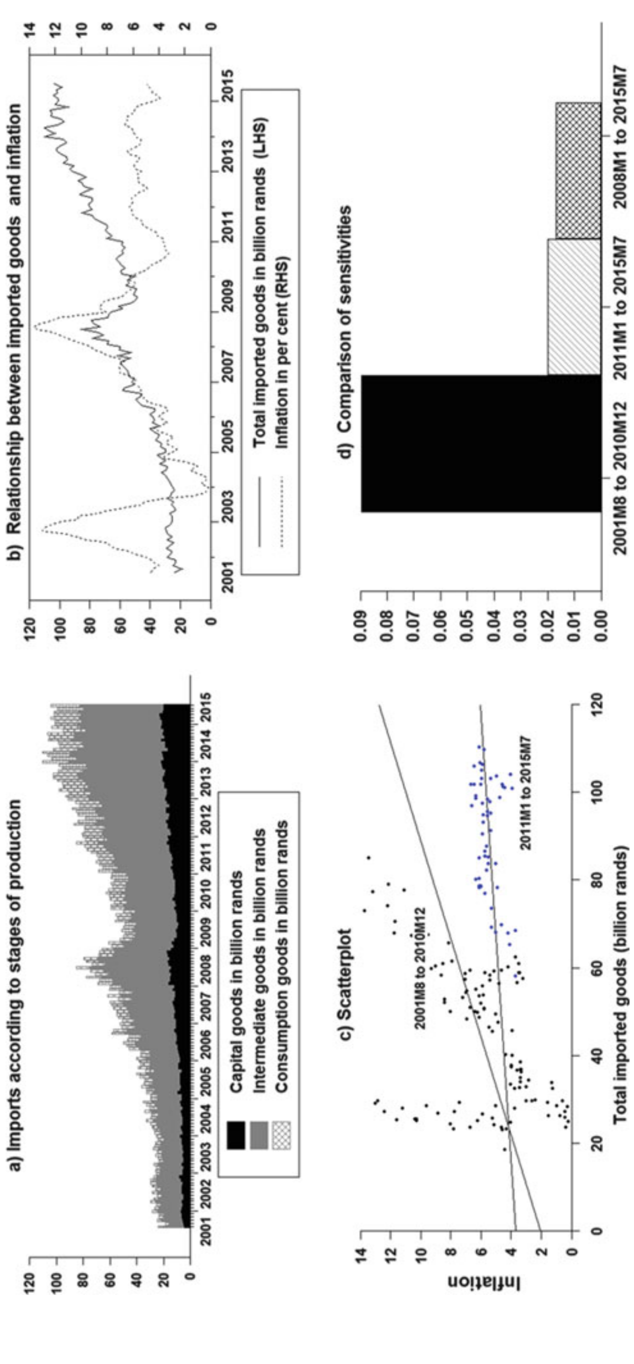

Fig. 15.1 Imported goods according to stages of production (R billions). *Source*: SARB and authors' calculations

amplification effects of global imports growth, the rand depreciation against the US dollar, oil prices, other commodity prices and break-even inflation expectations.

15.2 Does Import Growth Amplify Inflation Responses to Inflationary Shock?

To determine the amplification of world imports on domestic prices, the analysis begins by applying a modified Pentecôte and Rondeau (2015) approach to the headline CPI inflation Eq. (15.1).

$$Inflation_t = constant + \sum_{i=1}^{l} \beta_i inflation_{t\text{-}i} + \sum_{i=0}^{l} q_i \,\mathrm{Import}\, growth_{t\text{-}i} + \varepsilon_t \quad (15.1)$$

where ε_t denotes an inflationary shock and *import growth* denotes growth in world imports.[2] In addition, the analysis is extended to assess the role of imports growth in Advanced Economies (AE), Emerging and Developing Economies (E&Dev) and the United States (US). Each of these variables is used individually in the model to assess its role in propagating the domestic inflation responses to inflationary shocks.

The amplification magnitudes are determined by the differences between the actual and counterfactual inflation responses. The actual (counterfactual) inflation responses refer to inflation responses when a specific transmission channel from the variable of interest is included (excluded) in the model. The propagating (magnifying) or restraining (stifling) ability of the specific variable and channel is determined by the gap between the actual and the counterfactual responses. The analysis uses monthly (M) data for the period 2001M6 and 2015M7. Fig. 15.2 shows the estimated actual tends to exceed the counterfactual responses after 9 months based on Eq. (15.1). The gap between actual and counterfactual responses show that global import growth, AE, E&Dev economies imports growth do indeed propagate the responses of inflation to positive inflation shocks.

[2] Based on Cerra and Saxena (2008).

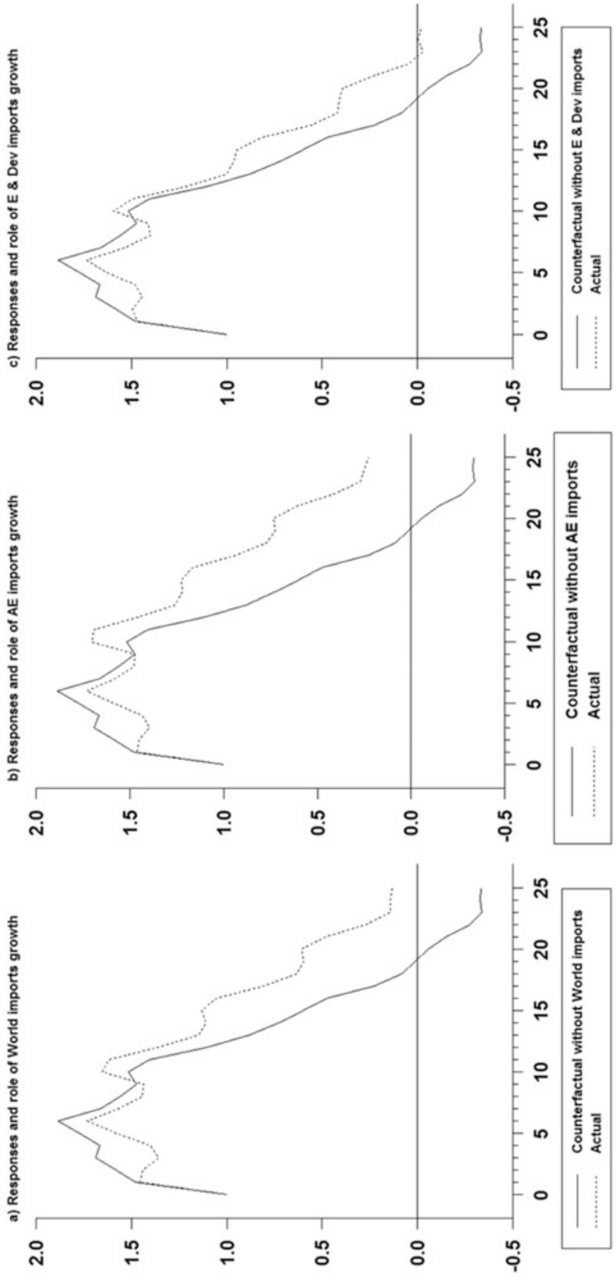

Fig. 15.2 Inflation responses to positive inflationary shock and the role of imports growth. *Source:* Authors' calculations

15.3 Impact of Positive Import Growth Shocks on the Domestic Inflation Rate

What is the role and magnitude of the impact of exogenous imports shocks on the domestic inflation rate? This section applies a second approach based on a four-variable VAR approach. The model includes annual global imports growth, commodity price inflation, domestic headline inflation, and changes in the rand/US dollar exchange rate. The model uses four lags selected by Akaike Information Criterion (AIC). The model is estimated using 10,000 Monte Carlo draws. Evidence confirms that inflation does respond to shocks to global imports growth, advanced economies, emerging and developing economies and US import growth shocks. However, three important aspects emerge from this analysis over and above the significant impulse responses. The duration and the magnitudes of the shocks differ as well.

Fig. 15.3(a) and (b) shows the inflation responses in terms of the magnitudes and fluctuations. A positive global import growth shock raises domestic inflation significantly for nine months and by about 0.2 percentage points at peak response. Advanced economies import growth shocks raise inflation for eight months. In addition, emerging and developing economies (EMEs) raise inflation for six months and 0.15 percentage points at peak response. Furthermore, the duration and magnitude of impact of US import growth shock alone is much lower and less persistent relative to the other categories.

In addition, Fig. 15.3(b) shows that import growth shocks to advanced economies induce more fluctuations in domestic inflation than the US alone. The implication is that, at times when the global economy is characterised by uneven growth and by implication import growth, the impact on domestic inflation will be much muted. This means that, indeed, the impact of the global import growth and the pass-through to domestic inflation does depend on the strength of global import growth.

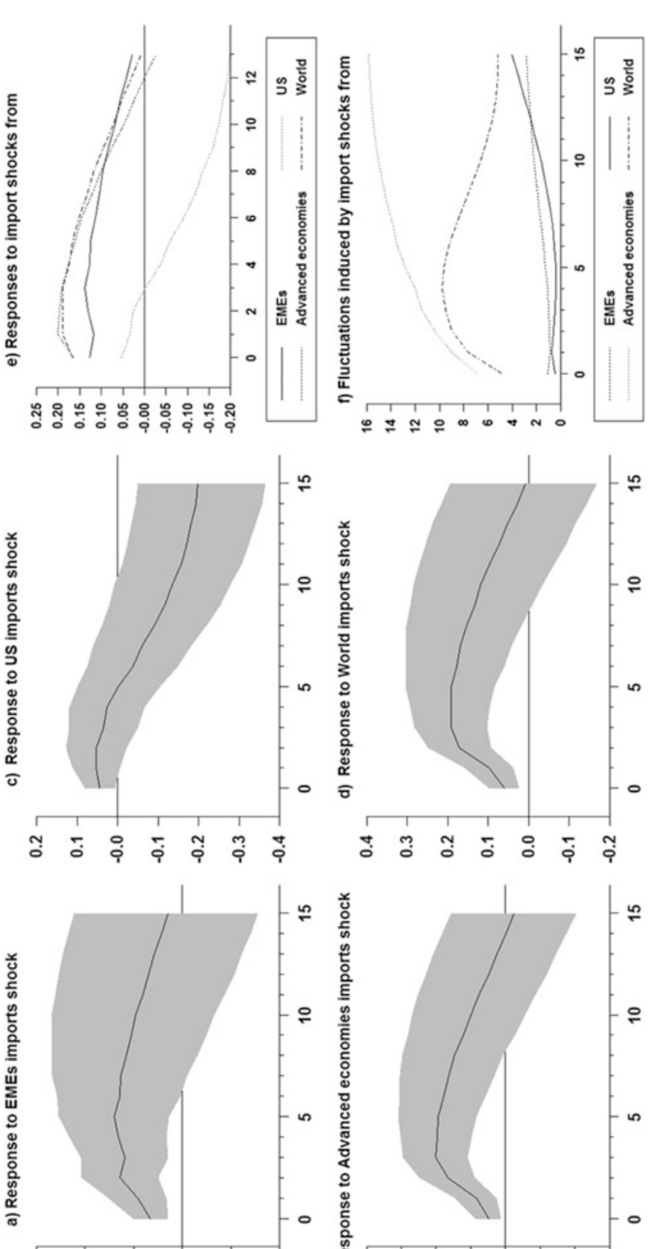

Fig. 15.3 Inflation responses and fluctuations due to global import growth. *Source*: Authors' calculations

15.4 Are There Asymmetric Responses of Domestic Inflation to Import Growth Shock?

Amongst the many lessons learned from the global financial crisis is the role of asymmetries and their impact on policy responses. This section examines evidence of asymmetric effects of global import growth on domestic inflation by applying a third approach, based on Kilian and Vigfusson (2011). Within a bivariate modified VAR model this approach makes a distinction between price increases and decreases and enables the examination of asymmetric responses based on the size of negative and positive import growth shocks.

Does domestic inflation react by the same magnitude to unexpected positive global import growth shock? To enable comparison of the responses to increases and decreases to imports the response to positive import growth shocks are inverted to be on the same scale as the negative responses. Fig. 15.4(a) and (b) shows that the impact of positive global import growth on domestic inflation is bigger than that of negative imports growth shocks. Indeed there are asymmetric responses.

In addition, positive import growth shocks have a bigger effect on inflation than negative shock. However, of interest currently in light of the global economic trends and projections is the impact of negative shocks as shown in Fig. 15.4(c). The domestic inflation responses in Fig. 15.4(c) show that a negative shock to global and advanced economies' import growth shock results in a decline of between 1 and 1.3 percentage points at peak.

These results support the view that the depressed state of the global economy and trade induces a downward bias on domestic inflationary pressures. In addition, these developments are partly contributing to the seemingly low ERPT to inflation. Furthermore, if the responses to positive import growth shocks are taken into account,[3] it is highly possible that the current muted pass-through to inflation is temporary and largely dependent on the subdued state of the global economy. This is

[3] The inflation responses in Fig. 15.4(a) vary between 1.25 and 1.8 percentage points at peak.

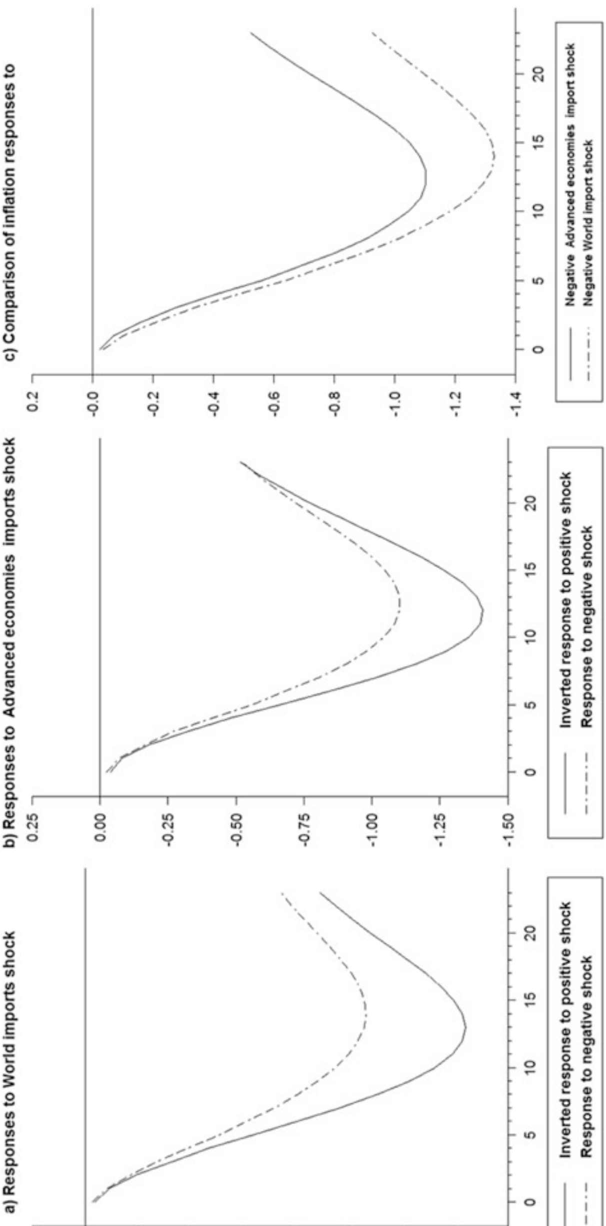

Fig. 15.4 Inflation responses to positive and negative global imports growth. *Source*: Authors' calculations

particularly the case given the large downward adjustments in import prices, oil prices and other commodity prices. This then leads us to explore the amplification role of the price components and factors in the next section.

15.5 How Significant Are the Amplifications of Short- to Medium-Term Risks to the Domestic Inflation Outlook?

In assessing the inflation outlook and deliberating on the policy stance, the Monetary Policy Committee not only seeks to balance the risks of potential shocks but also the manner in which they play an amplifying (propagating) or neutralising role. Key amongst the short to medium risks to the inflation outlook are the exchange rate and inflation expectations also inferred from break-even inflation rates. This section contributes to the understanding and analysis of the amplification role of the channels related to the exchange rate, commodity prices, oil prices and break-even inflation expectations of domestic inflation.

The analysis is based on an estimated four-variable VAR model which includes global import growth, domestic headline inflation, annual rand/US dollar exchange rate changes and break-even inflation expectations. The breakeven inflation variable is replaced in separate estimation, with annual commodity price inflation and oil price changes. The models are estimated using four lags and 10,000 Monte Carlo draws. The amplification role of these channels and risks to the inflation outlook focuses on the responses of domestic inflation to global import growth shock in the presence and absence of these selected transmission channels. This means that results focus only on the inflation responses when these variables and their channels of transmission are included and shut off in the model.

15.6 The Amplification of Inflation Responses by the Exchange Rate, Oil and Other Commodity Prices

Evidence in Fig. 15.5 indicates that inflation rises significantly as a result of a positive shock to global, advanced and emerging market economies' import gowth. This is particularly the case when the exchange rate is depreciating compared to when it is shut off in the model. The results show that the magnitude of the amplification of the exchange rate does also depend on the source of the import growth shock. The exchange rate depreciation tends to propagate the inflationary pressures exerted by a positive import growth shock to global and advanced economies. The cumulative amplification magnitudes rise over time and reach 0.6 percentage points by the end of the year following a positive import growth shock. At any given point in time, the exchange rate dynamics occur simultaneously with those of oil and other commodity prices. In Fig. 15.5 (a) and (b), it can be seen that oil and other commodity price changes amplify the responses of domestic inflation to positive global import growth shocks.

Furthermore, in Fig. 15.5(c) the amplification on inflation in the presence of high oil prices contributes 0.27 percentage points to inflation compared to 0.18 percentage points in the presence of commodity prices at peak. At the same time Fig. 15.6(a) shows that when inflation expectations are also included and are elevated, they propagate the impact of the exchange rate depreciation and import growth shocks on inflation by a cumulative 1.6 percentage points in 35 months. This means that inflation expectations affect inflation indirectly through amplification ability.

Indeed, policymakers should anchor inflation expectations as they also play a meaningful role in propagating inflationary responses to rand depreciation and inflationary shocks. Moreover, Fig. 15.7 shows that since 2015 the world import growth shock has exerted downward pressure on the actual inflation rate.

The counterfactual inflation exceeded actual inflation. A similar trend is observed with respect to the contributions of import growth price pressures due to advanced and emerging and developing economies.

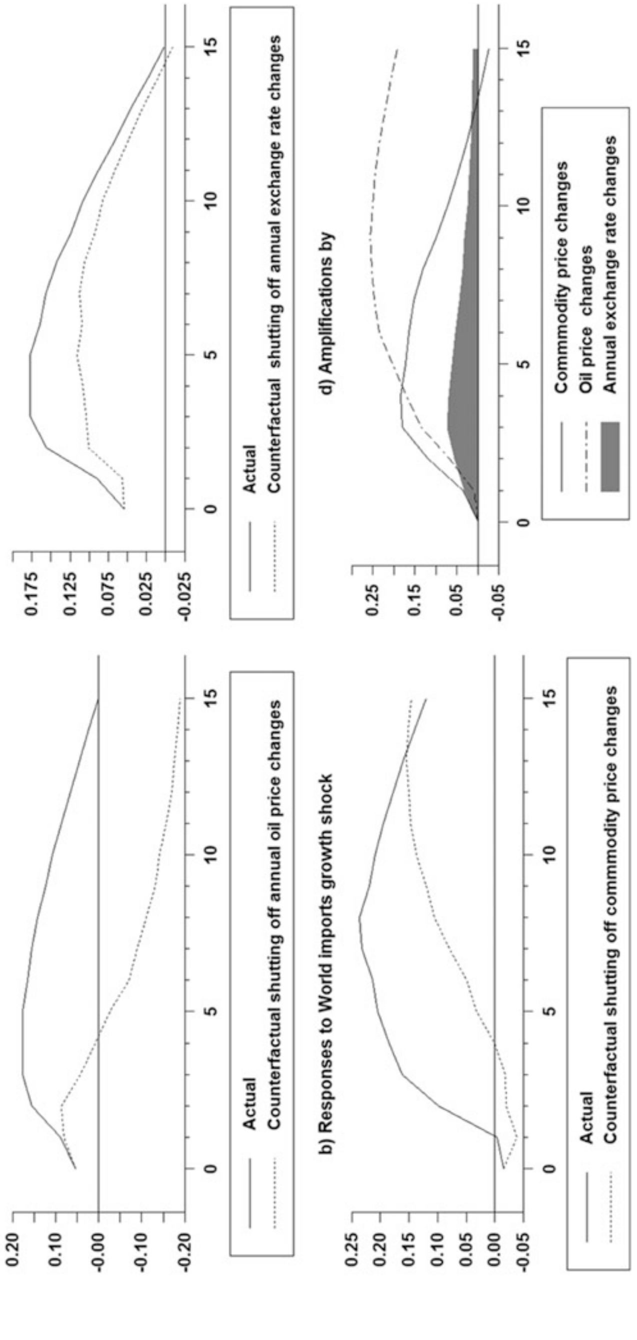

Fig. 15.5 Amplification of inflation responses by oil and commodity prices. *Source*: Authors' calculations

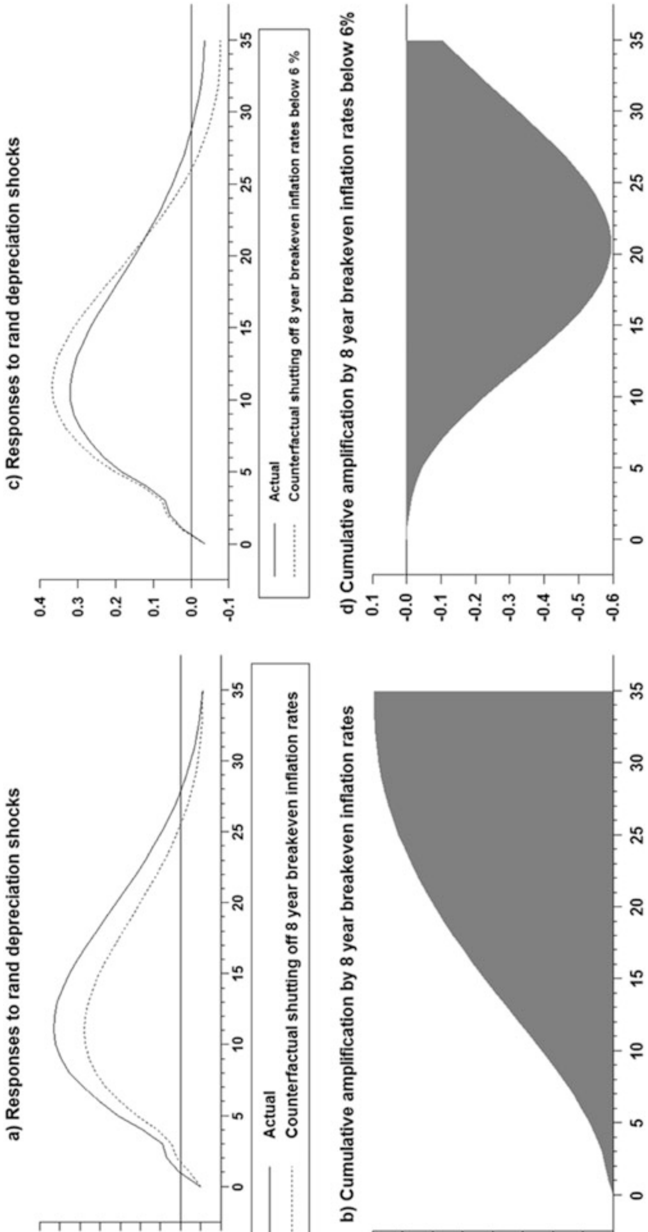

Fig. 15.6 Inflation responses to rand depreciation and the propagation role of break-even inflation rates.
Source: Authors' calculations

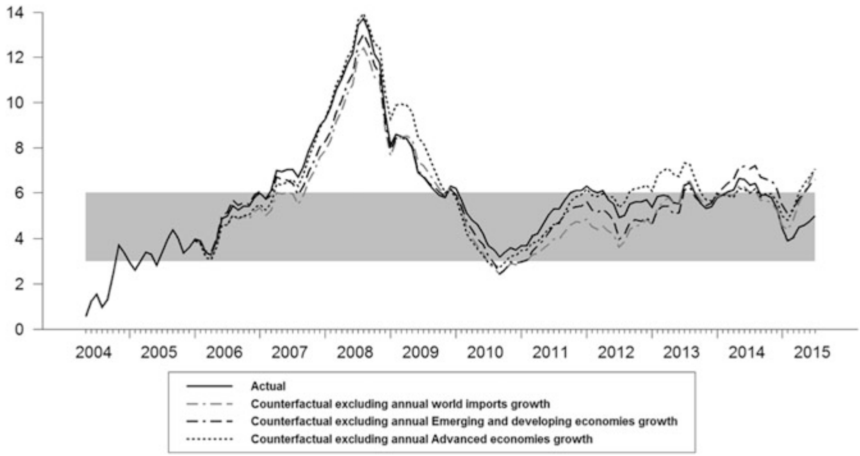

Fig. 15.7 Actual and counterfactual inflation and the role of world import growth. *Source*: Authors' calculations

However, it is also evident that emerging and developing economies' import growth has persistently exerted downward pressure on domestic inflation since 2013. The results suggest that indeed subpar global growth has resulted in muted inflationary pressures and has played a meaningful role in keeping inflation within the target band.

15.7 What Are the Implications of the Exchange Rate and Commodity Price Changes for the Repo Rate?

Global developments play a significant role in the policy discussions. Therefore, what does the data suggest the monetary policy responses are to positive domestic inflation shocks in the presence of subdued and even declining global imports? Fig. 15.8(a) shows that the counterfactual scenarios of repo rate response to domestic inflation differs depending on the source of import growth shocks. The repo rate responds more to positive inflationary shocks in the presence of positive import growth shocks due to the global and advanced economies than when these channels are shut off. In addition the cumulative repo rate responses in

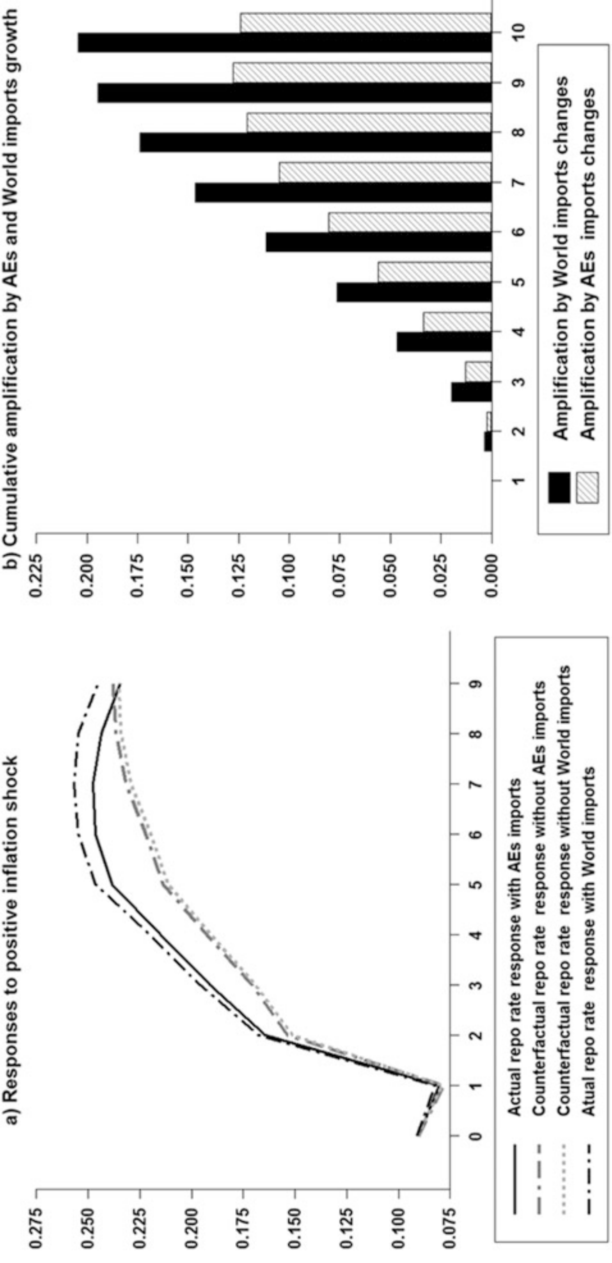

Fig. 15.8 Repo rate responses to positive inflation shocks and the role of imports. *Source*: Authors' calculations

Fig. 15.8(b) indicates that world import growth contributes about 0.225 percentage points to the increase in the repo rate within a year compared to 0.175 percentage points due to advanced economies.

Emerging and developing economies' positive import growth leads to a bigger amplification in the repo rate responses to positive inflation shocks than the advanced economies' import growth shock. This suggests that EMEs play a large amplification role in the repo rate to a positive shock to import price growth.

The repo rate would be tightened more in response to a positive inflation shock from emerging and developing economies. In addition, the Chinese imports growth leads to actual higher repo rate than when these are shut off in model. Alternatively, the results suggest that the policy rate response to foreign shocks is smaller when pass-through is low, i.e., the monetary policy response, to both foreign and domestic shocks depends on the degree of pass-through. This means that robust global import growth amplifies the response of the repo rate to positive inflation shocks. Indeed, the policymakers' pursuit of the price stability mandate considers global developments to the degree that they impact on the domestic inflationary pressure. However, external factors on their own do not constrain the policy responses to domestic inflationary pressures.

15.8 Conclusion and Policy Implications

In light of the decline in global trade, import prices, oil prices and other commodity prices, we revisited the role of positive global import growth shocks and how they amplify domestic inflationary shocks. Evidence shows that positive global import growth shocks propagate domestic inflation responses. The counterfactual scenarios show that the simultaneous occurrence of exchange rate, oil price, other commodity price and break-even inflation expectations shocks propagates the impact of positive global import growth shock on domestic inflation.

Furthermore, the counterfactual scenarios show that, indeed, the subdued state of the global economic growth has resulted in muted inflationary pressures. Global factors emanating from advanced, emerging market and developing economies have played a meaningful role in keeping domestic inflation within the target band. In addition, evidence indicates that the current state of the global economy has an impact on the rate at which the repo rate responds to domestic inflationary pressures.

The global demand cycle spills over into the domestic economy and has an impact on the ERPT to domestic inflation. In turn, the monetary policy response to both foreign and domestic shocks to the pursuit of the mandate of price stability responds to the degree of pass-through. The repo rate is tightened in response to positive domestic inflation shocks irrespective of conditions in global import growth. Overall, the pursuit of the mandate of price stability is not constrained by global import growth but pace of repo rate adjustment differs between when these are considered or not.

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16

Where Does the Exchange Rate Pass-Through to Import Price Inflation Threshold Lie?

Learning Objectives

- Establish the threshold of the exchange rate depreciation and the non-linearities it introduces in the response of import price
- The amplification of import price inflation response to positive import demand shock
- The magnitudes of the ERPT and persistence
- The importance of GDP growth on the second stage of the ERPT

16.1 Introduction

The previous chapter showed that global import growth or global demand cycle plays a role in the domestic inflation process. Severe exchange rate depreciation and volatility are passed to consumer prices via a number of different channels. This chapter focuses on the import prices channel or the direct exchange rate pass-through (ERPT) channel.[1] Is there a threshold of

[1] This is what is commonly referred to as the first (direct) stage of the exchange rate pass-through. i.e. when the depreciation leads to an increase that domestic importers pay for imported goods. In later

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the exchange rate depreciation that leads to the non-linear response of import price inflation to the exchange rate depreciation shock?

Annual growth in import prices is positively related to bilateral and trade weighted measures of the exchange rates. Some studies show that the ERPT estimates are sensitive to the exchange rate index used.[2] In addition, the size and speed of the ERPT to import prices can be affected by the choice of invoicing currency. The choice of invoicing currency of imported goods, i.e. "foreign currency invoicing or producer currency pricing" versus "domestic currency invoicing or local currency pricing" affects the ERPT.

The ERPT of the depreciation (appreciation) of the exchange rate is effected via a number of channels. The menu costs theory suggests that due to costs linked to changing prices, exporters may leave prices unchanged in the importers' currency if the exchange rates changes are small. However, when exchange rate changes exceed some threshold then large exchange rate magnitudes lead firms to change their prices. This hypothesis suggests that ERPT is asymmetric with respect to the size of exchange rate shocks. This is because price adjustments are more frequent in the case of large exchange rate changes than small ones. Is there a specific magnitude of the exchange rate changes that matters for the price adjustments?

This chapter assesses the degree to which import prices are a reliable measure of cost-push exchange rate induced shocks. Cost-push exchange rate shocks induce a trade-off between inflation and output volatilities. They are often costly to the degree they induce higher variability in the policy loss function and require firm policy responses. Hence, the degree to which they impact the ERPT to inflation can indeed be of policy relevance in how to think about an exchange rate policy. Establishing the threshold of the rand exchange rate depreciation impact on this first stage of the pass-through will also be of great value to policymakers. Thresholds, by informing policymakers about the nature of the asymmetric response and pricing behavior of importers to depreciations and

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stages of the production process, higher import prices for intermediate and finished goods can be passed on to consumer prices.

[2] See for example, Goldberg (2004), Pollard and Coughlin (2006), and Devereux and Engel (2001).

appreciations complements earlier findings on contractionary exchange rate depreciations and their balance sheet effects. The exchange rate movements and pass-through to import prices is instrumental to macroeconomic stabilisation policies and the achievement of the goals set out in the National Development Plan.

16.2 How Does the Import Price Inflation Respond to Positive Import Demand Shocks in the Presence or Absence of the Exchange Rate?

The responses of import price inflation, the degree of amplification due to the exchange rate depreciation and a positive import demand shock are assessed via a modified Pentecôte and Rondeau (2015) approach. The sample starts in 1990Q1 to 2015Q4 for prices of imports and non-factor services and the rand per US dollar exchange rate changes. Does imported price inflation (*IMP_Inflation*$_t$) respond differently in the presence or absence of the rand per US dollar exchange rate to positive import demand inflation shock? The inflation dynamics are given by Eq. (16.1).

$$IMP\_Inflation_t = constant + \sum_{i=1}^{4} \beta_i IMP\_inflation_{t-i} + \sum_{i=0}^{4} k_i exchange\,rate_{t-i} + \varepsilon_t \quad (16.1)$$

where, ε_t denotes a positive import demand inflation shock. The equation allows the determination of both the actual (counterfactual) inflation responses when the exchange rate (*exchange rate*) channel is included (shut off) in the model. The propagating (magnifying) or restraining (stifling) ability of the exchange rate channel is determined by the gap between actual and counterfactual responses.

Fig. 16.1 shows the effects of the exchange rate depreciation on import process for the periods 1990Q1 to 1999Q4 and 2000Q1 to 2015Q4.

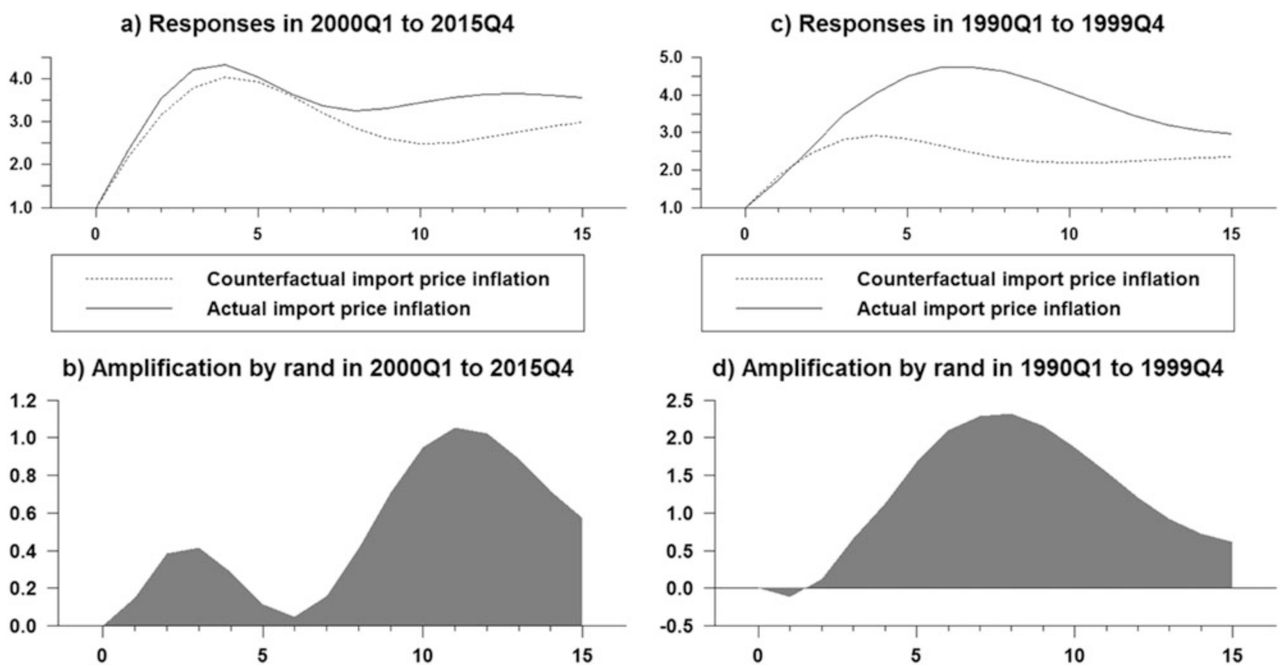

Fig. 16.1 Import price inflation responses to import demand shock and the amplification effects of the exchange rate changes rand denotes. *Source*: Authors' calculations

In both periods, the impulse responses of the actual import price inflation exceed those of the counterfactual scenario when the exchange rate channel is shut off. This suggests that the exchange rate amplifies the responses of import inflation to positive import demand shocks in Fig. 16.1(a) and (c).

The results also show that the amplification effects of the exchange rate have changed and have become lesser post-1999Q4. The comparisons show that between 1990Q1 and 1999Q4 the amplification effects of the exchange were as high as 34 per cent (1.20/3.52) compared to 14.4 per cent (0.49/3.41) during 2000Q1 to 2015Q4. This suggests that the exchange rate plays a relatively small amplification role in import price inflation responses due to positive import demand shocks during the inflation targeting period. What could explain this change in the amplification abilities of the rand per US dollar exchange rate? One reason is that the contribution of different components to total imports has remained largely unchanged since 1998. Alternatively, the absence of big structural changes over the long term in the composition of imports became less important for the ERPT to import prices. Another reason could be related to the import penetration ratio. Theory suggests that a growing and larger import share is a good proxy for the import penetration faced by firms. This implies that countries with a larger import share should have a greater pass-through of the exchange rate and import price fluctuations to domestic prices. The prolonged increase in the import penetration ratio since the early 1990s declined in 2009 and has largely moved sideways since then.

With regard to other influences, vast empirical studies show that the exchange rate volatility (in both directions) over and above some macroeconomic factors does affect the pass-through to import prices. This line of thinking suggests that greater exchange rate volatility can make importers more wary of changing prices and more willing to adjust profit margins, thus reducing measured pass-through. This is a possible third factor that can explain the observed reduced amplification effects of the exchange rate. This is particularly relevant when taking into account aggregate demand uncertainty. Studies in literature show that aggregate demand shifts in conjunction with exchange rate fluctuations tend to alter the profit margins of importers, particularly in imperfectly competitive market environments, thus reducing the degree of pass-through. This means that, due to increased aggregate demand uncertainty, the amplification effects on the exchange rate become reduced, suggesting that the ERPT is minimised during recessions and periods of subdued growth and demand.

16.3 The Non-Linear Effects of the Exchange Rate Pass-Through to Import Price Inflation

To assess whether the annual exchange rate changes follow a linear or non-linear process, the logistic smooth transition regression (LSTR) or exponential smooth transition regression (ESTR) have to be tested on the data. The shapes of the different transition models are shown in Fig. 16.2.

The logistic smooth transition auto regression model is monotonic and the smoothness of the transition between two regimes smoothly depends on how much the transition variable is smaller or greater than the threshold. On the other hand, the exponential smooth transition auto regression model is symmetrical and switches between two regimes smoothly depending on how far the transition variable is from the threshold.

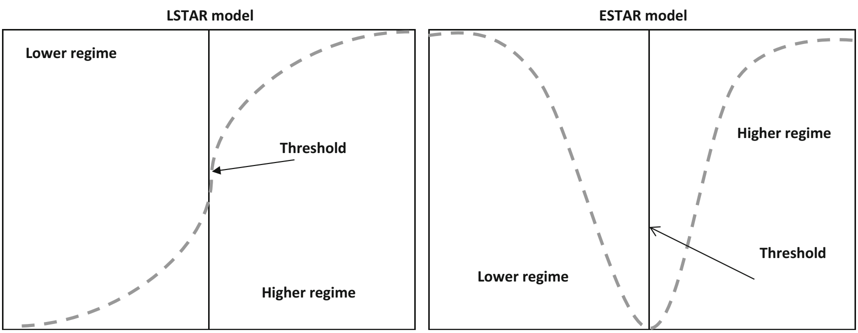

Fig. 16.2 Transition functions of the exchange rate pass-through to import price inflation. *Source*: Authors' drawings

The hypothesis for the best model to estimate the ERPT to import prices is tested and the results in Table 16.1 show evidence that the exchange rate follows a non-linear process. In addition, the best exchange rate lag to use as the transition variable in the estimations is the current rather than any lag. Hence the LSTR model rather than the ESTR is modelled based on the significance of interaction term H12.

The dependant variable is import price inflation and the explanatory or control variables are the current and lagged changes in the rand/US dollar exchange rate, the lagged exporter marginal costs, the output gap (measured as the deviation of potential from actual real GDP) to account for domestic demand conditions, and headline CPI inflation. The results of the LSTR in Table 16.2 show that low and high ERPT regimes occur around 0.28 per cent. The graphical presentation of the transition function depicting the threshold in Table 16.2 is shown in Fig. 16.3.

This indicates that there is no complete ERPT in both regimes. Earlier, we asked: What could possibly explain the decline in the propagation effects of the rand exchange rate? Based on the threshold results and the incomplete ERPT, it is possible that the prevalence of producer-currency pricing for the large proportion of imported goods partly explains the differences post 1999Q4. In addition, the threshold level of the exchange rate depreciation, the incomplete pass-through and the decline in the magnifying effects of the exchange rate can partly explain observed low expenditure switching effects despite the persistent exchange rate depreciation and monetary policy tightening.

Campa and Goldberg (2006) and Taylor (2000) show that those periods of more stable exchange rate, inflation and monetary performance contribute to the low exchange rate pass-through to import prices and the choice of the invoicing. Nonetheless, the analysis acknowledges that a disaggregated analysis of the ERPT based on the components of imported goods can reveal more about which components are mostly affected by producer-currency pricing and the impact of the exchange rate volatility. In addition, literature shows that aggregation can lead to smooth non-linear responses.

Table 16.1 Selecting the ideal exchange rate changes lag as the transition variable

	Rand		$Rand_{t-1}$		$Rand_{t-2}$		$Rand_{t-3}$		$Rand_{t-4}$	
Test	*F*-stat	Signif	*F*-stat	Signif	*F*-stat	Signif	*F*-stat	Signif	*F*-stat	Signif
Linearity	5.51	(0.00)	1.71	(0.09)	2.11	(0.03)	3.01	(0.00)	2.91	(0.00)
H01	2.95	(0.03)	1.58	(0.19)	2.93	(0.03)	5.48	(0.00)	6.70	(0.00)
H02	6.59	(0.00	1.21	(0.31)	2.73	(0.04)	1.59	(0.19)	1.24	(0.30)
H03	4.20	(0.00)	2.13	(0.09)	0.56	(0.69)	1.56	(0.20)	0.79	(0.53)
H12	5.21	(0.00)	1.41	(0.21)	2.96	(0.01)	3.62	(0.00)	4.01	(0.00)

Source: Authors' calculations
Note: signif indicates the *p*-value

Table 16.2 The results of the logistic smooth transition model

Dependent variable: Import price inflation				
Variable	Coefficient	Standard error	*T*-statistics	*P*-value
Linear part				
Constant	9.165	4.183	2.191	0.028
Import inflation$_{t-1}$	0.359	0.095	3.792	0.000
Rand$_t$	0.268	0.047	5.706	0.000
Rand$_{t-4}$	−0.037	0.028	−1.355	0.176
GDP gap	1.858	0.627	2.961	0.003
GDP gap$_{t-2}$	−1.750	0.582	−3.006	0.003
Non-linear part				
Inflation$_{t-1}$	0.422	0.106	3.976	0.000
Inflation$_{t-4}$	−0.333	0.114	−2.922	0.003
Rand$_{t-2}$	−0.254	0.058	−4.387	0.000
Rand$_{t-4}$	0.289	0.074	3.905	0.000
Speed of transition/Gamma	8.523	9.956	2.856	0.032
Threshold	**0.284**	**4.650**	**2.437**	**0.002**
Centered R^2	86%	–	–	–
R-Bar^2	84%	–	–	–
PT above threshold	**0.479**	**0.080**	**6.021**	**0.000**
PT below threshold	**0.417**	**0.095**	**4.370**	**0.000**

Note: PT refers to pass-through. We estimated the model using four lags and apply the general to specific approach through eliminating the last insignificant value until remaining with insignificant coefficients and re-estimate the model. The model was estimated to be adequate and passed the model diagnostics criterion. The marginal costs had an insignificant effect
The bold text indicates key variables

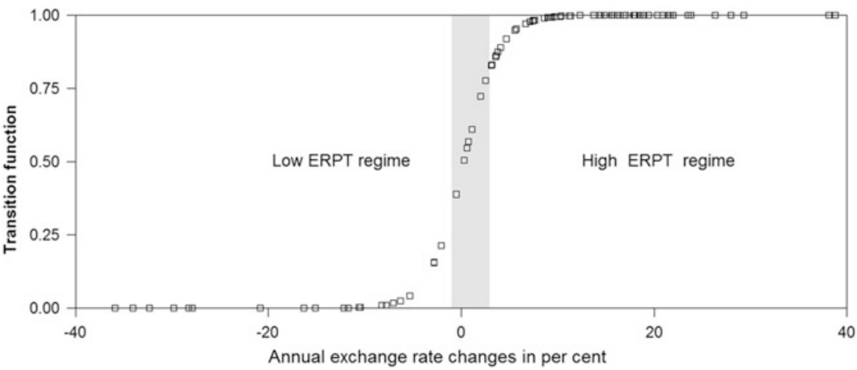

Fig. 16.3 Transition variable and ERPT regimes. *Source*: Authors' calculations

16.4 What Are the Magnitudes of the Exchange Rate Pass-Through and Persistence?

The established threshold reveals that the ERPT to import prices occurs around the deprecation of 0.28 per cent. Empirical studies establish that a combination of price rigidities and producer pricing strategies such as pricing-to-market explain partial ERPT. Assessment of what the South African data and the results in this study suggest involves comparing the ERPT magnitudes to import prices based on the threshold in Table 16.2. Fig. 16.4 presents the magnitudes of ERPT results. Evidence indicates a higher ERPT magnitude (0.48 per cent) to import price inflation above the exchange rate threshold than below it (0.42 per cent).

In addition, evidence in Fig. 16.4(b) shows that the persistence of import price inflation is higher above the exchange rate threshold than below it. This shows the link between the high degree of the ERPT of depreciation and the high persistence of import price inflation at depreciated levels above the threshold. This implies that importers do not fully adjust their prices to depreciations and appreciations. The results suggest that they engage in the pricing-to-market strategies to protect market share. Such a strategy is characterised by producers possibly using

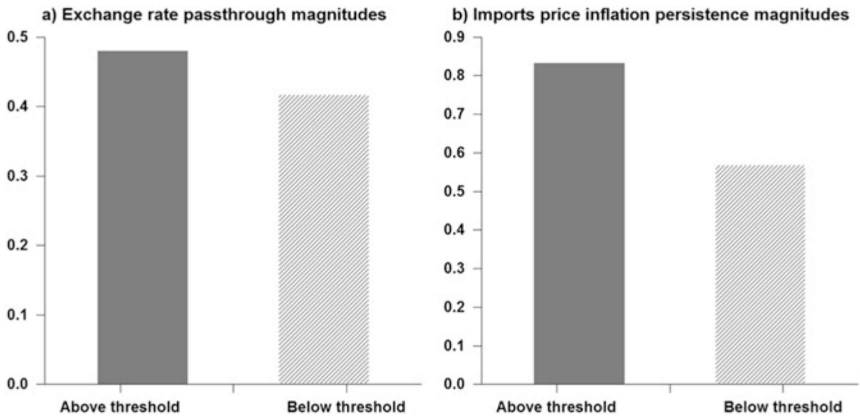

Fig. 16.4 Pass-through and import price inflation persistence magnitudes. *Source*: Authors' calculations

appreciation periods to raise their margins and depreciation periods to engage in market share protection, hence partial ERPT to import prices.

The analysis conducts a further robustness test to examine the differential effects of exchange depreciation shocks effects above and below the threshold using Eqs. (16.2) and (16.3) respectively. The effect of exchange rate is separated according to the exchange rate changes in relation to threshold.

$$IMP\_Inflation_t = constant + \sum_{i=1}^{4} \beta_i IMP\_inflation_{t-i} + \sum_{i=0}^{4} k_i Exch\_abovethreshold_{t-i} + \varepsilon_t \tag{16.2}$$

$$IMP\_Inflation_t = constant + \sum_{i=1}^{4} \beta_i IMP\_inflation_{t-i} + \sum_{i=0}^{4} p_i Exch\_belowthreshold_{t-i} + \varepsilon_t \tag{16.3}$$

In Eq. (16.2) the *Exch_abovethreshold* means the dummy which equals the value of exchange rate changes above the threshold and zero otherwise. In Eq. (16.3) the *Exch_belowthreshold* means the dummy which equals the value of exchange rate changes below the threshold and zero otherwise. The cumulative import price inflation responses to the two positive shocks based on dummies are shown in Fig. 16.5. The cumulative impulse responses show that exchange rate depreciation leads to increases in import price inflation. The pass-through above threshold exceeds that below it. This supports the robustness of earlier findings, but using a different technique.

Given that more observations of the variables in the model lie above the threshold value, can they tell more about the magnitudes of the exchange rate deprecation on import price inflation? The menu costs theory asserts that the size of the exchange rate shock matters more to the rate of price adjustments. To assess the non-linear responses of import prices to both exchange rate depreciation and appreciation, the chapter applies a modified threshold VAR version of the Balke (2000) model. The model uses import price inflation and annual exchange rate changes spanning 1990Q1 to

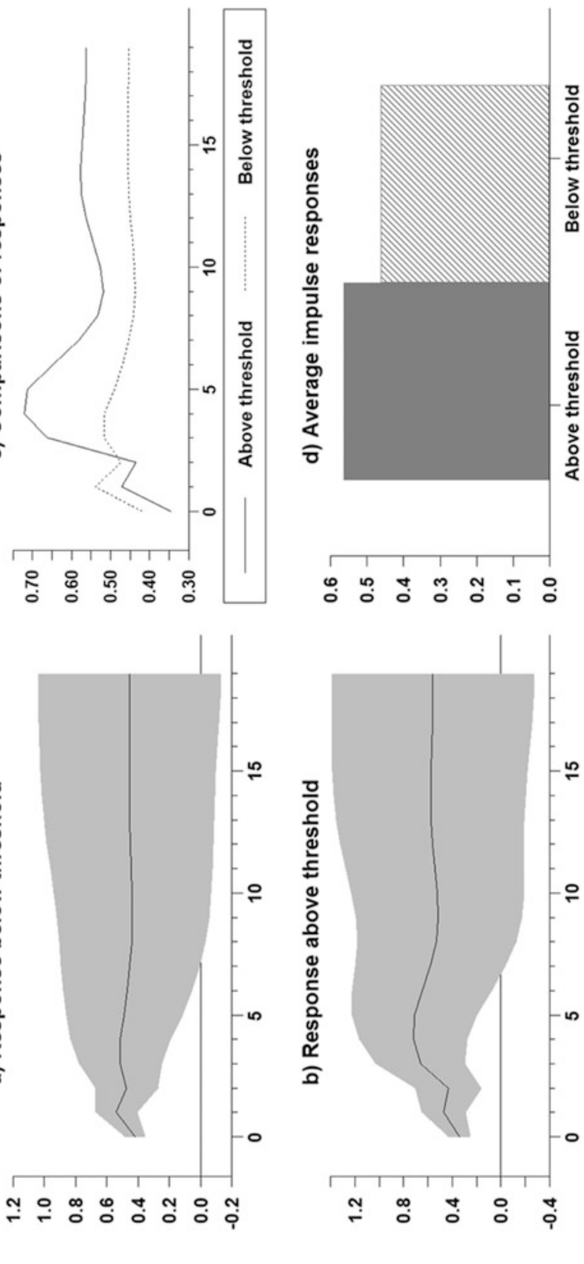

Fig. 16.5 Import price inflation responses to exchange rate depreciation shock and the role of the threshold. *Source*: Authors' calculations

2015Q4 and 10,000 draws. This is to determine whether there are asymmetries in any direction and size of the exchange rate changes based on exchange rate changes as threshold variable. In addition, the analysis shows the non-linearities in response of exchange rate shocks related to both the size and sign of exchange rate changes. The shock denotes a standard deviation (SD) shock.

Evidence indicates that the peak import price inflation responses are bigger in absolute value due to larger rand depreciation or appreciation shock than small size shock. This shows that import price inflation responds asymmetrically to the size of the rand exchange rate shocks. Thus, import price inflation remains slightly elevated in this regime due to the depreciation shock in the exchange rate and when it continues to change by bigger magnitudes. At the same time, the subsiding inflationary pressures due to an appreciation will be small if the exchange rate appreciates by small magnitudes.

16.5 What Are the Implications of Importer Pricing Behaviour on the Second Stage of the Exchange Rate Pass-Through to Headline Inflation?

We conclude the analysis by looking at the second stage of the ERPT by focusing on the effects of positive import price inflation on headline inflation. The results are based on the VAR model with import price inflation, GDP growth, consumer price inflation, and exchange rate using two lags and 10,000 Monte Carlo draws. The quarterly (Q) data spans 2000Q1 to 2015Q4 then after determine the impulse responses of consumer price inflation to import price when GDP growth and exchange rate are shut off respectively in the model.

Fig. 16.6(a) shows that actual headline inflation exceeds both the counterfactual scenarios, which exclude both annual exchange rate changes and GDP growth rates. This means that the amplification induced by these two variables is significant and large. Fig. 16.6(b) shows that GDP growth leads to bigger amplification than annual exchange rate changes.

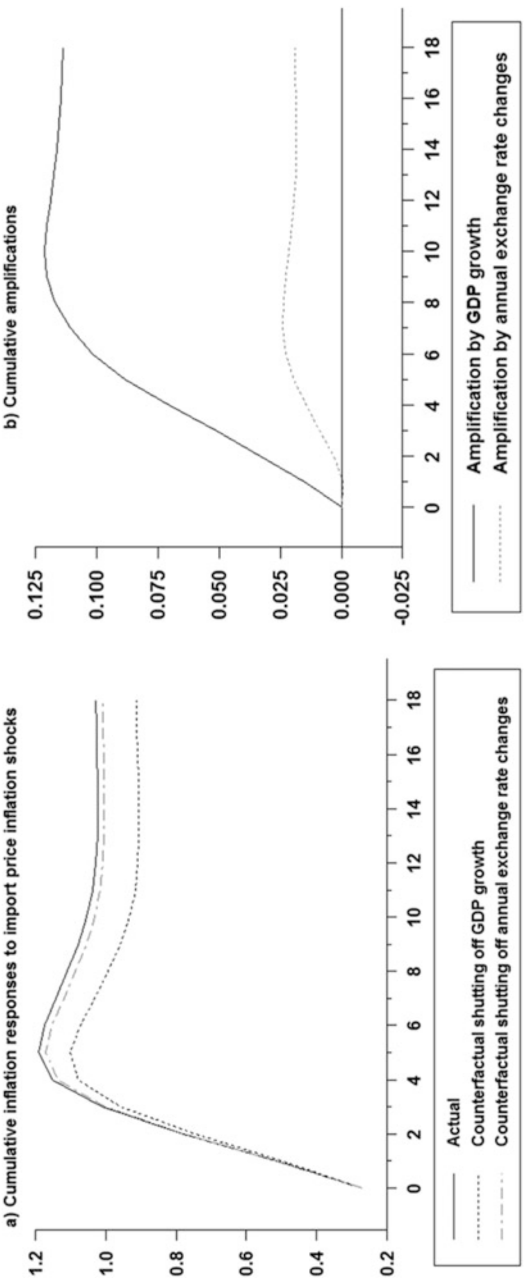

Fig. 16.6 CPI responses to imported inflation due to amplifications by GDP and the exchange rate. *Source*: Authors' calculations

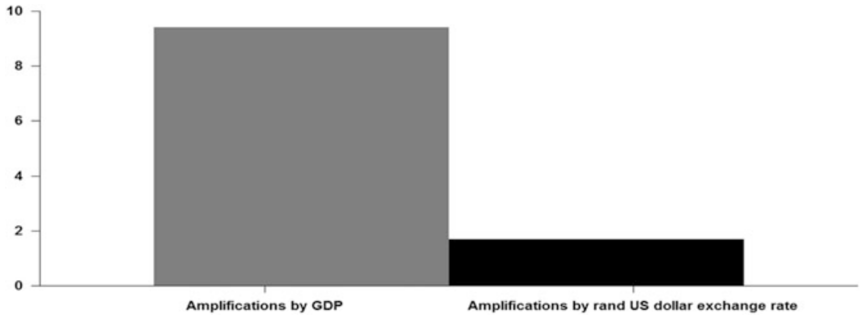

Fig. 16.7 Amplifications due to GDP growth and exchange rate changes. *Source*: Authors' calculations

This means that a bigger proportion of the exchange rate changes are mostly already passed through to import prices resulting in limited amplifications on the second stage of the transmission of ERPT to headline inflation. In addition, the results show that demand conditions matter more for the second stage of the ERPT and amplifications on headline inflation. In addition, Fig. 16.7 shows the percentage of amplifications of positive import price shocks by the exchange rate and GDP growth on headline inflation.

It is evident that GDP has more amplification abilities on headline inflation (9.4 per cent) compared to the exchange rate (1.6 per cent). Indeed, the presence of demand pressures tends to propagate the impact of inflationary shocks on headline inflation.

16.6 Conclusion and Policy Implications

We have shown evidence of non-linearity in ERPT to import price inflation beyond a threshold exchange rate depreciation of 0.28 per cent. In addition, there is high persistence of import price inflation in higher exchange rate depreciation regime than in the low exchange rate changes regime. Import price display asymmetries to large compared to small depreciations or appreciations above the exchange rate threshold. At the same time, GDP growth amplifies the responses of headline inflation to import price inflation by 9.4 per cent which is larger than the 1.6 per cent due to exchange rates. In policy terms, this means that inflation will tend to exhibit more stickiness (persistence) at higher levels in the presence of rand depreciation regimes.

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17

GDP Growth Threshold and Asymmetric Exchange Rate Pass-Through to Import Prices

Learning Objectives

- The non-linearities introduced by the GDP growth threshold on the first stage exchange rate pass-through to import prices inflation
- The persistence and exchange rate pass-through magnitudes to import price inflation subject to the GDP growth threshold

17.1 Introduction

A vast amount of literature shows that in small open economies such as South Africa the exchange rate is an additional transmission channel for monetary policy over and above the aggregate demand channel. So far, other chapters have addressed the first stage of the exchange rate pass-through (ERPT) to import prices subject to global demand and exchange rate changes. There is a positive relationship between GDP growth and import price inflation suggesting that business cycles matter. This implies that the exchange rate pass-through to import prices is also affected, albeit indirectly by aggregate demand and supply. Empirical findings by other studies do not show the GDP threshold effects and the amplification

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exerted by business cycles on the exchange rate pass-through to import price inflation.[1] At what level of GDP growth is the exchange rate pass-through to import prices inflation dampened or heightened by GDP growth dynamics? Do non-linearities of the first stage exchange rate pass-through to import prices inflation depend on threshold of GDP growth and what is the level? What level of GDP growth leads to asymmetric pass through of the rand dollar depreciation (appreciation) to import price inflation?

This chapter assesses the importance of non-linearities and amplification roles of GDP growth on the first stage of the exchange rate pass-through to import price inflation. Apart from the direct effects between GDP growth and import prices, does GDP growth amplify the ERPT depending on the GDP growth threshold? If so, what does it tell us about the ability of importers and local producers to transfer exchange rate depreciations (appreciations) to consumers? For monetary policy purposes, does the persistence and pass-through of import price inflation differ subject to the GDP growth threshold?

17.2 The Amplification Role of GDP Growth on Import Prices Inflation

The empirical analysis starts by showing evidence from a four variable VAR model for the sample period 1993Q1 to 2015Q4. The model includes annual GDP growth, import price inflation, changes in the rand per US dollar exchange rate and inflation. Fig. 17.1 shows that the responses of import price inflation differ in models analysing the ERPT to import price inflation when GDP growth is included and its role when it is shut off. This evidence shows that in the presence of GDP growth, imported price inflation would be much higher than when GDP growth is shut off in the model. This suggests GDP growth matters for pass-through of rand depreciation shocks to imported inflation and GDP growth acts as an important intermediary conduit for this.

[1] See Correa and Minella (2006) and Cheikh (2012) amongst others.

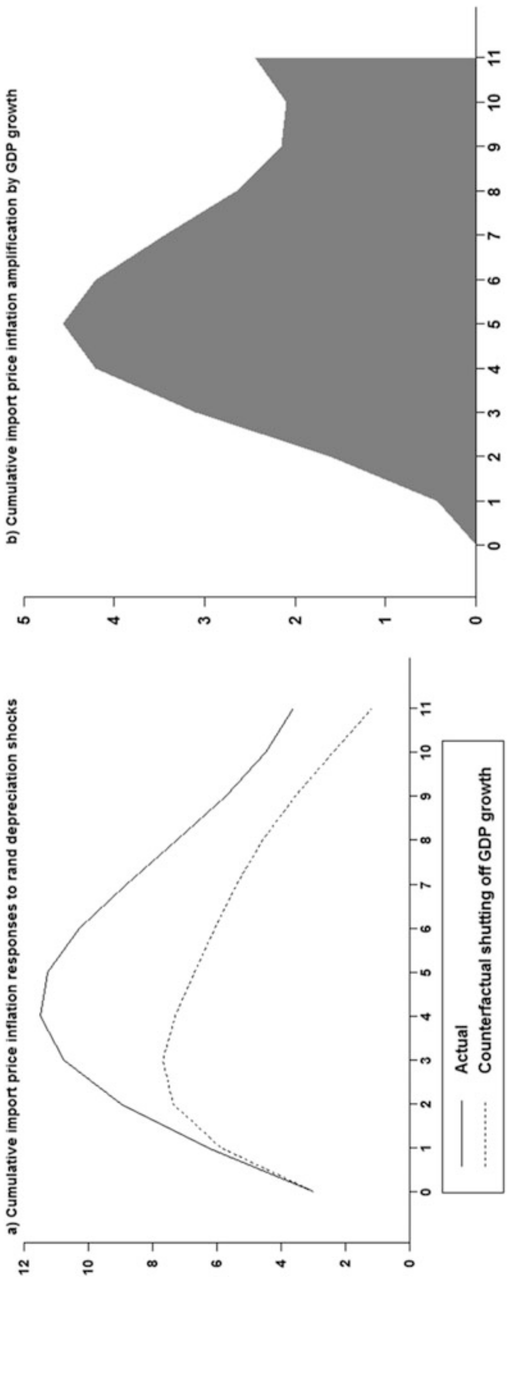

Fig. 17.1 The role of GDP in the first stage of the exchange rate pass-through. *Source*: Authors' calculations

Has the role of GDP changed post 2007Q2? Does import price inflation respond differently in the presence and absence of GDP growth to positive import demand shocks? The amplifications are assessed by a modified Pentecôte and Rondeau (2015) approach based on Cerra and Saxena (2008) using the imported price inflation *IMP_Inflation* Eq. (17.1) and import demand shock is defined by the error term:

$$IMP\_Inflation_t = constant + \sum_{i=1}^{l} \beta_i IMP\_inflation_{t-i} + \sum_{i=0}^{l} w_i GDP_{t-i} + \varepsilon_t \tag{17.1}$$

where, ε_t denotes an import demand shock. The analysis determines the actual and counterfactual inflation responses. The actual (counterfactual) inflation responses refer to inflation responses when a GDP growth channel is included (shut off) in the model. Eq. (17.1) is estimated using four lags. The propagating (magnifying) or restraining (stifling) ability of the specific variable and channel is determined by the gap between actual and counterfactual responses. Fig. 17.2 shows that actual import price inflation increases more in the presence of GDP growth than when it is shut off in the model. This suggests that GDP growth amplifies the import price inflation responses. Fig. 17.2(b) GDP growth amplifies import price inflation by a peak of 0.35 percentage points between the eighth and ninth quarters.

Are there discernible changes post-2007Q3? The role of the business is separated to determine the effects between pre- and post-2007Q2. Fig. 17.2(c) shows that post-2007 GDP growth led to lower actual import price response compared to what it would be when GDP growth is shut off in the model. Thus low GDP growth post-2007Q2 contributed to lower import price inflation.

If GDP growth contributed to low exchange rate pass-through to import price inflation post-2007, how significant was the role of the recession? The estimated equation below is used to determine the effects

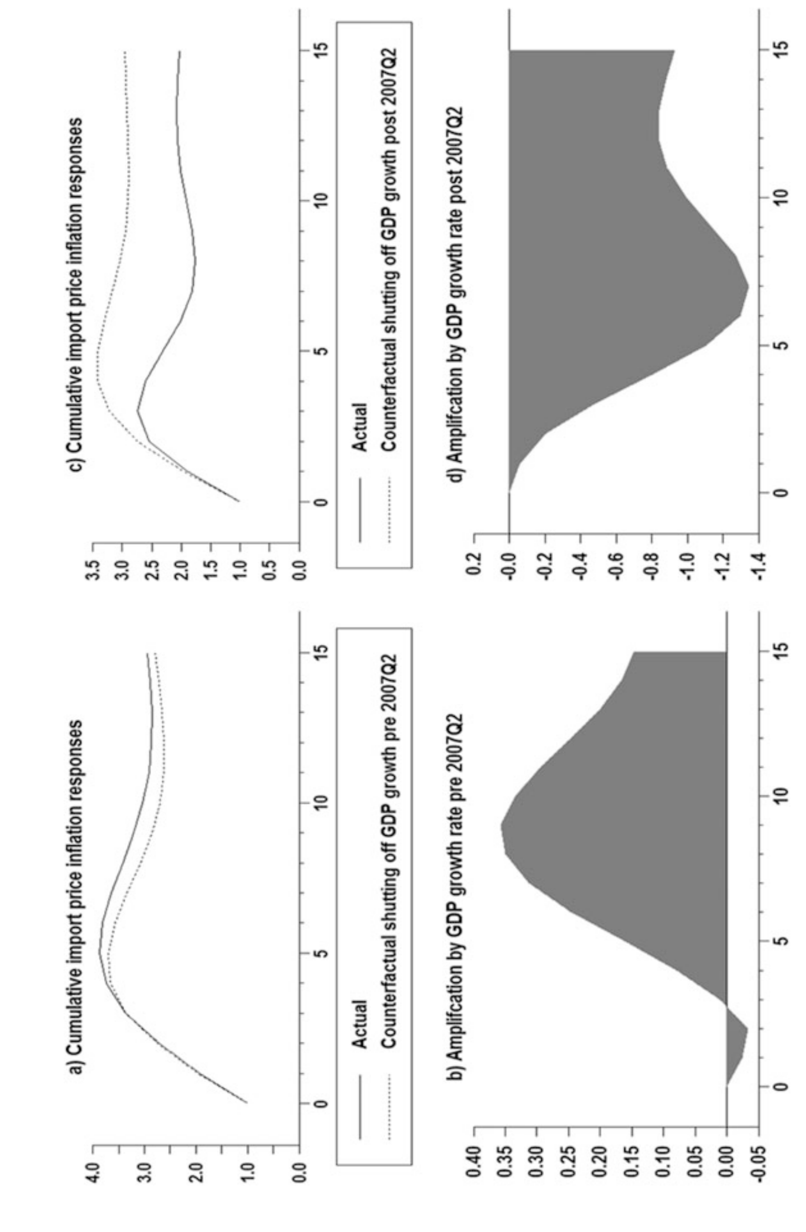

Fig. 17.2 Import price inflation responses to positive inflation shocks and role of GDP growth pre-2007Q2. *Source*: Authors' calculations

of recession on ability of the exchange rate (rand) to impact the import price inflation.[2] The GDP recession dummy equal one in 2009Q1 to Q3 and zero otherwise.

$$\begin{aligned} Import\ price_t = {} & 2.04 + 0.60{*}Importprice_{t-1} + 0.20{*}Rand \\ & - 0.27{*}Rand{*}GDPRecession_{dummy} \\ & - 8.59{*}GDPrecession_{dummy} \end{aligned} \tag{17.2}$$

This equation shows that the rand depreciation has a positive effect on import price inflation. However, the impact of the rand depreciation becomes negative when interacting (multiplying) the exchange rate changes and the recession dummy. This suggests that the recession leads to a dampened impact of the exchange rate on import price inflation. This is further evidence that the business cycle does impact the pass-through of exchange rate depreciation to import prices.

17.3 Is There Evidence of Asymmetric Effects?

In this section, estimation of asymmetric effects of GDP growth on import price inflation is done via a bivariate modified VAR model based on Killian and Vigfusson (2011) using import prices and GDP in the model with two lags and 10,000 Monte Carlo draws. This approach distinguishes between the effects of GDP growth increases and decreases, to determine the two aspects of asymmetry. The first asymmetry investigation is based on the size of negative and positive GDP shocks. The size of the shock refers to standard deviation (SD) shock. Since GDP growth currently is very low but not negative, it is important to use deviations from the long-run mean growth. Second, the asymmetry is determined based on the sign of GDP shock. Fig. 17.3 shows that a large negative shock to deviation from the GDP long-run mean growth leads to much depressed import price inflation. This suggests that the pass-through is impacted by domestic developments over and above other macroeconomic factors.

[2] Coefficients in the equation are statistically significant at all significant conventional levels.

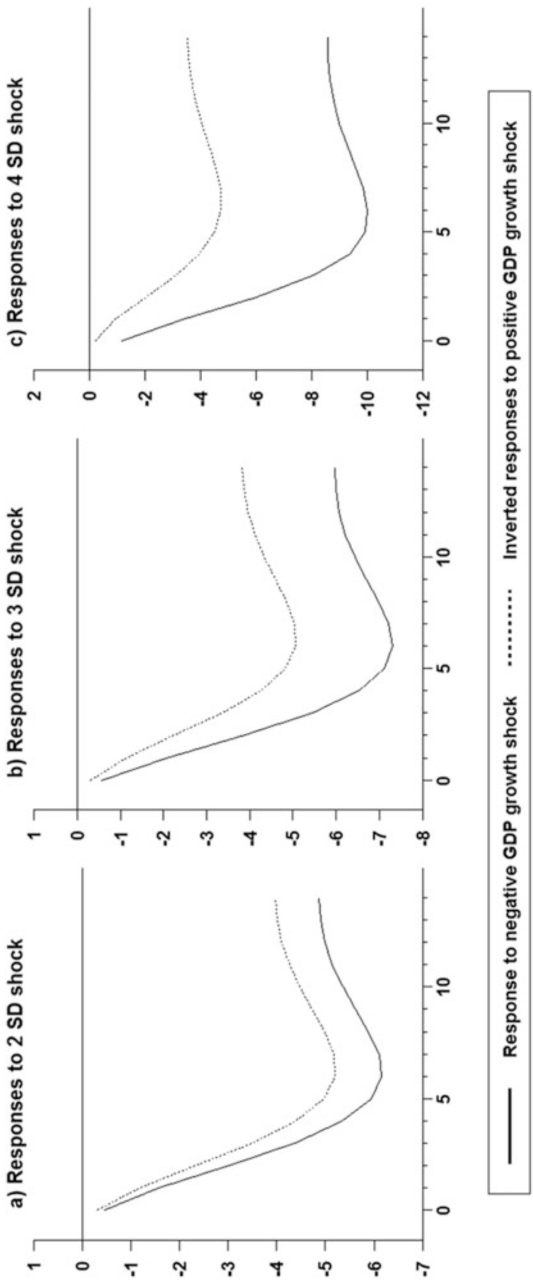

Fig. 17.3 Responses of imported inflation to negative and positive GDP growth shocks. *Source*: Authors' calculations

The second aspect of asymmetry of import price inflation to both positive and negative GDP growth shocks is shown in Fig. 17.3. However, the responses of import price inflation to positive GDP shocks are inverted to make it comparable to those of responses to negative shocks. Fig. 17.3 shows that negative GDP growth shocks lead to a bigger impact than positive GDP growth shocks.

This shows that as long as growth remains subdued, the ERPT to import price inflation is likely to remain muted.

17.4 The GDP Threshold and Implications for the Pass-Through of Rand Depreciation to Imported Inflation

Which lag of GDP growth should be used as a transition variable to determine non-linear effects? A number of tests are used to determine which lag needs to be included as the transition (latent) variable in the model which depicts the state of business cycle. In addition, it is possible that the business cycle impacts the response of inflation to rand depreciation shock with a lag. Table 17.1 shows that a number of tests to select the appropriate model reject linearity when using current, one-period and two-period lags of GDP growth.

The tests based on current GDP growth indicate that the logistic smooth transition regression model (LSTAR) is the best model to capture the relationship rather than the exponential smooth transition model. Thus the current GDP growth rate will be used as the transition variable to test for the asymmetric response of imported price inflation to rand depreciation shock. The LSTAR model is estimated to determine the pass-through regimes. Table 17.2 indicates that GDP growth threshold occurs at 2.1 per cent as shown in the shape of the transition function in Fig. 17.4. This means that below (above) 2.1 per cent is a regime of a low (high) ERPT to import prices.

Based on the results in Table 17.2 we calculate the persistence of the pass-through and import price inflation. The ERPT to import price inflation is bigger in the high GDP growth regime than in the low

Table 17.1 Selected the transition variable and model choice

	GDP		GDP_{t-1}		GDP_{t-2}		GDP_{t-3}		GDP_{t-4}	
Test	F-stat	Signif.	F-stat	Signif.	F-stat	Signif.	F-stat	Signif.	F-stat	Signif.
Linearity	3.77	(0.00)	1.88	(0.05)	2.15	(0.02)	1.12	(0.35)	0.92	(0.54)
H01	4.99	(0.00	2.70	(0.04)	2.43	(0.05)	1.95	(0.11)	0.60	(0.67)
H02	2.66	(0.04)	1.29	(0.28)	1.09	(0.37)	0.36	(0.83)	0.41	(0.80)
H03	2.65	(0.04)	1.52	(0.21)	2.64	(0.04)	1.11	(0.36)	1.72	(0.15)
H12	4.01	(0.00)	2.01	(0.05)	1.77	(0.10)	1.13	(0.35)	0.50	(0.86)

Source: Authors' calculation

Table 17.2 Results of logistic smooth transition model

Variable	Coeff.	Std. error	t-stat	p-value
Linear part				
Constant	2.14	0.67	3.17	0.00
Import inflation$_{t-1}$	0.57	0.08	6.79	0.00
Rand	0.06	0.09	0.72	0.47
Nonlinear part				
Rand	0.21	0.10	2.23	0.03
Speed of transition	11.15	15.97	0.70	
GDP threshold	**2.11**	**0.30**	**6.96**	
Centered R^2	74%			
R-Bar^2	73%			
PT in high GDP regime	**0.64**	**0.10**	**6.12**	**0.00**
PT in low GDP regime	**0.14**	**0.19**	**3.75**	**0.04**

Source: Authors' calculation
Note: PT refers to pass-through. We estimated the model using four lags and apply the general to specific approach through eliminating the last insignificant value until remaining with insignificant coefficients and re-estimate the model. The model was estimated to be adequate and passed the model diagnostics criterion. The dependent variable is import price inflation. The bold value indicates the main findings to the core analysis

GDP growth regime. The ERPT is around 0.64 in the high GDP growth regime which suggests that import prices inflation rise by about 6.4 percentage points following a 10 per cent rand depreciation shock. The ERPT is around 0.14 in the low GDP growth regime, which means that import price inflation rises by about 1.4 percentage points following a 10 per cent rand depreciation shock. In addition, import price inflation tends to be more persistent in the high GDP regime than in the low GDP growth regime.

17.5 Would the Conclusions Differ When Using a Different Technique?

This section applies another approach based on the interactive dummy variable approach to determine the non-linear effects induced by GDP growth regimes. The dummy equals one when the GDP growth exceed the threshold of 2.1 per cent and zero otherwise. This dummy is interacted with the exchange rate changes. Evidence in Table 17.3 indicates that the

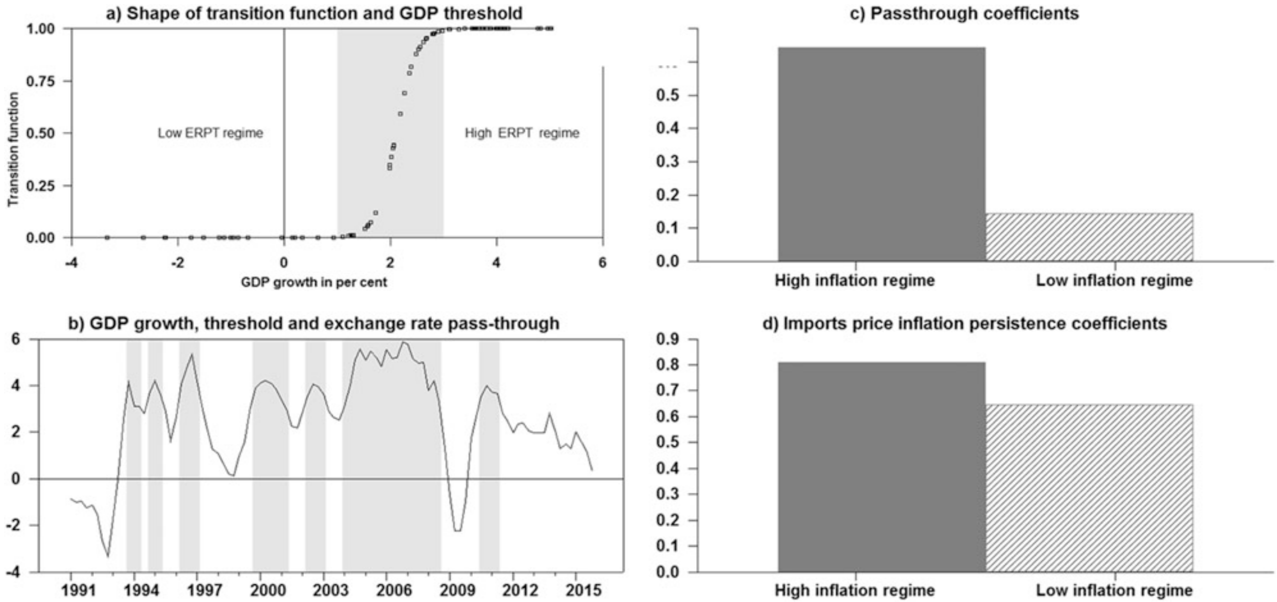

Fig. 17.4 Transition function and GDP threshold and inflation regimes. (a) Shape of transition function and GDP threshold; (b) GDP growth, threshold and exchange rate pass-through; (c) Passthrough coefficients; (d) Imports price inflation persistence coefficients
Note: Shading in (b) refer to high exchange rate pass through regimes
Source: Authors' calculations

Table 17.3 Threshold equations for GDP growth threshold effects on the pass-through

	Model A		Model B		Model C		Model D		Model E	
Constant	1.678	(0.02)	2.122	(0.00)	2.398	(0.00)	6.237	(0.16)	5.346	(0.21)
$Inflation_{t-1}$	0.606	(0.00)	0.576	(0.00)	0.527	(0.00)	0.511	(0.00)	0.564	(0.00)
Rand	0.189	(0.00)	0.078	(0.25)	0.091	(0.16)	0.105	(0.12)	0.089	(0.20)
Rand*THRESH			**0.183**	**(0.00)**	**0.151**	**(0.01)**	**0.139**	**(0.02)**	**0.174**	**(0.01)**
GDP gap					1.073	(0.07)	1.097	(0.07)		
R^2	71.5%		74.0%		75.4%		75.6%		74.2%	
PT in low regime	**0.479**	**(0.0)**[a]	**0.183**	**(0.19)**	**0.193**	**(0.11)**	**0.214**	**(0.08)****	**0.203**	**(0.15)**
PT in high regime	**0.479**	**(0.0)**[a]	**0.615**	**(0.00)***	**0.512**	**(0.0)***	**0.499**	**(0.00)***	**0.602**	**(0.00)***

Source: Authors' calculation

Note: PT refers to pass-through and inflation refers to import price inflation. The dependant variable is import price inflation

[a]Implies no distinction was made in regimes. *,** indicates significance at 1 and 10 per cent level

ERPT to imported inflation is bigger in the high GDP growth regime. This evidence supports the asymmetric effects induced by the business cycle.

17.6 Exchange Rate Pass-Through Below and Above GDP Threshold

For a further robustness test of the asymmetries in the responses of import price inflation induced by GDP growth threshold, this section estimates a three-variable VAR model and 10,000 Monte Carlo draws. The model includes annual changes in the rand per dollar exchange rate, import price inflation and the dummy for GDP growth above threshold and zero otherwise. Evidence shows that in Fig. 17.5(a) when GDP growth exceeds the threshold, import price inflation tends to rise by the cumulative amplification by GDP growth in Fig. 17.5(b).

In contrast, Fig. 17.5(c) shows that when GDP growth is below the 2.1 per cent threshold, actual import price inflation would be lower than the counterfactual import price inflation. Thus GDP growth leads to a dampening effect on import price inflation in Fig. 17.5(d).

17.7 Conclusion and Policy Implications

We have presented evidence that GDP growth amplifies the responses of import price inflation to import demand shocks. Furthermore, we estimate that the GDP growth threshold occurs at 2.1 per cent and leads to non-linear ERPT to import price inflation. Import price inflation is more persistent above the threshold. The evidence is consistent with a model of optimizing importing firms, which suggests that the degree of ERPT is higher during periods of high GDP growth. During periods of high growth, firms can increase marks-ups without losing market share. This also indicates that the behaviour of importers' margins is aligned to changes in the GDP growth rate. The results of the impact of the business cycle on the ERPT are further corroborated by the fact that the recession

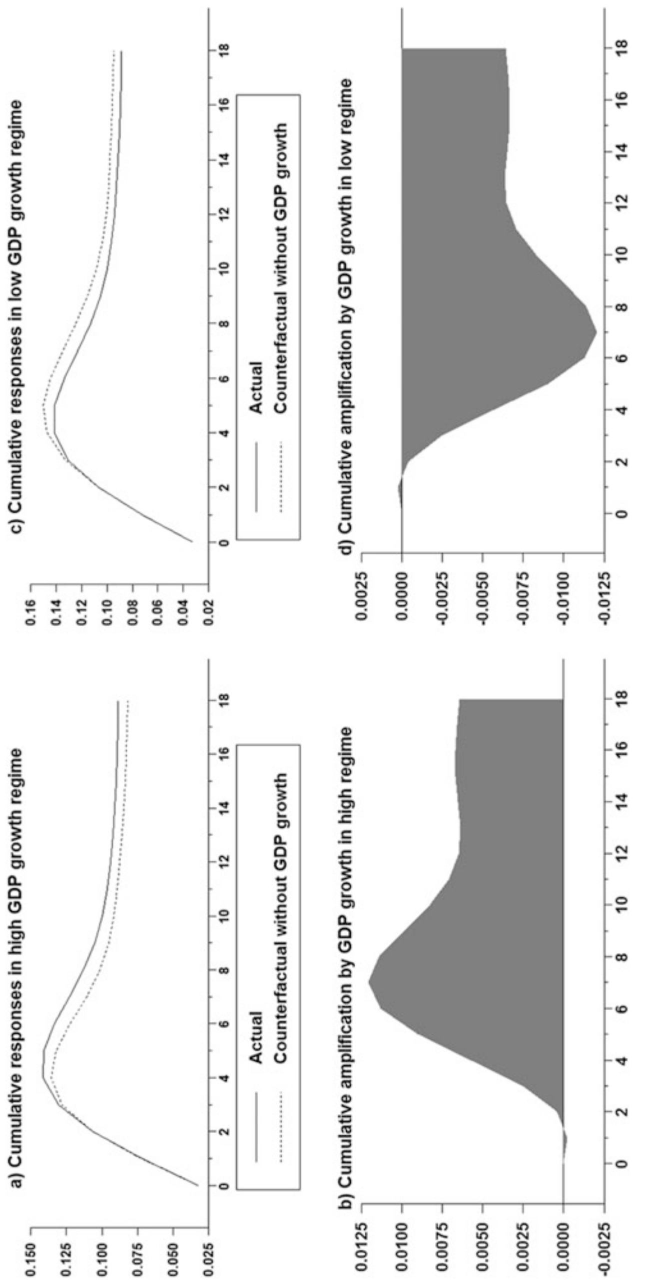

Fig. 17.5 Import price inflation and GDP amplification subject to the GDP growth threshold. *Source*: Authors' calculations

led to a dampened impact of the exchange rate depreciation shock on import price inflation.

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18

Inflation Rate and R/US$ Depreciation Shocks on Import Price Inflation: Inferences from Deviations from the 6 Per cent Inflation Rate

Learning Objectives

- The inflation threshold that induced non-linear exchange rate pass-through effects
- The effects of the negative and positive shocks to inflation deviations from 6 per cent target on imports price inflation
- The difference in amplification induced by inflation below and above 6 per cent

18.1 Introduction

This chapter complements the previous analysis by anchoring the analysis of the first stage of the exchange rate pass-through (ERPT) to headline inflation on the inflation target band. Literature shows that exchange rate and inflation variability play a key role in lowering the degree of the exchange rate pass-through (ERPT) to import prices. This means that low and stable inflation regimes coupled with increased global competition pressures result in a low ERPT as firms find it difficult to pass-through price increases. Does the headline CPI inflation rate matter for the rand depreciation shock effects on import price inflation? What are the effects

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of the negative and positive shock to inflation deviations from the 6 per cent target on import price inflation? Is there a difference in amplification induced by inflation below and above 6 per cent, and within 3–6 per cent target on magnifying the response of import price inflation to import demand shocks? Are there policy implications for the enforcement of the price stability mandate?

18.2 What Role Does Monetary Policy Play in Mitigating Import Price Inflation Responses to Inflationary Shocks?

The analysis begins by examining the role of headline CPI inflation in propagating import price inflation to unexpected positive import demand shocks. In the following sections we examine this effect by separating the propagation abilities of inflation (i) below and above 6 per cent inflation rate, and (ii) within the 3–6 per cent target band and below 4.5 per cent inflation rate. This segmentation of the inflation rates contributes to the assessment of the optimality of the current 3–6 per cent and mid-point of inflation target band. We apply a modified version of the Pentecôte and Rondeau (2015) approach to show the amplification of a positive import demand shock on import price inflation ($IMP\_Inflation_t$) via headline CPI ($CPI\_Inflation$) inflation. Does imported price inflation respond differently in the presence and absence of headline CPI inflation to positive import demand inflation shock? The inflation dynamics are given by Eq. (18.1):

$$IMP\_Inflation_t = constant + \sum_{i=1}^{l} \beta_i IMP\_inflation_{t-i} + \sum_{i=0}^{l} q_i CPI\_inflation_{t-i} + \varepsilon_t \qquad (18.1)$$

where ε_t denotes a positive import demand inflation shock. We determine the actual (counterfactual) inflation responses when the headline CPI inflation channel is included (shut off) in the model. Four lags are used in the estimation of Eq. (18.1). The propagating (magnifying) or restraining (stifling) ability of the headline CPI channel is determined by the gap between actual and counterfactual responses. The study uses quarterly (Q) data for the period 1990Q1 to 2015Q4 collected from the IMF IFS and South African Reserve Bank for prices of imports and non-factor services, headline CPI inflation, GDP growth and the rand per US dollar exchange rate.

The gap between responses of actual import price inflation and the counterfactual response indicate that inflation propagates the responses of import price inflation to positive import demand inflation shock. The counterfactual response refers to import price inflation when the headline inflation is shut off in the model. Do the amplification magnitudes induced by headline inflation differ (i) above and below 6 per cent, (ii) between 3 and 6 per cent, and (iii) below 4.5 per cent? The gaps between actual and counterfactual import price inflation do vary according to the level of inflation in Fig. 18.1. The cumulative propagating ability of inflation is much lower when inflation is below 6 per cent than when it is above 6 per cent Fig. 18.1(e).

In addition, Fig. 18.1(b) shows that when inflation is below 4.5 per cent the propagation effects are very limited and almost diminished than when inflation is anywhere within the 3–6 per cent target band. This finding confirms that the level of inflation within the target range matters. The results mean that the enforcement of price stability weakens the propagating abilities of inflation and indeed do result in a stable inflation environment. However, it is evident that this is truly achieved when the inflation rate is below 4.5 per cent relative to anywhere else below 6 per cent. This is additional evidence that weakens and refutes the argument that the inflation targeting band should be widened beyond 6 per cent and that just being within the band is good enough.

Are there asymmetric effects based on the deviations from 6 per cent threshold? Asymmetric responses have implications for the adjustment of the policy rate. The asymmetry is assessed based deviations from the 6 per cent inflation rate. Asymmetry effects based on the size of the negative and positive inflation shock. Evidence Fig. 18.2(b) suggests that big negative

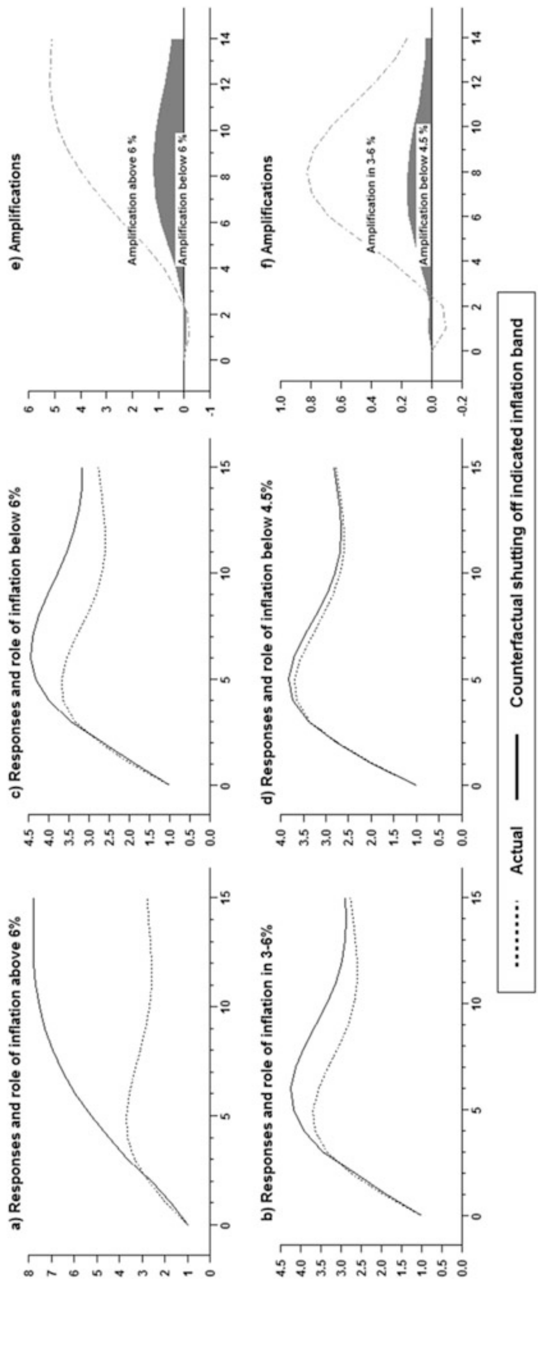

Fig. 18.1 Amplification effects based of the level of inflation. *Source*: Authors' calculations

inflation shocks lead to larger declines in import price inflation than small shocks. In addition, there is asymmetry based on the sign of the shock. The results in Fig. 18.2(d) suggest that negative inflation deviations from 6 per cent lead to a large decline in import price inflation than positive deviations of the same magnitude above 6 per cent. Thus, inflation below 6 per cent has benefits in mitigating high import prices.

18.3 At What Inflation Threshold Is There Asymmetry on the Exchange Rate Pass-Through to Import Price Inflation?

Evidence shows that inflation follows a non-linear process and it is best modelled using the logistic smooth transition auto regression model. This section uses the logistic smooth transition regression (LSTR) model based on the modified Junttila and Korhonen (2012) model specification. The variables include import price inflation as the dependent variable conditioned on current annual changes in the rand per US dollar exchange rate, proxy for the exporter marginal costs and the output gap (measured as the deviation from real GDP growth of potential) to account for domestic demand conditions. Since the premise is that the exchange rate effects on import price inflation are dependent on the level of headline CPI inflation, we use the latter as a transition variable. The sample spans 1990Q1 to 2015Q4.

The results in Table 18.1 show that the inflation threshold is at 5.66 per cent and lies within the 3–6 per cent inflation target band. The threshold delineates between high and low ERPT regime.

The long-run ERPT to import price inflection is bigger at around 0.76 in the high headline CPI inflation regime than 0.48 in the low headline CPI inflation regime. This suggests the pass-through is incomplete in the long-run. Thus 10 per cent rand depreciation in the high inflation regime leads to 7.6 per cent increase in import price inflation compared to 4.8 per cent in the low inflation regime. This suggests there are benefits in keeping inflation below the threshold level. The transition function depicting the regimes of low and high ERPT regimes in Fig. 18.2 reveals that more data points lie above the threshold value.

Table 18.1 Results of the logistic smooth transition model

Dependent variable: Import price inflation				
Variable	Coefficient	Standard Error	*T*-Stat	*P*-value
Linear part				
Import inflation$_{t-1}$	0.85	0.16	5.35	0.00
Import inflation$_{t-2}$	−0.22	0.18	−1.21	0.23
Rand	0.13	0.06	2.03	0.04
GDP gap	−1.60	0.84	−1.91	0.06
GDP gap$_{t-1}$	1.84	0.88	2.08	0.04
Non-linear part				
Import inflation$_{t-1}$	0.25	0.24	1.06	0.29
Import inflation$_{t-2}$	−0.33	0.24	−1.40	0.16
Rand	0.40	0.15	2.71	0.01
Rand$_{t-1}$	−0.40	0.10	−4.01	0.00
Rand$_{t-4}$	0.22	0.08	2.74	0.01
Speed of transition	5.41	5.26	1.03	–
Threshold (Headline inflation)	**5.66**	**0.50**	**11.31**	**0.00**
Centered R^2	86%	–	–	–
R-Bar^2	84%	–	–	–
PT in high H. inflation regime	**0.761**	**0.191**	**3.993**	**0.000**
PT in low H. inflation regime	**0.476**	**0.280**	**1.701**	**0.089**

Source: Authors' calculations

Note: PT refers to pass-through. We estimated the model using four lags and apply the general to specific approach through eliminating the last insignificant value until remaining with insignificant coefficients and re-estimate the model. The model was estimated to be adequate and passed the model diagnostics criterion. The model was estimated including the constant. The marginal costs have an insignificant effect

The degree of persistence in the import price inflation and headline CPI in the low and high inflation regimes based on the autocorrelation plots and auto-regressions with one lag in Fig. 18.3 shows that these dynamics decay over time. The grey shaded area indicates the bands used to determine the significance of the autocorrelations values. The inflation persistence coefficients in Fig. 18.3(b) show that inflation tends to be persistent in the high inflation regime. Similarly, import price inflation is slightly higher in high inflation regime in Fig. 18.3(c). We conclude that inflation persistence and pass-through are higher in the high inflation regime.

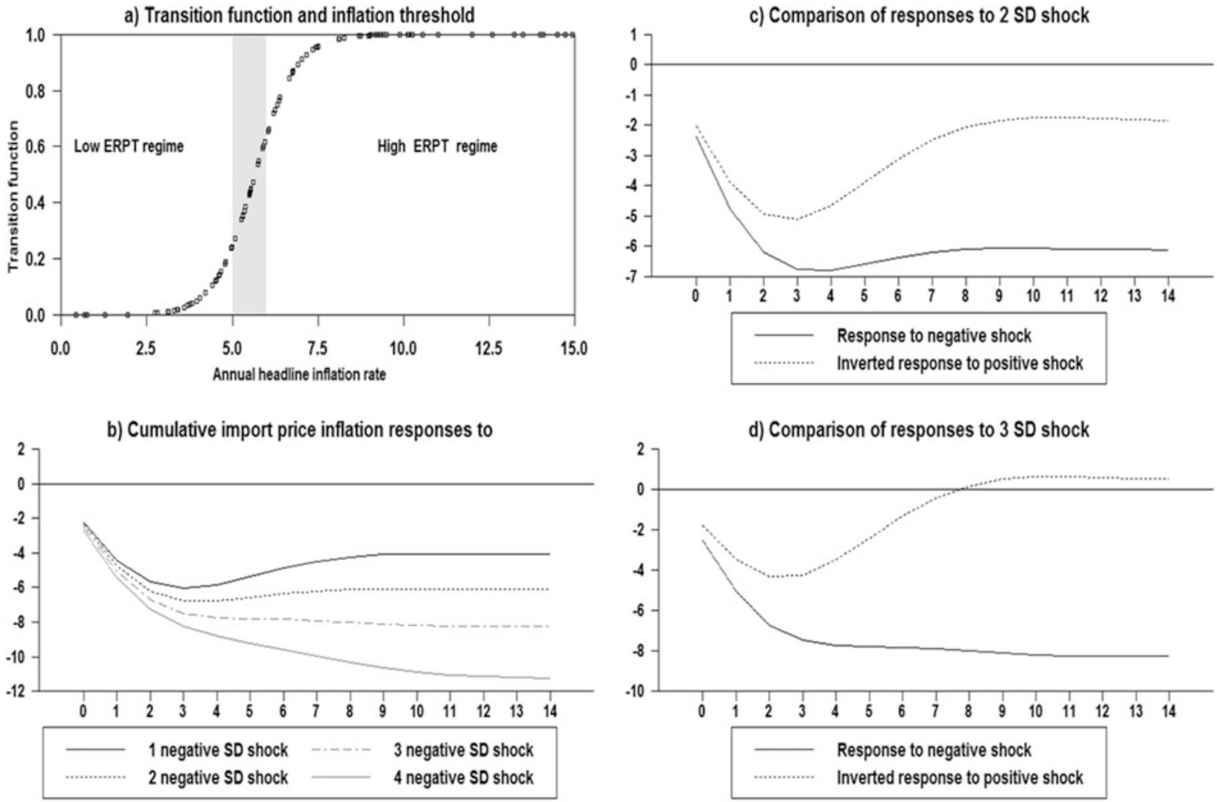

Fig. 18.2 The transition function and the exchange rate pass-through (ERPT) regimes. *Source*: Authors' calculation

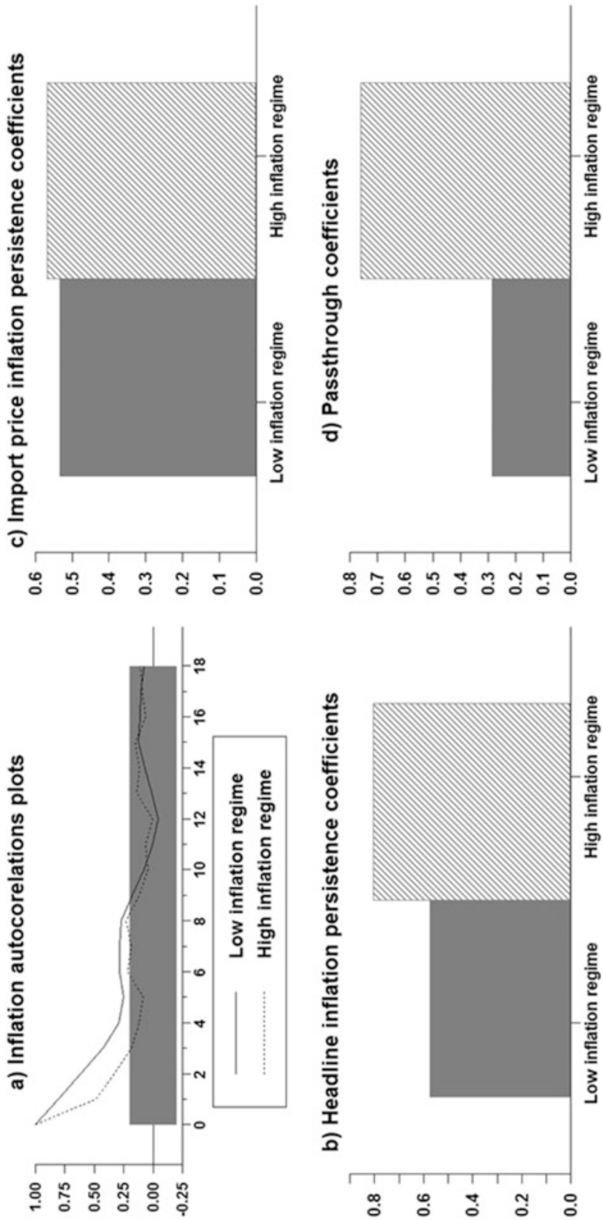

Fig. 18.3 Measures of inflation persistence in low and high inflation regimes. *Source*: Authors' calculations

18.4 Conclusion and Policy Implications

This chapter examined whether different aspects of inflation propagates the response of import price inflation to import demand inflation shock. Evidence indicates that the cumulative propagating ability of inflation is much lower when inflation is below 6 per cent and particularly so when it is below 4.5 per cent. Levels above 6 per cent are bad for inflationary pressures. Evidence indicates that asymmetric effects of inflation on import price inflation. Shocks to deviations from the 6 per cent inflation reveal that big negative inflation shocks lead to larger decline in import price inflation than positive shocks of similar size. This evidence supports the role of low and stable inflation in mitigating the level of import price inflation and the first stage of the ERPT in supporting other macroeconomic policies.

In addition the chapter shows that the threshold beyond which inflation leads to different ERPT is 5.66 per cent and lies within the 3–6 per cent inflation target band. Import price inflation is slightly persistent in the high inflation regime. When inflation is below 4.5 per cent the propagation effects induced by headline inflation are very limited and almost diminished than when inflation is anywhere within the 3–6 per cent target band. This finding confirms that the level of inflation within the target range matters for the definition of what price stability means.

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Part IV

Direct Exchange Rate Pass-through and Causes of Non-Linear Inflation Responses to Rand-US Dollar Exchange Rate Depreciation Shocks

19

The Inflation–Finance–Growth Nexus: Where Does the Inflation Threshold Lie?

Learning Objectives

- Establish the inflation threshold which exerts differential inflation effects within the inflation–finance–growth nexus via a number of econometric approaches
- The transmission of positive M3 and credit shocks via government consumption and the impact on GDP relative to the upper band of the inflation target

19.1 Introduction

This chapter establishes the inflation thresholds and their non-linear effects within the inflation–finance–growth nexus. A variety of techniques are used to ascertain whether the results are robust for the choice of technique. Is there a threshold above which inflation exerts a negative effect on GDP growth and below which it enhances growth when controlling for the interactions within the finance–GDP growth nexus? Furthermore, the official inflation target band is 3–6 per cent. Does the threshold where inflation has negative effects on output growth lie within or above the inflation target band? Is the finance–GDP growth nexus is

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impacted by the inflation regimes, for instance, whether inflation is in a low or high regime and what is the role of government consumption expenditure? Does fiscal policy act as a conduit in the transmission of shocks to GDP growth and does this role vary with inflation regimes?

19.2 The Linear Relationship Between Inflation and Economic Growth

Fig. 19.1 shows a negative long-run relationship between economic growth and inflation using five-year averages for the sample period 1966–2012. Despite the negative relationship, inflation explains about 55 per cent of average GDP growth over 5-year periods. Furthermore, the highest levels of GDP growth were achieved when inflation is below 4 per cent, implying the presence of non-linearities in the inflation and GDP growth relationship. The various hypotheses of the best models to estimate the non-linearities involved show the rejection of the exponential smooth transition regression (ESTR) linearity in favor of a logistic smooth transition regression (LSTR).

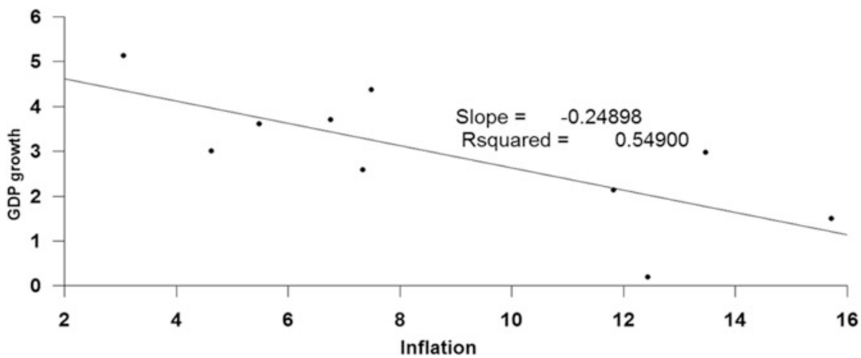

Fig. 19.1 Five-year average GDP growth and inflation rate. *Source*: South African Reserve Bank and authors' calculations

19.3 Do Inflation Bands Reveal Non-linear Inflation Effects on Growth?

First, this section tests for the non-linear features in the functions that relate economic growth to various inflation bands by the modified Pentecôte and Rondeau (2015) approach to the inflation Eq. (19.1). The analysis uses annual data from 1966 to 2012.

$$GDP\,growth_t = constant + \sum_{i=1}^{4} \beta_i GDP\,growth_{t-i} + \sum_{i=0}^{4} q_i Inflation\,band_{t-i} + \varepsilon_t \tag{19.1}$$

where ε_t denotes an error term and *Inflation band* denotes inflation in different target bands. The band refers to dummy that equals an inflation band and zero otherwise. Two dummy variables are used. The first dummy equals one when inflation exceeds 6 per cent and zero otherwise. The second equals one when inflation is below 6 and zero otherwise. The impulse responses of GDP growth to shock to inflation above and below 6 per cent in Fig. 19.2 show that GDP growth declines when inflation is above 6 per cent, in contrast to when inflation is below 6 per cent.

Do these effects vary with the inflation bands? Fig. 19.2(c) shows the results for the bands (i) 0–3 per cent, (ii) 0–4.5 per cent, (iii) 3–6 per cent, and (iv) above 6.5 per cent. The dummy variables created for these bands equal one for each band and zero otherwise. The results show that all inflation bands below 6 per cent inflation have positive impact on GDP growth compared to those in which inflation exceeds 6 per cent.

The impulse responses show that positive inflation shocks when inflow is below 6 per cent have a positive impact on GDP growth. For instance in Fig. 19.2(b) to (e) inflation in 0–3 per cent, below 6 per cent, between 3 and 6 per cent and below 4.5 per cent exerts positive effects on GDP growth. In contrast, when inflation is above 6 per cent and 6.5 per cent, GDP growth declines in Fig. 19.2(a) and (f). This shows that inflation above the 6 per cent has detrimental effects on GDP growth.

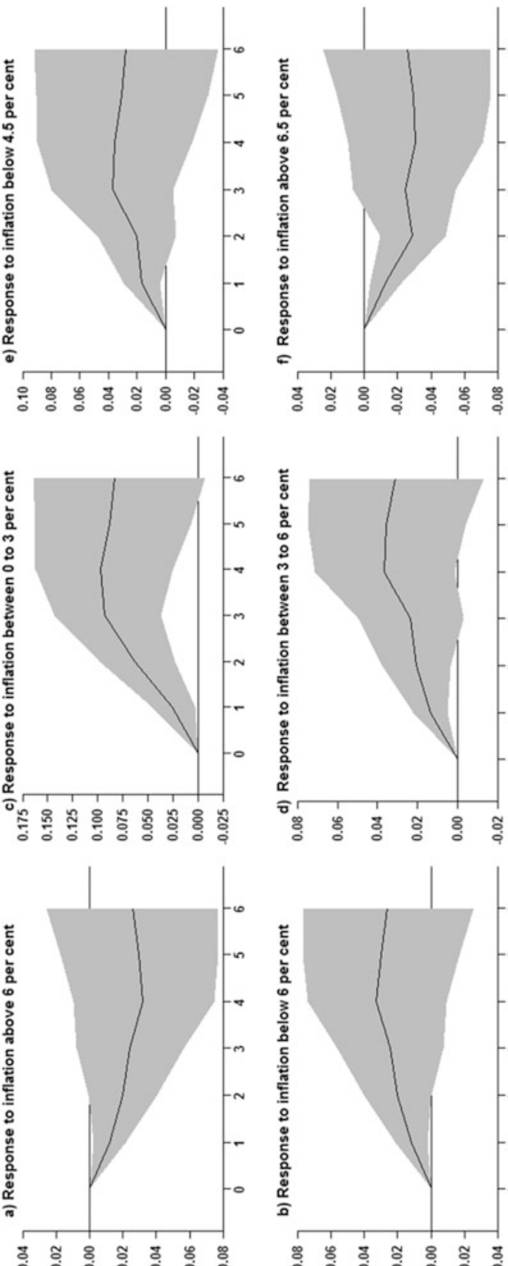

Fig. 19.2 GDP responses to inflation above and below 6 per cent. *Source*: Authors' calculations

Table 19.1 Non-linear effects of the 3 per cent inflation bands on GDP growth

	Coefficient	*T*-statistics
Constant	0.232	1.09
D_{3-6}	0.001	0.45
D_{6-9}	−0.011	(−2.59)*
D_{9-12}	−0.008	(−2.41)*
D_{12-15}	−0.014	(−2.73)*
D_{15-20}	−0.017	(−3.72)*

Source: South African Reserve Bank and authors' calculations

Note: The estimated coefficients of the different inflation groups (D_{3-6} to D_{15-20}) represent the effects of GDP growth of each group relative to D_{0-3} which is 0–3 per cent. We use 0–3 per cent as the lower reference band or benchmark band. The estimated and corresponding HAC standard errors for each inflation group as reported in various regressions using the 3 per cent intervals. *Implies significant at 5 per cent level. The results were estimated including other determinants of economic growth indicated in variables sections

Furthermore, we establish the non-linear regression results based on the inflation bands controlling for determinants of growth; the inflation rate, household consumption expenditure growth, trade openness, growth in the terms-of-trade, government expenditure growth, gross fixed capital formation growth and M3 growth. Trade openness is sum of exports and imports as per cent of GDP. This approach shows that inflation bands above 6 per cent have significant negative effects on GDP growth compared to the benchmark of less than 3 per cent in Table 19.1. This suggests the point at which the threshold occurs is below 6 per cent.

19.4 Does Fiscal Policy Amplify the Transmission of Inflation Effects on GDP Growth?

The role of fiscal policy measured by government consumption expenditure growth is captured in the gap between the GDP growth responses to inflation band shock below 6 per cent and above 6 per cent using Eqs. (19.2) and (19.3). Eq. (19.2) is equivalent to setting the estimated coefficient of government consumption expenditure growth $Govt_{t-i}$ in Eq. (19.3) to zero. That is, the equation enables the derivation of counterfactual impulse response of GDP growth to inflation above and below 6 per cent.

$$GDP\,growth_t = constant + \sum_{i=1}^{4} \beta_i GDP\,growth_{t-i} + \sum_{i=0}^{4} k_i Govt_{t-i} + \sum_{i=0}^{4} q_i Inflation\,band_{t-i} + \varepsilon_t \quad (19.2)$$

Fig. 19.3(b) shows that the effect of inflation below six, which is positive on GDP growth, is larger when government consumption expenditure growth is included in the model. In contrast Fig. 19.3(c) shows that inflation above 6 per cent lowers GDP growth and the decline is bigger when government consumption expenditure is included in the model. Government consumption spending worsens the decline in GDP growth when inflation exceeds 6.5 per cent. This might be indicative of a pricing channel linked to inflating of contracts in anticipation of high inflation.

However, below 4.5 per cent government consumption amplifies the effect of inflation; this may indicate that low inflation may discourage excessive indexation of contracts to inflation levels. This means that fiscal policy plays a role as a conduit of the transmission of inflation shocks to GDP growth and the effects depend on the level of inflation. There are relative distortionary effects of pricing and allocation when inflation exceeds the 6.5 per cent. As a consequence, government consumption amplifies the GDP growth in the low inflation environment relative to the worsening effects, when inflation is above 6.5 per cent.

19.5 Inflation Threshold Using the Sarel (1996) Approach

The Sarel (1996) approach uses R-squared[1] from OLS (ordinary least squares) estimations to identify the threshold point. This tests whether (i) the structural break is significant, and (ii) the sign of the estimated

[1] R-squared is the number that indicates the proportion of the variance in the dependent variable that is predictable from the independent variable.

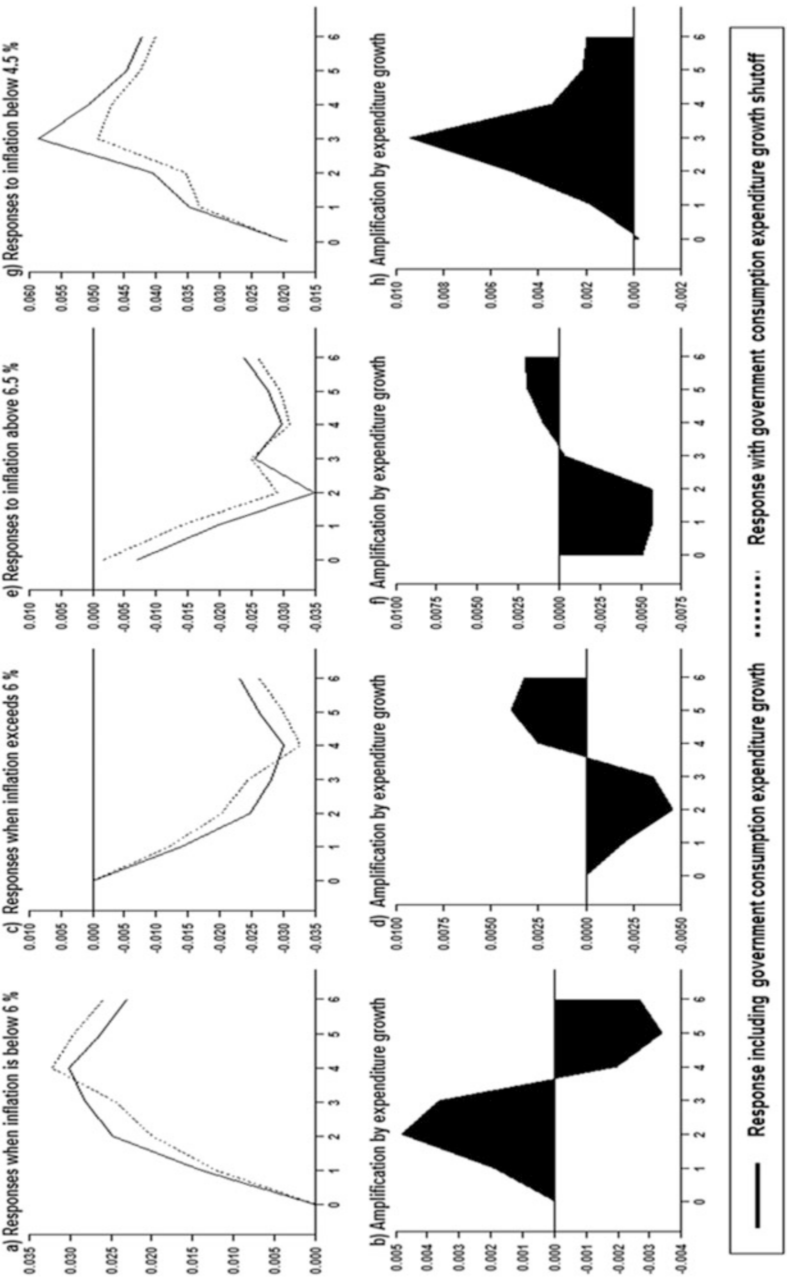

Fig. 19.3 GDP growth responses to inflation above and below 6 per cent and the role of government consumption expenditure. *Source*: Authors' calculations

inflation effects on growth on either side of the identified structural break. The level of the inflation rate at which the structural break occurs is chosen based on regressions that maximise the R-squared. This approach determines the level of the inflation rate at which the structural break occurs by choosing the level of inflation from different regressions, which maximise the R-squared. This is equivalent to choosing a threshold value that minimises the sum of squared residuals from individual regressions. The methodology is based on estimating Eq. (19.3) Using the following variables GDP growth (G_g), inflation (π_i), investment growth ($invg_t$), Household consumption growth ($consg_t$), government consumption expenditure growth ($Govg_t$), trade openness (OP_t), finance growth ($fing_t$):

$$\begin{aligned} Gg_t = c + \beta_1 \ln\pi_t + \beta_2 D(Inf) + \beta_3 Invg_t + \beta_4 Cong_t + \beta_5 Govg_t \\ + \beta_6 Op_t + \beta_7 \ln Gg_{t-1} + \beta_8 Fing + \varepsilon_t \end{aligned} \tag{19.3}$$

where $Inf = \ln(\pi_t) - \ln(\pi_t^*)$, $D = 1$ if $\pi_t > \pi_t^*$, 0 otherwise, π_t^* is the rate of inflation at which the structural break occurs. The main focus is effect of the two variables $\ln(\pi_t)$ and D including the other explanatory variables on GDP growth. When inflation is low $\pi_t < \pi_t^*$ then $D = 0$. The effect of inflation on GDP growth is estimated by the coefficient of $\ln(\pi_t)$. When $\pi_t > \pi_t^*$ it implies higher inflation, then we sum the coefficient of $\ln(\pi_t)$ and the coefficient on D. In addition, the coefficient of D estimates the difference in the inflation effects on GDP growth between the two sides of the identified structural break.

The R-squared results from the iterated regressions for various values of inflation thresholds based on the estimated models in Table 19.2 are shown in Fig. 19.4.

Fig. 19.4 shows that depending on the specification of the model under consideration, the value of the R-squared is maximised when the inflation threshold is between 4 and 5 per cent. The finding of the threshold within the 3–6 per cent inflation target band is robust to controlling for (i) disinflation effects in Model 4, (ii) different rates of increases in the inflation rate in Model 5, and (iii) the lagged effects of inflation rates in Model 3. Even the two stage least squares (2SLS), which controls for endogeneity confirms that the threshold occurs around 4 per cent. This means that the problem of endogeneity or simultaneity bias cited in the literature are of less importance with regard to affecting the estimated inflation thresholds.

Table 19.2 Various estimated model results based on different specifications of the Sarel approach

	Model 1		Model 2		Model 3		Model 4		Model 5		2SLS	
	Coeff	*T*-stat	Coeff	*T*-stat	Coeff	*T*-stat	Coeff	*T*-stat	Coeff	*T*-stat	Coeff	*T*-stat
Constant	0.349	(2.77)	0.413	(3.21)	0.426	(3.08)	0.382	(3.21)	0.426	(3.08)	0.4	(3.095)
Linf_t	−0.008	(−2.74)	0.004	(−1.37)	0.005	(2.25)	0.004	(−1.98)	0.011	(2.72)	0.003	(0.734)
D(Inf)	–	–	−0.016	(−2.83)	−0.023	(−4.01)	−0.016	(−4.19)	−0.023	(−4.01)	−0.017	(−2.691)
Invg	0.058	(2.64)	0.049	(2.38)	0.057	(2.19)	0.048	(2.21)	0.057	(2.19)	0.024	(1.049)
Cong	0.458	(12.59)	0.447	(13.13)	0.449	(12.3)	0.466	(16.07)	0.449	(12.3)	0.444	(13.90)
Govg	−0.095	(−2.12)	−0.078	(−1.82)	−0.049	(−1.09)	−0.044	(−1.23)	−0.049	(−1.09)	−0.065	(−1.531)
lnG_{t-1}	−0.014	(−2.99)	−0.015	(−3.21)	−0.015	(−3.05)	−0.015	(−3.35)	−0.015	(−3.05)	−0.015	(−3.133)
Openness	0.072	(4.35)	0.07	(4.39)	0.079	(4.69)	0.084	(7.69)	0.079	(4.69)	0.071	(4.28)
ToTg	–	–	–	–	−0.024	(−0.54)	−0.038	(−0.94)	−0.024	(−0.54)	–	–
M3g	0.039	(1.34)	0.055	(1.87)	0.055	(2.17)	0.049	(2.28)	0.055	(2.17)	0.073	(2.476)
Inflation persistence												
$\text{Ln}\pi_{t-1}$	–	–	–	–	−0.004	(−1.41)	–	–	–	–	–	–
$\text{Ln}\pi_{t-2}$	–	–	–	–	0.01	(−4.06)	–	–	–	–	–	–
Disinflation effects												
Disnfl	–	–	–	–	–	–	0.001	(−0.41)	–	–	–	–
Disinfl_{t-1}	–	–	–	–	–	–	0.009	(−5.28)	–	–	–	–
Rate of inflation changes												
Dinfl	–	–	–	–	–	–	–	–	−0.006	(−2.1)	–	–
Dinfl_{t-1}	–	–	–	–	–	–	–	–	−0.01	(−4.06)	–	–
R square	0.892	–	0.9	–	0.922	–	0.935	–	0.922	–	0.842	–
DW	1.96	–	1.923	–	2.117	–	2.043	–	2.117	–	–	–
Estimated threshold (%)	**–**	**–**	**4–5**	**–**	**4–5**	**–**	**4**	**–**	**5**	**–**	**4**	**–**
Threshold effect	–	–	−0.012	–	−0.018	–	−0.011	–	−0.012	–	−0.014	–

Source: Authors' calculations

Note: Model 1 refers to benchmark model without threshold effects

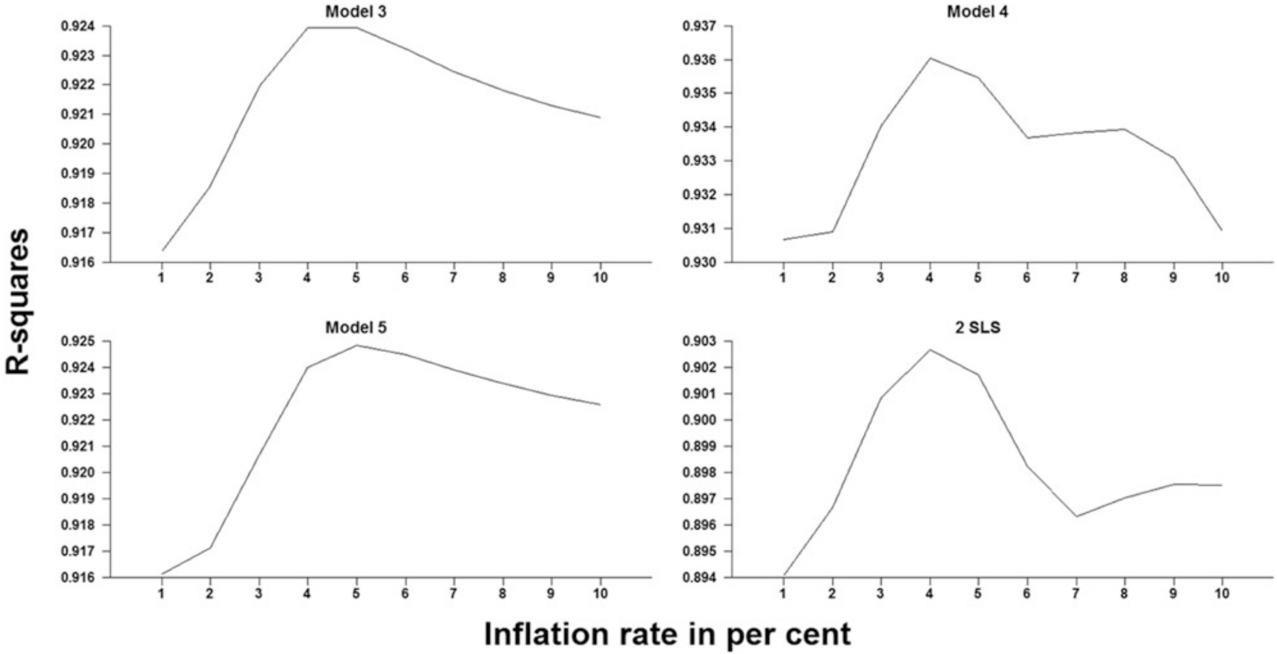

Fig. 19.4 R-squared and the determination of the inflation threshold. *Source*: South African Reserve Bank and authors' calculations. *Note*: For the different model specifications see Table 19.2

19.6 Does the Smooth Transition Regression Model Result in Different Results from Those of the Sarel (1996) Approach?

To deal further with the endogeniety issues and robustness checks of results based on the Sarel approach, this sections estimates the inflation thresholds based on the logistic smooth transition model (LSTR). Evidence from Table 19.3 shows that (i) the null of linearity is rejected, and (ii) since the rejection of linearity is stronger for the LSTR model it means that the LSTR model is preferred relative to the ESTR model. Hence the analysis uses the LSTR model.

The variables in Table 19.4 using the Sarel specification and Table 19.5, which encompass the GDP growth drivers are included in the Solow,[2] Ramsey and other models growth model. The government consumption growth is negative, reflecting that growth in government consumption can be viewed as a proxy for the government burden above a certain level of the inflation threshold. The investment variable has a positive sign indicating an increasing relationship between capital accumulation and growth irrespective of the inflation regime.

Trade openness positively affects economic growth below the inflation threshold. This is in line with both the neoclassical and endogenous growth theories. The positive effect is eroded once inflation is above the threshold. The effect of inflation on economic growth effect is strongly non-linear. Indeed, the impact of inflation on GDP growth depends on the level of the

Table 19.3 LM and *F*-test for linearity (*p*-values)

Test	*F*-statistics	*P*-value
Linearity	39.46	(0.0000)*
LSTR	21.61	(0.0000)*
ESTR	7.24	(0.0005)*

Source: Authors' calculations
Note: *implies significance at 1 per cent

[2] This a production function model applied to the study of growth problems by Robert Solow and it begins with a production function of the Cobb-Douglas type, where output depends in labor and capital.

Table 19.4 Results using the LSTR model based on the Sarel specification

	Model 1		Model 2		Model 3	
	Coeff	p-value	Coeff	p-value	Coeff	p-value
Linear part						
Constant	0.045	(0.138)	0.047	(0.09)	0.045	(0.112)
Inflation	0.014	(0.047)	0.016	(0.017)	0.0147	(0.024)
Investment	0.047	(0.095)	0.048	(0.038)	0.0641	(0.001)
Consumption	0.462	(0)	0.457	(0)	0.4664	(0)
Government	−0.041	(0.277)	−0.048	(0.225)	−0.045	(0.258)
Openness	0.044	(0.006)	0.054	(0.002)	0.0547	(0.002)
Finance	0.058	(0.145)	0.048	(0.063)	0.0187	(0.11)
Non-linear part						
Constant	−0.083	(0.004)	−0.091	(0.001)	−0.0784	(0.004)
Inflation	−0.022	(0.003)	−0.024	(0.001)	−0.0204	(0.004)
Speed of transition	7446.102		71093.156		36285.94	
Threshold (%)	**4.1**		**4.1**		**4.1**	
R^2	0.877		0.879		0.867	
Adjusted R^2	0.842		0.845		0.838	

Source: South African Reserve Bank and authors' calculations

inflation rate. The negative effects of inflation on growth become visible after a certain level of the inflation threshold has been reached. This result is evidence that inflation exerts different effects on growth depending on the level of the inflation rate.

Therefore the findings from the Sarel (1996) approach and the LSTR model arrive at the same conclusion. Furthermore, the plot of the R-squared values from the Sarel approach suggested that the break, which leads to a change in the inflation effects, was abrupt. We complement the R-squared values by showing the estimated transition functions for the specifications in Models 2, 3, 6 and 7 in Fig. 19.5. The transition functions of inflation from the low to the high inflation regime are smooth across models.

Table 19.5 LSTR results based on various economic growth theory specifications

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7	
Variable	Coeff	p-value	Coeff	p-value	Coeff	p-value	Coeff	p-value	Coeff	p-value	Coeff	p-value	Coeff	p-value
Linear part														
Constant	0.11	(0.046)	0.11	(0.134)	0.10	(0.107)	0.59	(0.173)	2.48	(0.088)	0.21	(0.176)	0.30	(0.066)
Infl	0.01	(0.071)	0.02	(0.218)	0.01	(0.165)	0.01	(0.054)	0.02	(0.022)	0.00	(0.586)	0.00	(0.462)
$Infl_{t-1}$	0.01	(0.225)	0.01	(0.246)	0.01	(0.241)	0.01	(0.228)	0.01	(0.176)	0.00	(0.645)	0.00	(0.501)
Popg	0.31	(0.707)	0.90	(0.046)	0.93	(0.052)	−0.07	(0.946)	−0.22	(0.814)	0.35	(0.394)	0.24	(0.547)
gfcapg	0.21	(0.000)	0.21	(0.000)	0.20	(0.000)	0.21	(0.000)	0.21	(0.000)	0.08	(0.000)	0.08	(0.000)
Trend	−0.03	(0.38)							0.17	(0.139)				
Openness											0.09	(0.000)	0.10	(0.000)
Consexg											0.44	(0.000)	0.45	(0.000)
$Lgdp_{t-1}$							−0.02	(0.228)	−0.09	(0.1)	−0.01	(0.076)	−0.01	(0.024)
Govexpg					0.05	(0.642)							−0.05	(0.158)
Non-linear part														
Constant	−0.09	(0.08)	−0.11	(0.163)	−0.10	(0.108)	−0.10	(0.081)	−0.10	(0.074)	−0.04	(0.103)	−0.04	(0.096)
Infl	0.01	(0.41)	0.01	(0.435)	0.01	(0.494)	0.01	(0.406)	0.02	(0.241)	−0.01	(0.236)	−0.01	(0.269)
$Infl_{t-1}$	−0.03	(0.007)	−0.04	(0.008)	−0.04	(0.011)	−0.03	(0.009)	−0.04	(0.002)	−0.03	(0.004)	−0.03	(0.003)
$Infl_{t-2}$											0.03	(0.000)	0.03	(0.000)
Speed of transition	481.39	(0.172)	320.65	(0.24)	361.60	(0.318)	595.38	(0.197)	494.70	(0.056)	223.94	(0.118)	196.87	(0.087)
Threshold (%)[a]	**5.0**	**(0.000)**	**5.0**	**(0.000)**	**5.0**	**(0.000)**	**5.0**	**(0.000)**	**5.0**	**(0.000)**	**5.0**	**(0.000)**	**5.0**	**(0.000)**
Centered R2	62.5%		61.9%		62.1%		63.3%		65.0%		92.8%		93.1%	
R-Bar^2	51.5%		52.1%		51.0%		52.5%		53.3%		89.7%		89.8%	

Source: Authors' calculations

[a]Implies value round to nearest to one decimal point. The model passed the diagnostics tests. The inflation has been log transformed

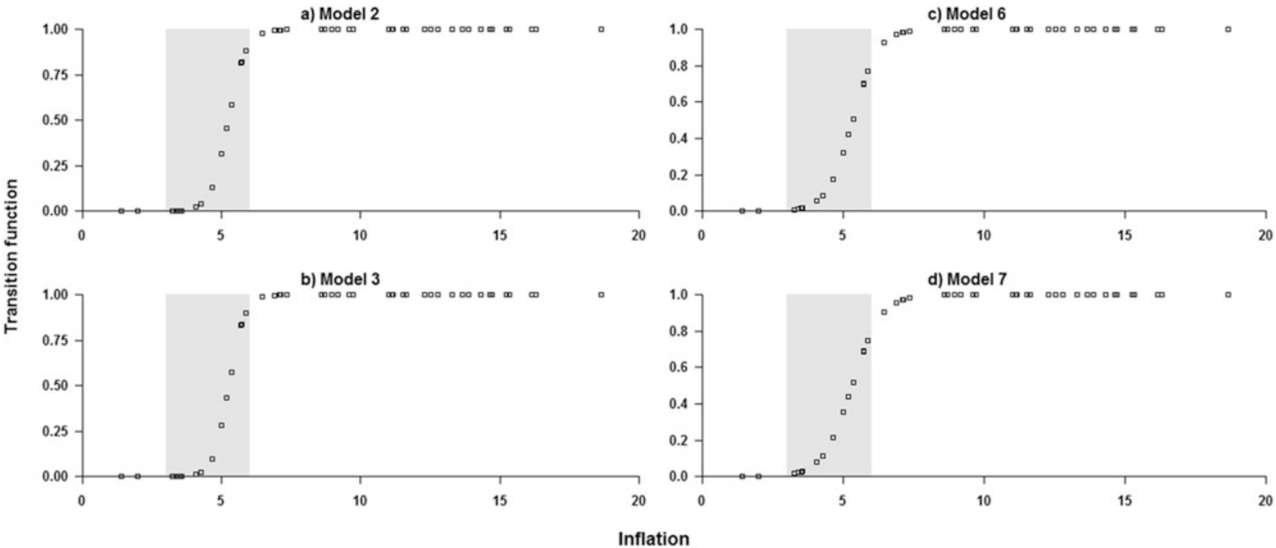

Fig. 19.5 The transition functions of various inflation threshold models. *Source*: Authors' calculations. *Note*: The shaded portion denotes the 3–6 per cent target band

Table 19.6 Inflation threshold effects on the finance-GDP growth nexus

Variable	Coeff	p-value	Coeff	p-value
Constant	0.439	(0.007)	0.589	(0.001)
Infl	0.387	(0.004)	0.014	(0.002)
$Infl_{t-1}$	0.046	(0.613)	0.006	(0.037)
$Infl_{t-2}$	0.235	(0.012)	0.012	(0.001)
Gfcapg	0.093	(0.000)	0.099	(0.000)
Consexg	0.434	(0.000)	0.431	(0.000)
Govexpg	−0.055	(0.178)	−0.050	(0.211)
Op	0.087	(0.000)	0.084	(0.000)
M3g	0.098	(0.011)	0.124	(0.002)
Lgdp{1}	−0.018	(0.002)	−0.019	(0.001)
Popg	0.082	(0.838)	−0.060	(0.878)
Constant	0.037	(0.006)	−0.108	(0.000)
Infl	−0.435	(0.001)	−0.017	(0.006)
$Infl_{t-1}$	−0.231	(0.064)	−0.030	(0)
$Infl_{t-2}$	−0.033	(0.752)	0.010	(0.066)
Finance	−0.089	(0.079)	−0.113	(0.035)
Gamma	1081.292	(0.524)	832.955	(0.529)
Threshold (%)	**5.0**	**(0.000)**	**5.0**	**(0.000)**
Centered	94.1%		94.4%	
R-Bar^2	90.2%		90.7%	

Source: South African Reserve Bank and authors' calculations
Note: Finance is captured by M3g. The models passed all the diagnostics tests

19.7 Does the Inflation Threshold Impact the Finance–GDP Growth Nexus?

The financial variable used in the estimation of the finance–growth nexus is growth in the broad money supply (M3).[3] The results of the model including M3 and GDP growth in Table 19.6 confirm that inflation affects the role of finance on economic growth. In the low inflation regime, finance has a significant and positive effect on economic growth. This effect becomes significantly negative in the high inflation regime. The results are robust to whether we use inflation in logarithm or in level form.

[3] Credit extended to the private sector is a counterpart of M3 money supply. This means that M3 growth also captures bank credit to the private sector.

Does M3 and credit growth exert differential effects on GDP growth when inflation is above the 6 per cent inflation threshold? The aim is to determine the effect of finance on GDP growth depending on the inflation rate. Eq. (19.4) is used to determine this effect by using a dummy variable which equals the value of growth in the financial variable ($Finance^{*}\ inflation_{dummytt-i}$) when inflation is in the indicated band and zero otherwise.

$$GDP\,growth_t = constant + \sum_{i=1}^{4} \beta_i GDP\,growth_{t-i} + \sum_{i=0}^{4} k_i Finance^{*}inflation\_dummy_{t-i} + \varepsilon_t \quad (19.4)$$

Fig. 19.6 shows the impulse of GDP growth on positive shocks to growth in credit and M3 based on the 6 per cent inflation threshold. M3 and credit growth shocks have positive and significant effect on GDP growth when inflation is below 6 per cent. In contrast, when inflation exceeds 6 per cent, these financial variables shocks lower GDP growth. This means that there are benefits to keeping inflation below 6 per cent.

The analysis concludes by looking at the role of government consumption on the transmission of credit and M3 growth shocks to GDP growth, depending on the inflation threshold of 6 per cent.

$$GDP_t = constant + \sum_{i=1}^{4} \beta_i GDP_{t-i} + \sum_{i=0}^{4} k_i Finance^{*}inflation\_dummy_{t-i} + \sum_{i=0}^{4} h_i Gov_{t-i} + \varepsilon_t \quad (19.5)$$

Evidence in Fig. 19.7 shows that government consumption amplifies GDP growth increases due to positive M3 and credit shocks when inflation is below 6 per cent compared to when is above 6 per cent.

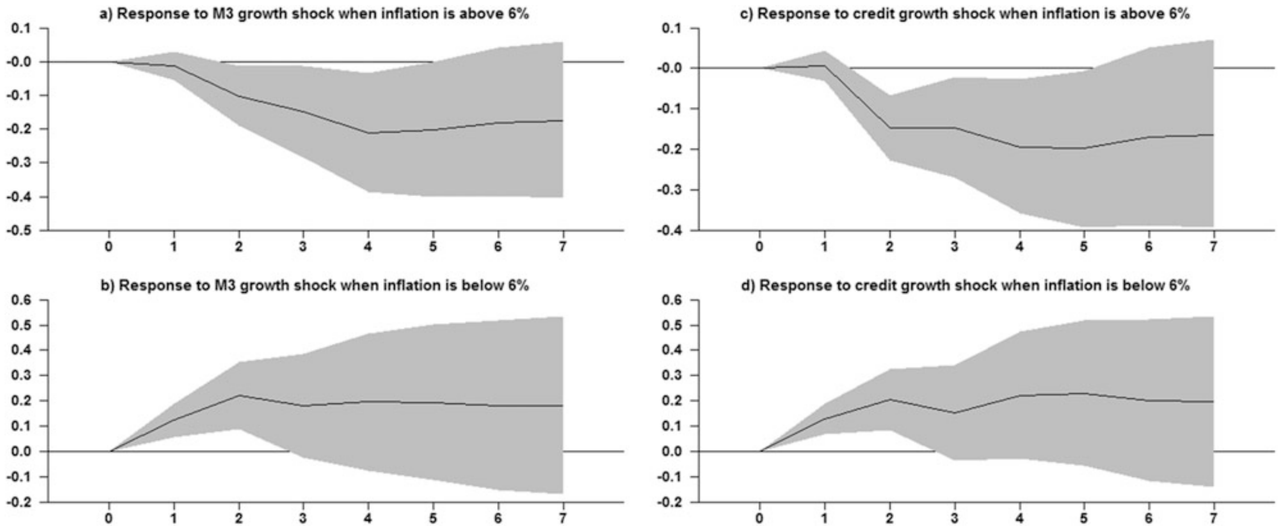

Fig. 19.6 GDP growth responses to positive M3 and credit growth and role of the inflation threshold. *Source*: Authors' calculations

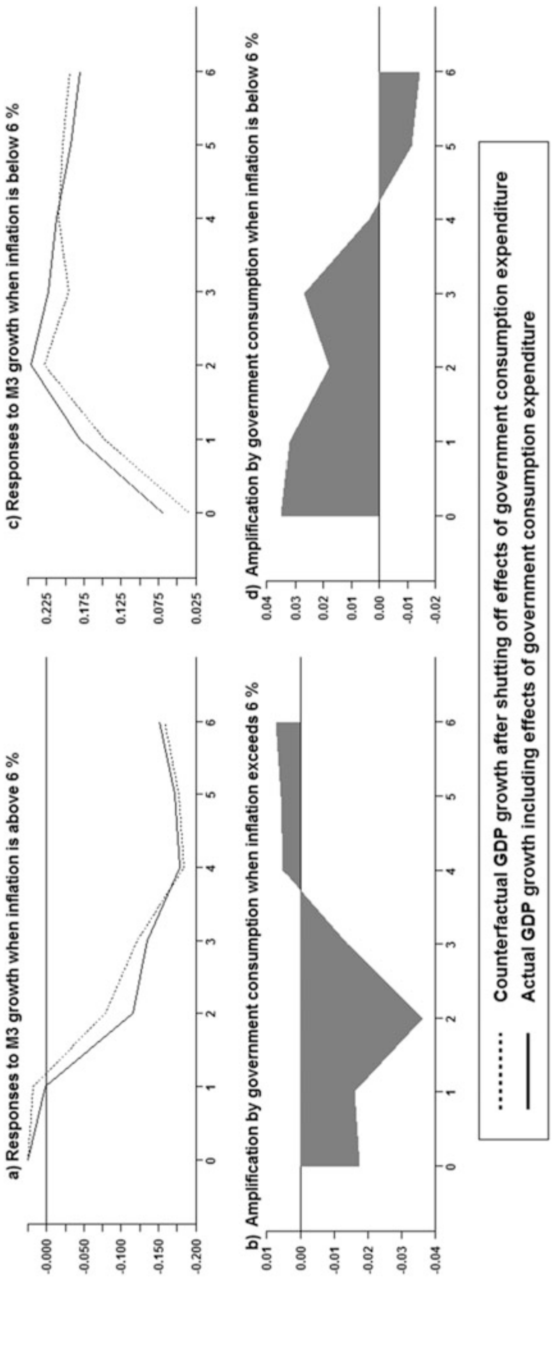

Fig. 19.7 GDP growth responses to positive M3 growth and role of inflation threshold and fiscal policy. *Source*: Authors' calculations

19.8 Conclusion and Policy Implications

This chapter explored the inflation thresholds beyond which inflation exerts negative effects on the growth–finance nexus. We used a number of econometric techniques to establish the inflation thresholds and test their robustness. The results from various techniques used in the chapter establish the inflation threshold that exerts negative effects in the finance–growth nexus to lie within a range of 4–5 per cent. When inflation is above this threshold range, it exerts a negative effect on the finance–growth nexus. The results are not only robust to the econometric technique used but are also statistically significant across various specifications. The policy implication is that policy interventions should be directed at keeping the inflation rate within the target range and preferably below 4 per cent to support and enhance a sustainable financial deepening and economic growth.

Furthermore, we establish that failure to take into account the effects of the inflation thresholds underestimates the effects of inflation on growth by 1.5 times. This means that failure to take into account the inflation non-linearities can seriously bias results towards finding a small inflation effect on GDP growth. Results that do not account for inflation thresholds can give a misleading impression that inflation must become quite high before its cumulative effects become important.

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20

The Output Gap, Exchange Rate Depreciation Shock and Inflation: Non-Linear Effects and Implications for Monetary Policy

Learning Objectives

- The threshold at which the output gap leads to changes in the exchange rate pass-through(ERPT) to inflation
- Policy rates adjustments to inflationary pressures between the low and high output gap regimes
- The effects of non-persistent and persistent rand depreciation shocks in different output gap regimes
- How the output gap affects the relationship between public spending and monetary policy

20.1 Introduction

Demand creates its own supply. As such, inadequate aggregate demand destroys supply. Krugman (2015), observes that events post the global financial crisis provide more evidence that economies with persistently weak demand seem to suffer large declines in both potential and actual output. Against this background, this chapter assesses the extent to which the output gap has affected the response of inflation to the prolonged

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rand-US dollar depreciation shock. Have different output gap regimes affected the policy rate adjustments to inflationary pressures?

Moreover, under which regimes do output gap regimes constrain policy decisions to react to inflationary developments? Does the output gap amplify inflation responses to rand depreciation shock? Given that fiscal policy is part of the policies used to alleviate the effects of persistent demand shortfalls, the analysis explores how the output gap affects the relationship between public spending and monetary policy.

20.2 Output Gaps Derived from the Extended Kalman Filter, Constant Kalman Filter and Hodrick–Prescott Approaches

Despite the uncertainty surrounding the estimates of the output gap and potential output growth rate, they remain an important unobservable macroeconomic variable that is used as a guide for setting monetary policy. The output gap provides valuable information about supply-side capacity and the degree to which aggregate demand can expand without accelerating inflation. Eq. (20.1) relates inflation (π) to the output gap measured as the deviation of actual output (Y^a) from potential output (Y^p).

$$\pi = \beta(Y^a - Y^p) \tag{20.1}$$

From Eq. (20.1) there will be inflationary pressures in the presence of excess demand when actual output exceeds potential output (i.e., a positive output gap) and deflationary pressures when the output gap is negative. However, the magnitude of the pass-through from the output-gap varies from incomplete to complete pass-through and changes from time to time.

The measurement of the output gap is a contested area driven by methodological assumptions. We applied an extended (or time-varying) Kalman filter approach, which uses the time-varying parameters to decompose output into trend and cyclical components. This approach does not lead to a smooth trend, which is a major weakness of both the

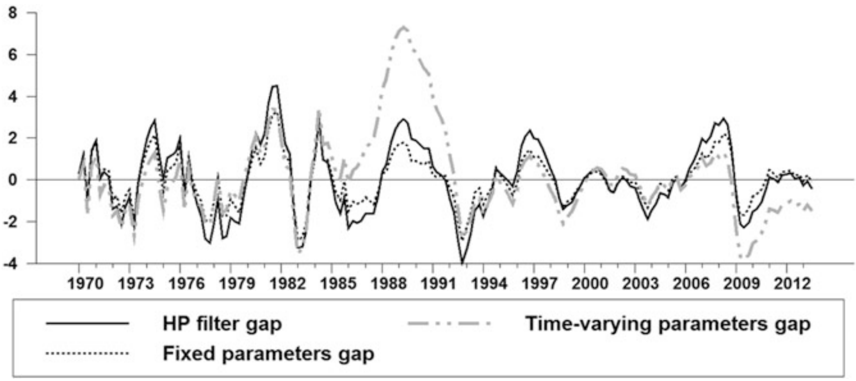

Fig. 20.1 Different output gap measures in percent. *Source*: Authors' calculations

Hodrick–Prescott (HP) filter and the quadratic time trend methods. In the extended Kalman filter approach, both the potential output and output gap are the state variables and their time-varying parameters are estimated simultaneously to capture the dynamics over a period. The potential output is then extracted from the time-varying processes used to produce the output gap and test the existence of the Phillips curve relationship.

Fig. 20.1 shows the measures of the output gap using three different techniques using quarterly (Q) data from 1970Q1 to 2014Q1. The different measures vary to the extent that they indicate the degree of economic slack. However, they point to the fact that there are no signs of overheating in the economy since 2009. Demand-side pressures remain muted in the period under review. Both the HP filter and the constant Kalman parameter measures suggest that the output gap has been closed and is at zero since 2010Q4, with a slight downward trend towards the negative territory in recent times. The time-varying Kalman parameters shows that the output gap is estimated to have remained negative since 2009. Although the degree of economic slack has been reduced since 2011 it seems to have stabilised around less than 2 per cent since.

20.3 Has the Relationship Between Inflation and the Output Gap Changed since the Inflation Targeting Period?

What is the relationship between the various output gap measures and inflation? The scatter plots in Fig. 20.2 indicate a positive relationship between inflation and various output gap measures. The strength of the positive relationship differs across measures, pointing to the uncertainty involved in the measurement of the output gap.[1]

Overall, the trends in Fig. 20.1(a) confirm that it is possible that there are times at which both inflation and the output gap move in the same direction, as well as times at which they diverge. These dynamics point to the fact that the nature of shocks that drive inflation and the output gap

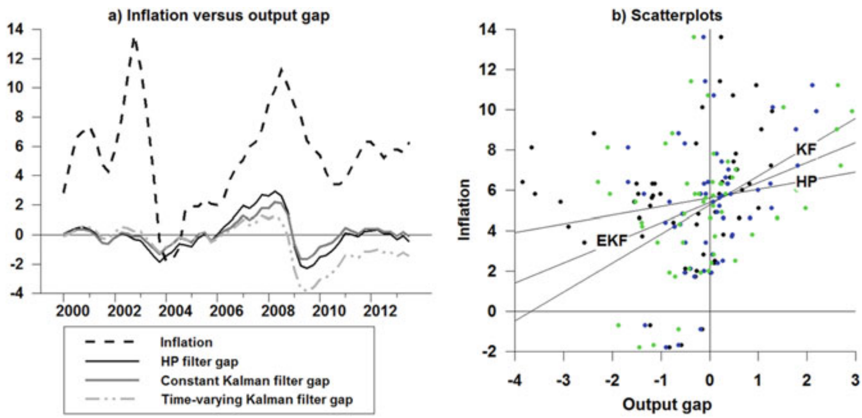

Fig. 20.2 The relationship between various output-gap measures and inflation. (a) Inflation versus output gap; (b) Scatterplots. *Source*: Authors' calculations. *Note*: The abbreviations in (b) depict the relationship between inflation and specific output gap. KF means constant Kalman filter, EKF means the extended Kalman filter gap and HP means Hodrick Prescott filter

[1] See for example, Orphanides and Williams (2002), Laubach and Williams (2003, 2015) on the impact of the uncertainty in the measurement of potential output on the estimates of the natural rate.

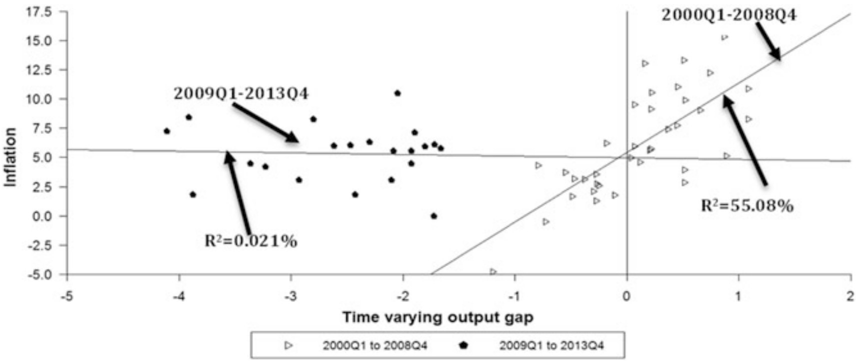

Fig. 20.3 Inflation and output gap post-2009. *Source*: Authors' calculations

may at times move these variables in different directions. The slope of the positive relationship is much steeper when using the constant Kalman filter than both HP and extended Kalman filter parameter output-gaps. These slopes show the differences in the abilities of these measures to capture factors that characterise the changes in the relationship across time.

Has the relationship changed post-2009? Fig. 20.3 shows that the relationship between the output gap and inflation has been rather weak and slightly negative. This means that post-2009 we have experienced periods of a negative output gap and inflation.

Having established a negative relationship between the output gap and inflation post-2009, does it mean that output gap has no relevance in monetary policymaking process? We formally explore the role of the exchange rate pass-through (ERPT) to inflation subject to the output gap regimes in the empirical section. The remainder of the analysis uses the extended Kalman filter output gap.

20.4 What Is the Role of the Output Gap in the Exchange Rate Pass-Through?

To assess the influence of the output gap on the ERPT of rand depreciation shocks to inflation this section uses quarterly (Q) data from 1980Q1 to 2014Q2. Before determining the relationship, a series of threshold tests

Table 20.1 Determining the non-linearity model of output gap

Hypothesis tested	*F*-statistics	*p*-value	Decision
Linearity	5.30	0.00	Reject
H01—test of the first order interaction terms only	9.78	0.00	Reject
H02—test of the second order interaction terms only	2.19	0.09	Reject
H03—test of the third order interaction terms only	3.04	0.03	Reject
H12—test of the first and second order interactions terms only	6.12	0.00	Reject

Source: Authors' calculations

Table 20.2 The role of the output-gap in the exchange rate pass-through to inflation

Variable	Coefficient	T-Stat	Significance
Linear part			
Inflation$_{t-1}$	0.950	46.432	0.000
Rand$_{t-1}$	0.009	3.831	0.000
Non-linear part			
Rand	0.040	2.303	0.021
Rand $_{t-1}$	−0.051	−2.018	0.044
Rand $_{t-3}$	0.046	1.797	0.072
Speed of transition	5.694	2.377	0.017
Output-gap threshold	**0.892**	**3.314**	**0.001**

Source: Authors' calculations

Note: The dependent variable is inflation rate. We do not show the constants but only show the coefficients of variables we use to estimate pass-through and those which are significant. We included the fourth lag of the exchange rate in the upper regime. When we remove it the model does not convergence. However, this coefficient is insignificant and did not improve the explanatory power of variables in the model

are conducted to determine where the threshold for the output gap occurs and whether the process is non-linear. We applied the Tsay and Hansen tests and concluded that there is a threshold and the output-gap follows a non-linear data generating process in Table 20.1.

Furthermore, Table 20.1 indicates that the LSTR model is the appropriate model to estimate the transition function for the ERPT subject to the output gap threshold. The process of the estimation of the transition function begins by estimating the model so that the inflation rate is dependent on the four lags of inflation, current and four lags of annual rand changes in Table 20.2. We apply the general to specific approach.

The insignificant last values in each part of the model are removed from the estimations. The results show that the output gap threshold occurs at around 0.892 per cent and this transition of the ERPT subject to the output gap threshold is shown in Fig. 20.4. The regions below and above the threshold correspond to regimes of low and high output gap regimes. We also categorise the regimes of the pass-through of the rand depreciation shocks to inflation.

Furthermore, based on the coefficients in Table 20.2 we can calculate the responses of the ERPT magnitudes of the rand depreciation to inflation for the low and high output gap regimes. The long-run pass-through magnitudes in each output gap regime are calculated as the sum of the impact of the rand on inflation in each output gap regime divided by one minus the lagged inflation rate coefficient.

The pass-through magnitudes derived from estimations in Table 20.2 are very small in low output gap regime suggesting that 1 per cent rand depreciation shock leads to 0.18 per cent increase in the inflation rate compared to 0.692 per cent in the high output-gap regime. This confirms

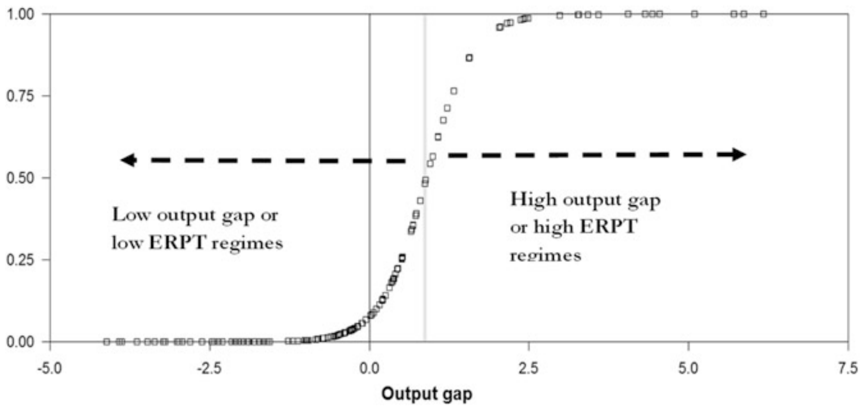

Fig. 20.4 The output gap transition function and the exchange rate pass-though (ERPT). *Source*: Authors' calculations

that the output-gap does impact the pass-through of rand depreciation shocks into inflation.

Furthermore, we estimate the counterfactual analysis based on the modified Pentecôte and Rondeau (2015) approach based on Cerra and Saxena (2008) applied to the inflation Eq. (20.2) to corroborate the results.

$$Inflation_t = constant + \sum_{i=1}^{4} \beta_i \, inflation_{t-i} + \sum_{i=0}^{4} q_i \, Output\_gap_{t-i} + \sum_{i=0}^{2} w_i \, Rand\_Dummy_{t-i} + \varepsilon_t \tag{20.2}$$

where ε_t denotes an error shock and *Output_gap* denotes the time varying output gap and *Rand_Dummy* denotes the positive changes in exchange rate or depreciation only and zero otherwise. This equation is estimated using quarterly (Q) data from 2000Q1 to 2014Q2. The results are based on 10,000 Monte Carlo draws. To measure the influence of the output gap we estimate actual and counterfactual inflation responses. The actual (counterfactual) inflation responses refer to inflation responses when output gap channel is included (excluded) in the model. The propagation (magnifying) or restraining (stifling) ability of the specific variable and channel is determined by the gap between actual and counterfactual responses.

Fig. 20.5(a) and (b) shows that the rand depreciation shock leads to significant inflationary pressures. Moreover, actual inflation increases more than the counterfactual rate in Fig. 20.5(a). Fig. 20.5(b) indicates that the output gap amplifies the inflation responses to rand depreciation shock. For the analysis of the impact of the output gap post-2009Q4, Fig. 20.5(c) shows that actual inflation response remains lower than the counterfactual response. As shown in Fig. 20.5(d) the inclusion of the output gap leads to lower inflation responses. The results suggest that output gap matters. Furthermore, the negative output leads to reduced ERPT to inflation.

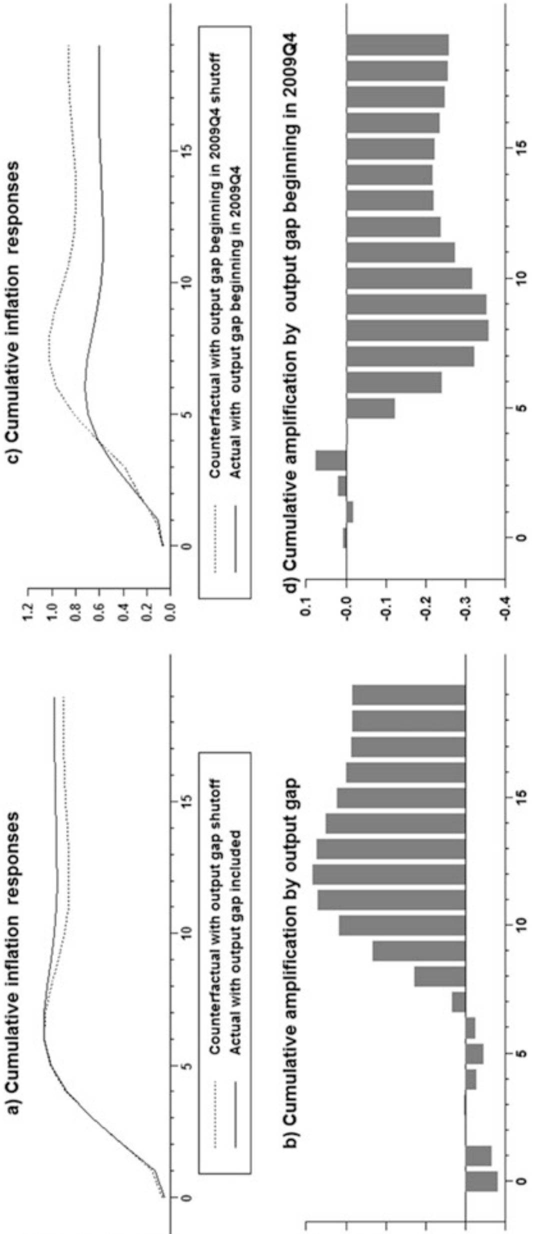

Fig. 20.5 Inflation responses to rand depreciation shock. *Source*: Authors' calculations

20.5 The Response of Inflation and Repo Rate to the Rand Depreciation Shocks in the Low Output Gap Regime

What might a regime-dependent VAR model tell us about how inflation responds to rand depreciation shocks in this regime? Furthermore, how does the policy rate respond? The regime dependent VAR model consists of annual rand changes, inflation and the repo rate. The model is estimate with 10,000 Monte Carlo draws. Inflation increases in response to the rand depreciation shock even in low output gap regimes. The rand depreciation shock does lead to significant inflation pressures. In addition, the rand depreciation shock induces a significant proportion of fluctuations in inflation in the low output gap regime and this explains nearly 45 per cent of inflation movements in this regime. How does monetary policy respond? The policy rate is tightened and the results show that the cumulative tightening amounts to about 1.2 per cent in eight quarters and in longer horizons. The repo rate response does not, however, imply that policymakers are targeting the exchange rate. Rather, the response should be interpreted as being consistent with a forward-looking policy to curb inflationary pressures.

Fig. 20.6(b) shows that the persistence of the rand depreciation shocks matters for inflation response in the low output gap regime. Inflation rises to both persistent and non-persistent rand depreciation shocks in Fig. 20.6(b). This indicates that the rand depreciation shock is inflationary in both regimes. The persistence of the rand depreciation shock matters for the ERPT to inflation. In addition, Fig. 20.6(c) shows that the repo rate is tightened more due to rand depreciation shock in the high output-gap regime than in the low regime. This is because inflation increases more in the high output-gap regime compared to the low regime in Fig. 20.6(d). The repo rate tightening does not imply that policy makers are responding to the exchange rate but are consistent with a forward looking policy conduct.

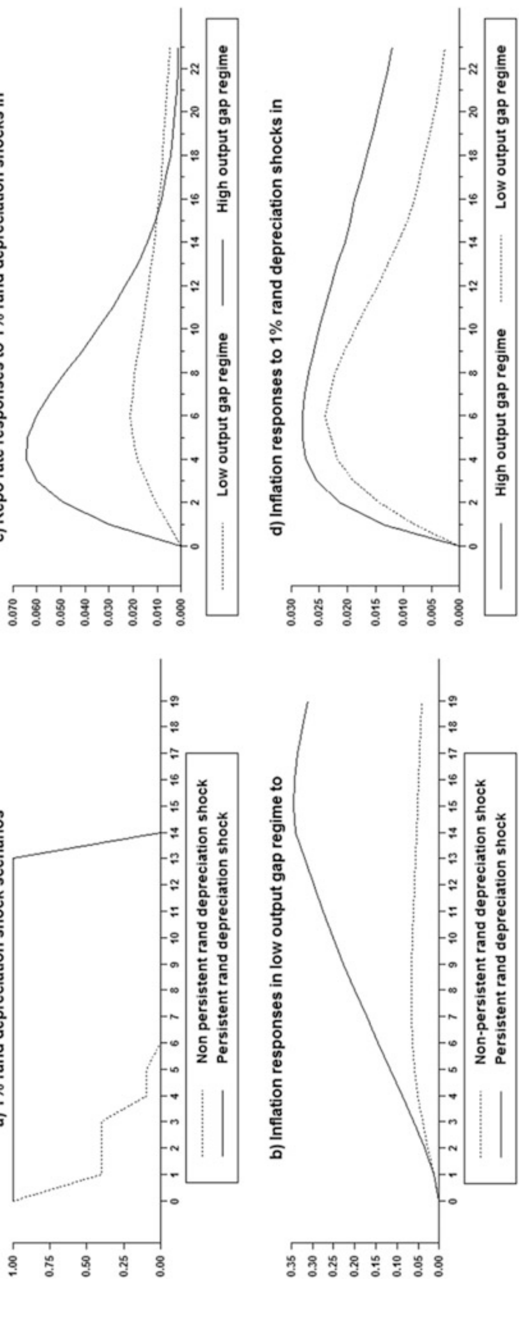

Fig. 20.6 Responses to rand depreciation shocks. *Source*: Authors' calculations

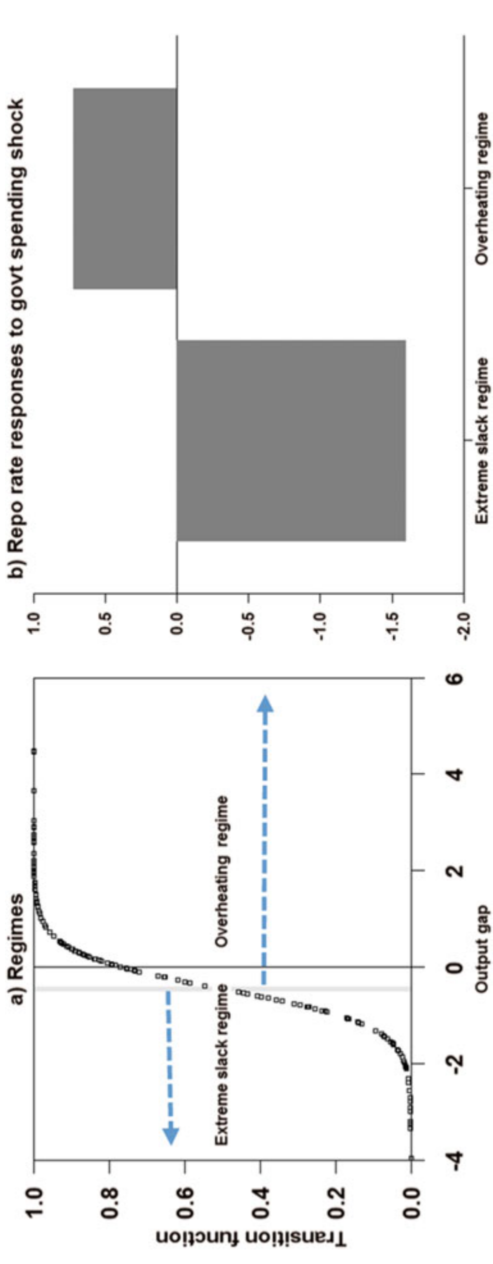

Fig. 20.7 The output-gap transition function and the impact of public spending. (a) Regimes; (b) Repo rate responses to govt spending shock. *Source:* Authors' calculations

20.6 Is the Link Between Monetary Policy and Public Spending Affected by the Output Gap Threshold?

The state of public finances and the fiscal policy is important; particularly in view of the ongoing debate about the role respective policies can play in boosting growth. For the assessment of the interaction between the output gap, public spending and monetary policy, the analysis adopts and modifies the Lopez-Villavicencio (2013) logistic smooth transition model specification. The fiscal policy variable refers to changes in government consumption expenditure for the period 1980Q1 to 2013Q4. The model includes the current and four lags of changes in government spending as explanatory variables in both the linear and non-linear parts. This is consistent with delays in implementing government projects following the budget announcement.

The LSTR approach establishes that the output gap threshold occurs at -0.453 per cent, shown by light shaded area in Fig. 20.7(a). The finding of a negative threshold is similar to those reported by Lopez-Villavicencio (2013) for the USA. In contrast to their approach we use current and four lags of public consumption spending.

Furthermore, the public spending effect on policy rate in Fig. 20.7(b) is bigger during extreme recessionary periods than in expansionary regimes. The implication is that there is a role for countercyclical fiscal policy.

20.7 What Determines the Responses of the Repo Rate to Inflation in Different Output Gap Regimes?

This section estimates the LSTR to assess the nature of the transition function for the policy rate responses to inflationary pressures subject to the output gap threshold. The estimated LSTR model in Table 20.3 suggests that the policy rate depends on its first lag, current and lagged inflation rate, past output gap in both linear and non-linear parts.

Table 20.3 The effects of inflation and output gap on the repo rate in different output gap regimes

Variable	Coefficient	p-value
Linear part		
Repo rate$_{t-1}$	0.9309	0.00
Inflation	0.0811	0.03
Inflation$_{t-1}$	−0.0803	0.07
Output-gap	−0.1293	0.37
Non-linear part		
Repo rate$_{t-1}$	0.0634	0.17
Inflation	−0.0934	0.05
Inflation$_{t-1}$	0.0980	0.07
Output-gap$_{t-1}$	0.2784	0.08
Speed of transition	7.5813	–
Output gap threshold	−0.4870	–
Inflation pass-through to policy rate	–	–
Pass-through in low output gap regime	**0.012**	–
Pass-through in high output gap regime	**0.950**	–

Source: Authors' calculations
Note: Bold is used to highlight the difference in magnitudes between the two regimes.

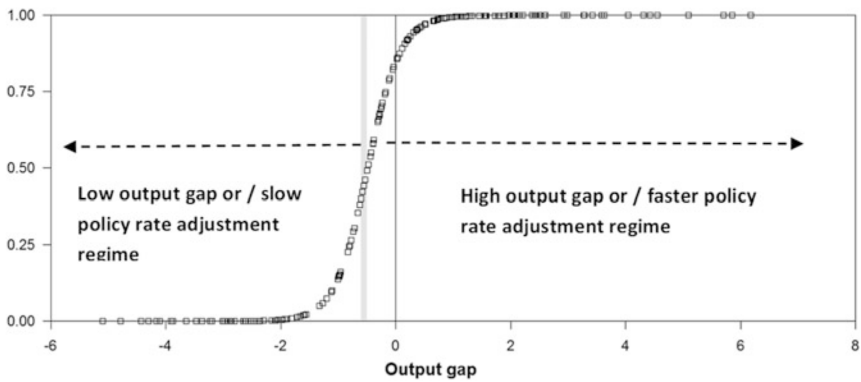

Fig. 20.8 Output gap regimes and the policy rate adjustments. *Source*: Authors' calculations

In Table 20.3, the output gap threshold value is estimated to occur at -0.487 per cent. This evidence confirms that the output gap does impact the relationship between the repo rate and inflation between low and high output gap regimes. Furthermore, Fig. 20.8 shows the transition of the output gap from low to high regimes, threshold and the likely policy rate adjustment responses.

The policy rate is slightly adjusted to positive inflationary pressures in the low output gap regime.

20.8 Conclusion and Policy Implications

This chapter looked at the role of the output gap in the ERPT to inflation. The objective is to examine the extent to which the output gap non-linearly impacts macroeconomic relationships. Various measures of the output gap confirm that its relationship with inflation varies and is negative post-2009. The implication being that post-2009, inflation does rise in the presence of a negative output gap. This evidence is very much characteristic of the policymaking environment, dominated by episodes of adverse supply shocks and cost-push inflation.

The analysis establishes threshold levels for the output gap, which enables the regimes to be classified as low and high output gap regimes. Evidence indicates that the output gap impacts the response of inflation to the exchange rate depreciations shocks. Thus inflation rises more in the high output gap regimes than in the low regimes.

Due to the persistent period of trend depreciation in the exchange rate, we explored the effects of non-persistent and persistent rand depreciation shocks. We conclude that while inflation rises due to rand depreciation shocks, the increase is bigger in high regimes than in low regime. The current period of the persistent negative output gap and rand depreciation exists alongside the tightening monetary policy stance and fiscal consolidation. Evidence indicates that the public spending effects are larger during the extreme recessionary periods than in great expansionary regimes. The policy implication is that there is a role for countercyclical fiscal policy.

Furthermore, the output gap also impacts the policy rate adjustments to inflation shocks. As a result the policy rate responses differ between the low and high output gap regimes. The repo rate is slightly increased to positive inflationary pressures in the low output gap regime, in contrast to the aggressive adjustment in the high output gap regimes. Thus output gap regimes do constrain the pace of repo rate adjustment to inflationary pressures. That should not be confused with policy inaction. Policymakers do act but are mindful of GDP growth conditions.

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21

Do Economic Growth Regimes Impact the Pass-Through of Exchange Rate Shocks to Inflation?

Learning Objectives

- The GDP growth threshold and the non-linearities it introduces in the inflation responses to exchange rate depreciation shocks
- The role of GDP in altering the ERPT to inflation in different periods using counterfactual approaches

21.1 Introduction

Is the muted response of inflation to the prolonged and persistent exchange rate depreciation likely to be a permanent feature if GDP growth remains subdued? Or, will the impact of the exchange rate depreciation on inflation accelerate once aggregate demand takes off? This chapter empirically assesses the theoretical assertions that the exchange rate pass-through (ERPT) to inflation is intrinsically related to the state of the business cycle. In particular, do GDP growth regimes have an impact on the response of inflation to exchange rate depreciation shocks? In addition, this chapter assesses the role of GDP growth threshold in impacting the transmission of rand depreciation shock into

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inflation. These aspects are considered via two hypotheses that have been put forward:

Hypothesis 1: Rand/US dollar exchange rate depreciation shocks lead to higher inflation in periods of business cycle expansion than in slow growth periods.

Hypothesis 2: Large and abrupt rand/US dollar exchange rate depreciation shocks lead to higher inflation increase than do small depreciations in a low GDP growth regime.

21.2 What Is the Relationship Between Inflation Responses to Rand Depreciation Shocks Subject to GDP Growth Regimes?

The earlier chapter showed that the output gap dynamics cannot be described as following a linear process. This chapter uses the Balke (2000) multivariate approach to establish where the GDP growth thresholds occur and propagate fluctuations in inflation due to unexpected exchange rate depreciation. We use quarterly (Q) data from 1990Q1 to 2015Q3 for annual GDP growth, headline inflation and rand changes.

We examine hypothesis 1 to establish whether there is any evidence of non-linearity in the inflation response to the rand depreciation shocks. The Balke (2000) approach is used to establish the threshold of 2.4 per cent for GDP growth and this threshold is used to identify low and high GDP growth regimes. A threshold VAR model is estimated using one lag as selected, using Schwarz Bayesian criterion.[1] The model is estimated using 10,000 Monte Carlo draws. Fig. 21.1 shows that a 1 per cent exchange rate depreciation shock leads to a significant rise in inflation in the high GDP growth regime. This evidence supports hypothesis 1. The differential responses are consistent with findings in Cheikh (2012) suggesting that firms are more willing to effect pass-through cost increases

[1] Schwarz Bayesian criterion (SBC) is a criterion for model selection amongst a set of models and the model with the lowest SBC is preferred. It is also used to choose the number of lags to be used in the model in time series.

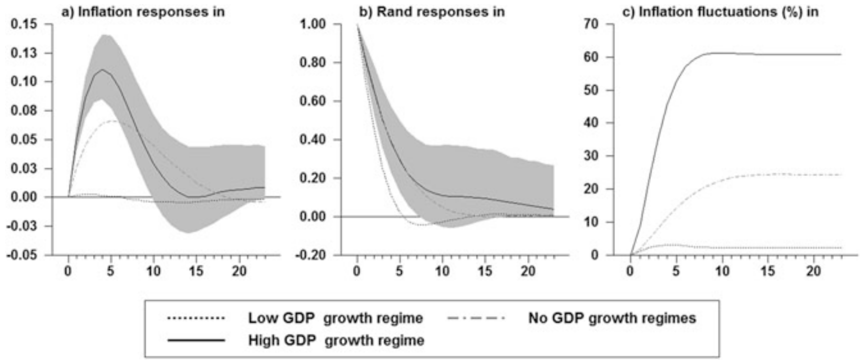

Fig. 21.1 Inflation and rand/US$ exchange rate responses to depreciation shock. *Source*: Authors calculations

such as those coming from the depreciation in the exchange rate when the economy is growing faster.

This evidence further suggests that the degree of the ERPT is more likely to be higher in periods of high GDP growth than during periods of GDP slowdown. How does the exchange rate react? Fig. 21.1 (b) shows the differential exchange rate responses to rand depreciation shocks. The exchange rate path following the rand depreciation shock is significantly elevated in the higher GDP regime than in the lower growth regime. Thus different exchange rate trajectories explain the differential responses of inflation to the rand depreciation shocks in both regimes.

In addition, evidence shows that rand depreciation shock induces more movements in inflation in the higher GDP growth regime Fig. 21.1(c), and that a large proportion of movements in the rand exchange rate are due to own movements. This means that exogenous factors not included in the model played a large role in R/US dollar movements. For policy, this analysis implies the need to factor in the non-linear transmission of the response of inflation to rand depreciation shocks over the business cycle. This may be particularly important during periods of volatile exchange rates.

21.3 Do GDP Growth Thresholds Lead to Asymmetry in the Inflation Responses to the Exchange Rate Depreciations?

We used the Tsay non-linear approach in the previous section to answer hypothesis 1. However, it does not test for the asymmetric effects of the exchange rate depreciation on inflation rate subject to GDP growth regimes. The Balke (2000) approach enables us to test for the asymmetries in the ERPT in GDP growth regimes. Using the Balke (2000) approach we are able to disentangle the extent to which the size of the depreciations and appreciations matter for the inflation responses subject to GDP growth regimes.

Testing hypothesis 2 is particularly relevant to the current policymaking period amidst low GDP growth, as well as the R/US dollar exchange rate having persistently depreciated since 2011. In light of the concurrence of the persistent exchange rate depreciation and a low GDP regime, is it possible that the price formation and inflation process have changed? Goldfajn and Werland (2000) show that the asymmetric pass-through may occur at times when a large depreciation does not translate to price increase. In such circumstances, low economic growth or a slow-down constrains the price adjustment that firms are able to make in proportion to the increase in production costs. It indicates that the transmission of the exchange rate changes would be higher when the economy is booming than in periods of slowdowns.

Fig. 21.2(a) shows the reaction of the rand exchange rate to a once (transitory) rand depreciation (appreciation) shock measured by one (small depreciation or appreciation) and two (large depreciation or appreciation) standard deviations (SD), respectively. Evidence shows that the rand depreciates but reverts back to pre-shock levels. The transitory rand depreciation shocks lead to transitory inflation increases as shown in Fig. 21.2(b), followed by subsiding inflationary pressures. The large rand depreciation shocks lead to higher inflation responses than small depreciation magnitudes, suggesting that the magnitudes of the depreciation asymmetrically impact inflation. This evidence supports hypothesis 2. Furthermore, the asymmetric effects of the exchange rate in the low GDP growth regime cut across magnitudes of the appreciation and depreciation.

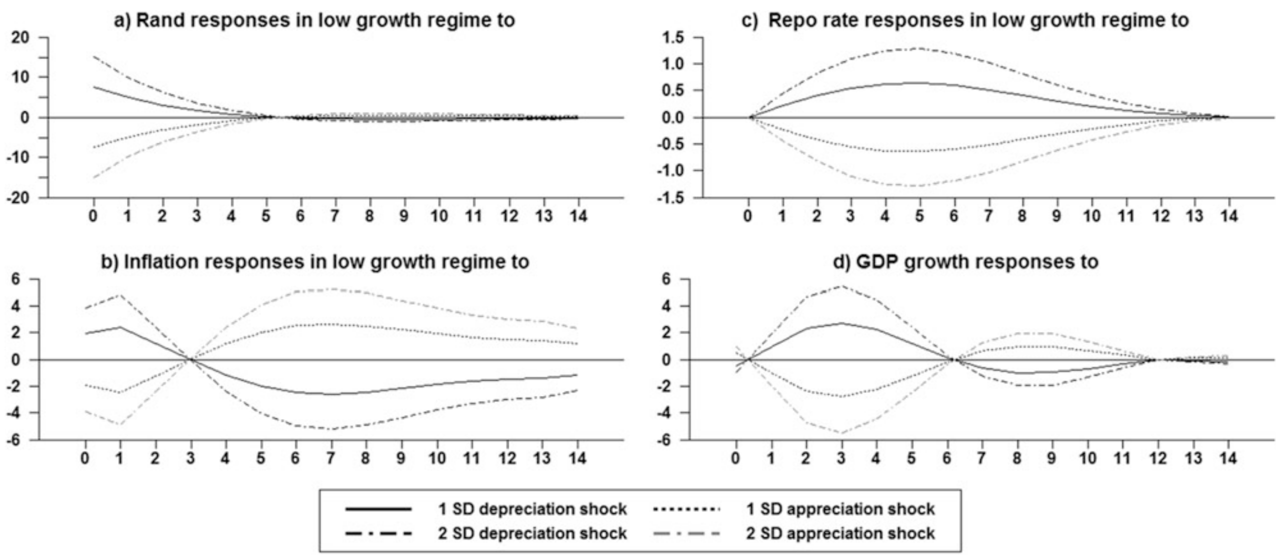

Fig. 21.2 GDP, rand and inflation responses to the depreciation in the low growth regime. *Source*: Authors' calculations

Does monetary policy react to such depreciation shock? Yes, it does. In Fig. 21.2(c) the repo rate is tightened. But the tightening is influenced by the magnitudes of rand depreciation shocks. Large magnitudes of the exchange rate depreciation shocks are accompanied by large inflation rate responses and aggressive monetary policy tightening.

The literature shows that flexible exchange rates and their adjustments to shocks assist in making open economies become more resilient. As such, the adjustments of the exchange rate cannot be bad across the wide macroeconomic activity. Therefore, does the rand depreciation shock stimulate GDP growth? Yes, it does: in Fig. 21.2(d) GDP growth increases for nearly 6 quarters due to the depreciation in the exchange rate. But the effects decline thereafter for over a year. The finding that GDP growth tends to rise following a rand depreciation shock suggests that as aggregate demand starts to recover the degree of the ERPT will also increase. This is particularly likely to be the case if the exchange rate depreciation is permanent.

21.4 Do Conclusions Differ from a Linear Threshold Model?

The robustness of the results is tested by estimating a threshold linear regression model. A threshold dummy based on the GDP threshold is created and equals one when GDP growth exceeds 2.4 per cent and zero otherwise. To determine the impact of GDP responses above and below this threshold on the exchange rate pass-through to inflation, we interact the GDP threshold dummy and annual exchange rate (*GDP threshold* Rand changes*) as shown in Eq. (21.1). If the threshold matters, then inflation increases more when GDP is above the GDP growth threshold.

$$\begin{aligned} &\mathit{Inflation} \\ &= f\left(\mathit{lagged\ inflation\ rate}, \mathit{rand\ changes\ and\ GDP\ threshold}^{*}\ \mathit{Rand\ changes}\right) \end{aligned} \tag{21.1}$$

In Eq. (21.1), apart from lagged inflation and the interacted terms, the variables used are the same as those used in the earlier estimations. The instrumental variable approach is used to control for feedback effects, which are normally referred to as the endogeneity problem between rand changes and inflation in Models 1 and 2. Table 21.1 shows that inflation persistence is high and ranges between 0.84 and 0.97 across estimated models. In addition, the estimates for the long-run ERPT range between 0.255 and 0.665, suggesting incomplete ERPT in line with findings in the vast global literature.

Does the impact of the rand depreciation shock on inflation differ according to GDP growth regimes? Yes, it does, the rand depreciation has a significant effect on inflation in the baseline model but the significant effect disappears in Models 1 and Model 2 (0.73) after controlling for the effects of GDP growth regimes. Overall evidence indicates rand depreciation has significantly high impact on inflation in high GDP growth regime.

21.5 Has the Role of GDP Growth in Amplifying Inflation Responses Changed?

To examine this question, the modified versions of Pentecôte and Rondeau (2015) as well as Cerra and Saxena (2008) specified in the inflation Eq. (21.2) are estimated.

Table 21.1 GDP regimes effects based on the linear threshold model. Dependent variable is inflation

	Baseline model (GMM)		Model 1		Model 2 (GMM)	
Variable	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value
Constant	0.389	0.147	0.418	0.09	0.367	0.002
Inflation$_{t-1}$	0.893	0.000	0.911	0.00	0.914	0.000
Annual Rand changes	0.041	0.000	0.002	0.88	0.007	0.730
GDP threshold* Rand changes	–	–	0.037	0.02	0.064	0.008
Long run pass-through[a]	0.255	0.004*	0.439	0.03**	0.665	0.045**

Source: South African Reserve Bank and authors' calculations

Note: [a]Long run pass-through of 1 per cent rand depreciation. * and ** refers to 1 and 5 per cent significance levels. The instruments include a constant, inflation$_{t-2}$, inflation$_{t-3}$, Rand changes$_{t-1}$, rand changes$_{t-2}$, thresholdcpi$_{t-1}$, thresholdcpi$_{t-2}$ and thresholdcpi$_{t-3}$

$$Inflation_t = constant + \sum_{i=1}^{l0} \beta_i inflation_{t-i} + \sum_{i=0}^{4} w_i GDPabove2.5_{t-i} + \sum_{i=0}^{4} w_i Rand\_dummy_{t-i} + \varepsilon_t \quad (21.2)$$

where, ε_t denotes an inflationary shock and *GDPabove*2.5 denotes a GDP growth dummy. The dummy has equal value of GDP growth above 2.5 per cent threshold and zero otherwise. In estimations for GDP growth below 2.5 per cent of 1 per cent, the specification of the dummy variable is changed. The $Rand\_dummy_{t-i}$ denotes the dummy for the rand depreciations and zero otherwise. The variable of interest is GDP growth which assesses the propagating effects of the rand depreciation shock to inflation. To measure the influence of GDP growth above or below 2.5 per cent or below 1 per cent, requires the estimation of the actual and counterfactual inflation responses. The actual (counterfactual) inflation responses refer to inflation responses when GDP growth is included (excluded) in the model. The estimations use quarterly data from 1990 to 2015Q3. The model is estimated using 10,000 Monte Carlo draws.

In Fig. 21.3, the responses of inflation to rand depreciation shock increase more than the counterfactual response when GDP growth is above 2.5 per cent compared to below 1 per cent. This means that the pass-through of the rand depreciation shocks to inflation amplify the effects of the exchange rate depreciation on inflation. The state of the business cycle matters for the degree of the ERPT to inflation. Furthermore, Fig. 21.4 compares the impact of the GDP growth on the ERPT to inflation when DGP growth is below 2.5 per cent for the whole sample and post-2007Q3.

Evidence shows that the rand depreciation shocks decrease the counterfactual inflation responses more than actual inflation response post-2007Q3. This means that the structural shocks associated with the global financial crisis have resulted in the further reduction of the ERPT to inflation beyond the usual low GDP growth regime effects.

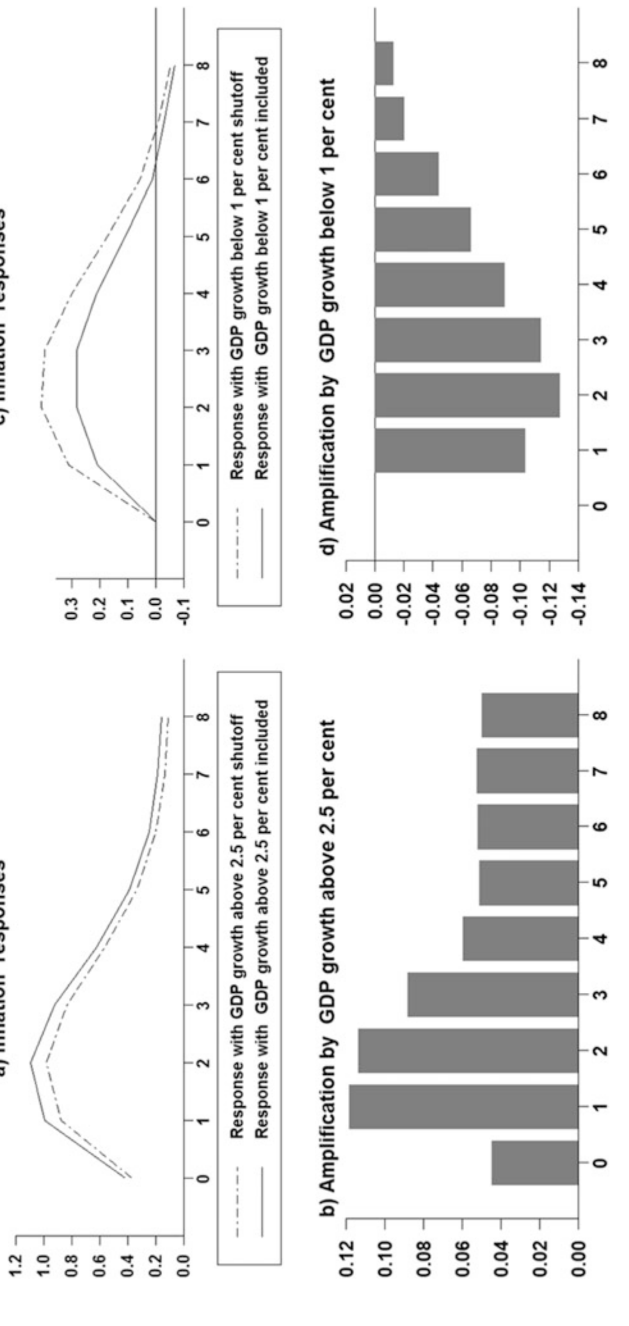

Fig. 21.3 Inflation responses to rand depreciation and role of GDP growth. *Source*: Authors' calculations

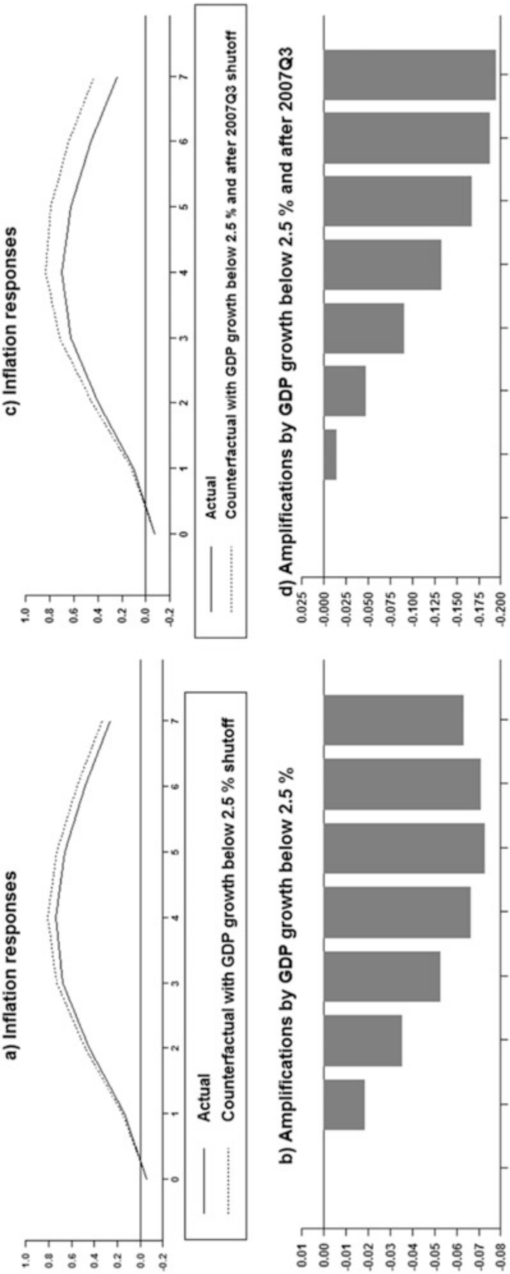

Fig. 21.4 Inflation responses to rand depreciation and role of GDP growth below 2.5 per cent. *Source*: Authors' calculations

21.6 What Would the Inflation Rate be in the Absence of GDP Growth?

Do GDP growth dynamics over time spill over to the inflation process? The historical decomposition approach is applied to determine the influence of GDP growth dynamics in the inflation process. Fig. 21.5(b) shows that GDP growth contributions resulted in the decline in inflation since 2012, indicating the effects of weak demand pressures in the inflation process despite the persistent depreciation in the exchange rate. Furthermore, in the absence of GDP growth dynamics, inflation would have been outside the 3–6 per cent inflation target band as shown in Fig. 21.5(a)

In addition, Fig. 21.6(a) shows that there has been a drag on GDP growth since the end of 2009. This implies that the effect of inflation as it moves toward the upper part of target band becomes a drag on economic growth. If inflation was low, GDP growth would be higher.

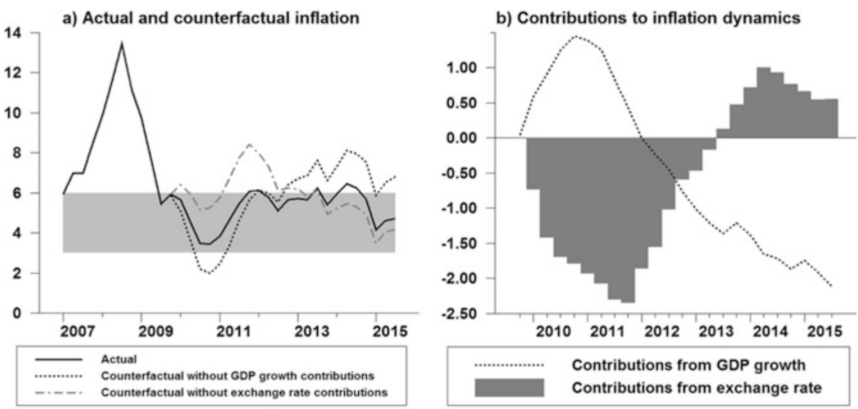

Fig. 21.5 Inflation and the role of GDP growth regimes. *Source*: Authors' calculations

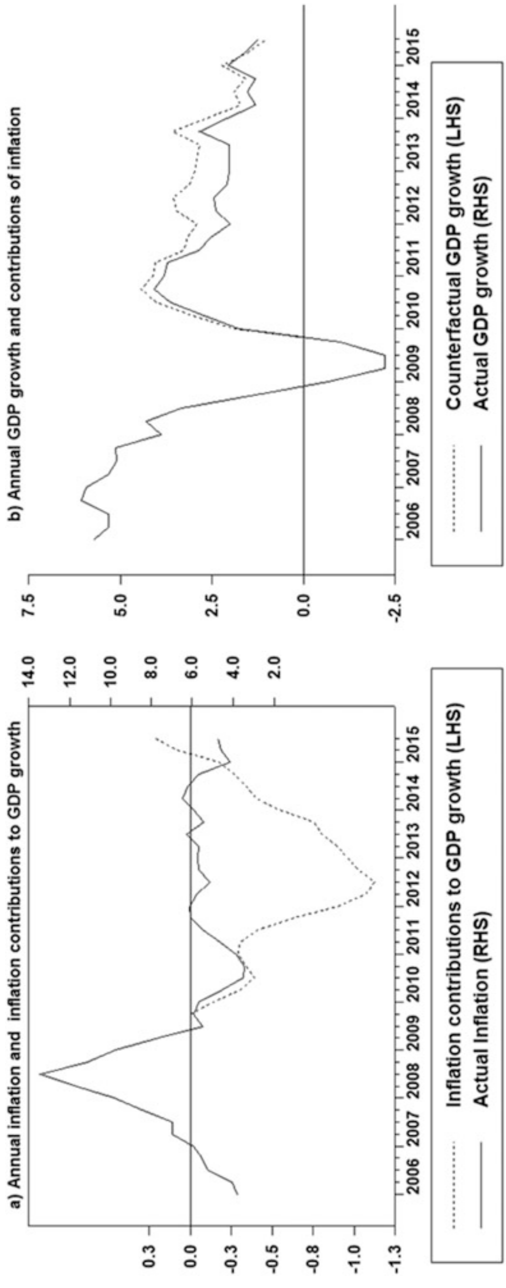

Fig. 21.6 Inflation contributions to GDP growth. *Source*: Authors' calculations

21.7 Conclusion and Policy Implications

This chapter investigated the role of GDP regimes in the ERPT to inflation. Evidence shows non-linearity in the response of inflation to rand depreciation shocks subject to GDP growth regimes. Furthermore, large rand depreciation shocks lead to higher inflation responses than small depreciation magnitudes. Monetary policy reacts to such depreciation shocks but the tightening is influenced by the magnitudes of the pass-through of the rand depreciation shocks to inflation. Large magnitudes of the exchange rate depreciation are accompanied by large inflation rate responses and aggressive monetary policy.

In policy terms, evidence means that the pass-through of large exchange rate depreciations to inflation is neutralised to some degree by the low GDP growth regime. In addition, the low exchange pass through to inflation in the low GDP growth regime is consistent with the menu cost theory of price changes, which suggests that producers subjected to low demand often hesitate to change prices frequently and may absorb a significant portion of cost increases.

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22

GDP Growth Threshold and Non-linear Effects of Repo Rate Shocks

Learning Objectives

- The non-linearities introduced by the GDP growth in the policy rate pace of adjustments
- The non-linear policy rate effects due to the GDP growth threshold
- Asymmetric credit growth shock effects on GDP growth in different GDP regimes

22.1 Introduction

The debate surrounding the potency of monetary policy effects conditional on GDP growth regimes is an ever-present feature in the policy setting process. The debate continues in light of the fact that the subdued state of the South African economic growth is largely a reflection of structural factors and monetary policy can have limited effects. In fact, other arguments suggest that monetary policy maybe "overburdened". Such views are founded on economic theory and empirical evidence showing that monetary policy is a demand management policy tool, effective for the management of cyclical economic developments. This

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chapter focuses on GDP growth thresholds to explore various dimensions related to role of economic growth in the policymaking process.

This chapter investigates the extent to which the GDP growth threshold affects the pace of repo rate adjustments. Is there a threshold level that exerts non-linearities in the transmission of the real effects of the policy rate? Does the lack of the distinction of the effects of the real policy shocks based on the growth regime overestimate the potency of policy effects on economic growth? Do different GDP growth regimes affect the path of the repo rate? If so, does this lead to non-linear responses to policy tightening and loosening?

22.2 Do Economic Theories Offer Explanations for the Asymmetric Policy Rate Shocks?

Empirical literature and evidence is not conclusive on the extent to which monetary policy exerts asymmetric effects on economic activity. It is not conclusive that big monetary shocks have smaller effects on real activity relative to small shocks. There is uncertainty on the extent to which the effects of monetary policy vary with the state of the business cycle. For instance, Barnichon and Matthes (2014) argue that the asymmetric effects of monetary policy on economic activity remain an open question to the extent that they vary with the size and direction of the policy shock.

What do the theories that explain asymmetries in policy shocks say? This prelude does not embark on an exhaustive literature review of all theoretical explanations of factors leading to asymmetric responses. However, it tries to bring forth those that touch on price rigidities, the credit channel, business and household confidence to the extent that it captures the business cycles, uncertainty and policy responses. Models based on assumptions that prices are rigid downwards than upwards are able to capture non-linearities in the real effects of monetary policy. This suggests that a contractionary monetary policy shock will have a pronounced real impact relative to accommodative monetary shocks Ravn and Sola (1997, 2004) and Tenreyro and Thwaites (2015).

Ball and Romer (1990) and Ball and Mankiw (1994) use microfoundations to deal with asymmetry introduced by price rigidities and the direction of the policy change. They show that in the presence of inflation, it is costless for firms to adjust prices and contractionary monetary shocks affect the real economy. The shock is transmitted via a decrease in aggregate demand which results in a decrease in relative prices. But the presence of inflationary pressures partly neutralises the effects of the decline in demand and therefore firms do not change prices and incur menu costs. However, in the case of accommodative monetary policy, because demand increases and there are inflationary pressures, firms adjust prices and incur menu costs. But because relative prices remain unchanged, the positive monetary shock is neutral.

The menu costs models also address effects of the magnitudes of changes in policy. Ball and Romer (1989, 1990) argue that small monetary shocks lead to output changes but the price level remains unchanged. Why is this the case? Due to menu costs, producers find it optimal to keep prices fixed rather than adjust them in response to small monetary shocks. In contrast, large monetary shocks compel producers to adjust their prices, leaving output unchanged. In short, yes, the size of the policy shock matters, such that small monetary policy shocks can lead to pronounced real effect on output relative to larger policy shocks. The presence of menu costs therefore makes responses to big monetary shocks neutral and responses to small monetary shocks non-neutral (Barnichon and Matthes 2014).

Overall, theories on menu costs policy initiatives result in three outcomes. First, assuming that there are no policy shocks, inflation should push future prices above the current level. Second, the model suggests that positive monetary shocks will lead to sharper differences between future and current prices. Therefore, sharper increases in price differences should lead to higher frequencies of price adjustments but leave output unaffected. Third, a negative monetary shock should lower future prices towards current prices and will impact real output.

Business and consumer confidence in the economic outlook can introduce asymmetries in the effects of monetary policy. Pessimistic views about the outlook during recessions and periods of elevated uncertainty can make expansionary monetary policy less effective, in contrast to periods of positive confidence during booms. Households and firms uncertain and pessimistic about the outlook, income and profitability are likely to spend and invest less even if monetary policy is more expansionary. This, therefore, makes output to be less sensitive or responsive to accommodative monetary policy (Agenor 2001). Linked to the confidence and uncertainty factors is whether the economy is facing capacity constraint or not. Asymmetry in policy responses occurs in cases where the economy is operating around full capacity. In such cases accommodative monetary policy has smaller effects in stimulating demand disproportionately and large effects on prices.

Credit frictions generated by asymmetric information between lenders and borrowers also introduce asymmetries in monetary policy effects on output. Tighter monetary policy increases interest rates and is transmitted to the balance sheets of households and firms via a number of channels. Gertler (1988) and Bernanke and Gertler (1989) emphasise the net worth and collateral effects introduced by credit constraints as sources of asymmetry in monetary policy responses. For instance, higher interest rates increase borrowing costs (and the external finance premium), the debt burden, riskiness of borrowers and potential defaults. In such instances, in managing the risk of the deterioration in the quality of their loan books, banks limit lending at a time when collateral values are low. Therefore, tighter monetary policy aimed at slowing inflation may lead to a tightening of credit constraints, thereby magnifying the impact of the initial policy shock on borrowing (both quantities and prices) and spending.

22.3 How Well Does the Model Without GDP Growth Thresholds and Regimes Capture the Stylised Effects Reported in Literature?

In most periods the downward trend in the repo rate is linked with improvement in economic growth; hence, there is a negative relationship between GDP growth and the repo rate. While the relationship between the repo rate and GDP growth is known, in this section we assess whether non-linearities and asymmetries play an important role in the transmission of the repo rate shocks. We estimate a VAR model using quarterly (Q) data from 1990Q1 to 2014Q4. The VAR includes annual GDP growth, credit growth and the repo rate. The ordering in the model assumes that economic growth is exogenous to the model and the repo rate reacts to economic growth in line with theoretical foundations relating capacity and inflation. Credit growth reacts contemporaneously to both economic growth and the policy stance. This ordering assumption suggests that both the policy rate and credit growth affect economic growth with a delay of a quarter. The model is estimated using two lags as chosen by the Akaike Information Criterion (AIC) and 10,000 Monte Carlo draws. The monetary policy shock variable is captured by repo rate. The results of responses to a 1 per cent positive shock to the repo rate on economic growth and credit are shown in Fig. 22.1.

The results in Fig. 22.1(a) show that the unexpected repo rate shock has adverse effects on economic growth, and the peak decline occurs between the sixth and eighth quarters. In addition, there is a strong feedback loop between credit and GDP growth. First, a positive 1 per cent GDP growth shock significantly raises credit growth for nearly nine quarters in Fig. 22.1(b). Second, consistent with vast findings in empirical literature, positive credit growth shock raises economic growth in Fig. 22.1(c) but in a transitory manner for nearly a year. Thereafter, GDP growth tends to decline. This supports the view that credit growth will not stimulate GDP growth perpetually. This also possibly suggests that there exists a credit threshold level above which credit growth begins to exert adverse effects on GDP growth. On the other hand, it is also possible that the interest rate channel comes into effect, as the repo rate rises significantly for a prolonged period following a positive credit growth shock in Fig. 22.1(d).

22.4 At What Level Does the Economic Growth Threshold Occur?

This section determines the GDP growth threshold and shows the effects of the policy rate on GDP growth subject to the growth regimes. First, the non-linear tests indicate that the GDP growth series is non-linear. The

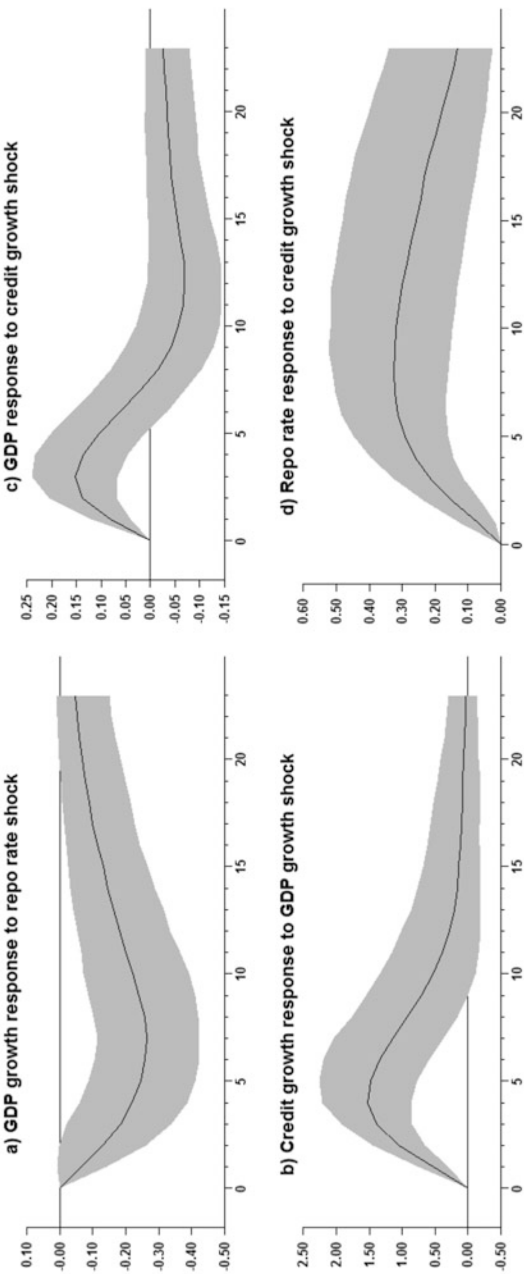

Fig. 22.1 GDP and credit responses to positive shocks. *Source*: Authors' calculations

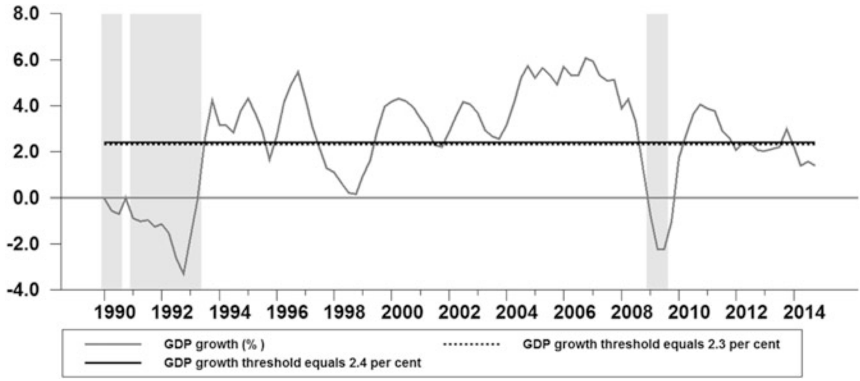

Fig. 22.2 GDP growth, recession episodes and threshold. *Source*: South African Reserve Bank and authors' calculations

Tsay arranged autoregressive test fails to reject the presence of the threshold in the GDP growth rate. Second, the Hansen threshold test rejects the null of no threshold in favour of the presence of threshold in GDP growth and establishes a threshold of 2.3 per cent. Third, the Balke (2000) threshold VAR approach identified a threshold of 2.4 per cent. This means that the GDP growth threshold is possibly bounded between 2.3 and 2.4 per cent. However, in view of the close proximity of these values, we use the 2.4 per cent threshold value as the upper limit in the analysis.[1] Fourth, the smooth transition model test rejects linearity in favour of non-linearity but fails to indicate which functional form to use. The failure to identify the functional form using smooth transition models implies that it could not conclude whether the movement from a lower regime is smooth or abrupt or very symmetric around the threshold.

Fig. 22.2 shows the estimated GDP growth thresholds over the business cycle phases. South Africa experienced recessions in 1990Q1–1990Q3, 1991Q1–1993Q2 and 2009Q1–2009Q3; these episodes are shown by the light grey shaded areas. The estimated GDP growth thresholds are 2.3 and 2.4 per cent, respectively.

[1] We used the 2.3 per cent threshold in the estimations and the results did not change significantly.

22.5 Are There Different Responses in GDP Growth in Different Growth Regimes to the Same Magnitude of Repo Rate Shock?

The regime-dependent VAR models are estimated using one and two lags based on the AIC tests for the lower and higher economic growth regimes, respectively and 1000 Monte Carlo draws. The results of the responses of GDP growth to a 1 per cent unexpected positive repo rate shock in Fig. 22.3(a) indicate that tight monetary policy shock leads to different GDP growth responses between the two regimes.

GDP growth declines with a delay in the lower growth regime. However, the decline is less severe compared to when the policy rate is tightened in the higher growth regime. Why is there such a difference in GDP growth impulses in the two regimes? The explanation possibly lies on the differences regarding the expected future path of interest rates and the persistence of the repo rate shock.

The trajectory of the repo rate in the two regimes differs in Fig. 22.3 (b) and there is a significant difference in the persistence of the policy rate shock. In the high growth regime, a positive 1 per cent repo rate shock is followed by further increases in the repo rate within the first four quarters following the initial shock. This suggests that the path of the repo rate initially rises steeply from 100 basis points[2] on impact to nearly 160 basis points in the fourth quarter in the high growth regime. In contrast, in a low growth regime a 100 basis points increase in the repo rate is not followed by any increases but a reduction in rates as the repo rate returns to pre-shock levels. Furthermore, the repo rate shock induces more fluctuations in GDP growth in the higher growth regime relative to a lower growth regime.

[2] **One basis point is** equivalent to 0.01% or 1/100th of a per cent or 0.0001 in decimal form. It is used to denote the percentage change in a financial instrument.

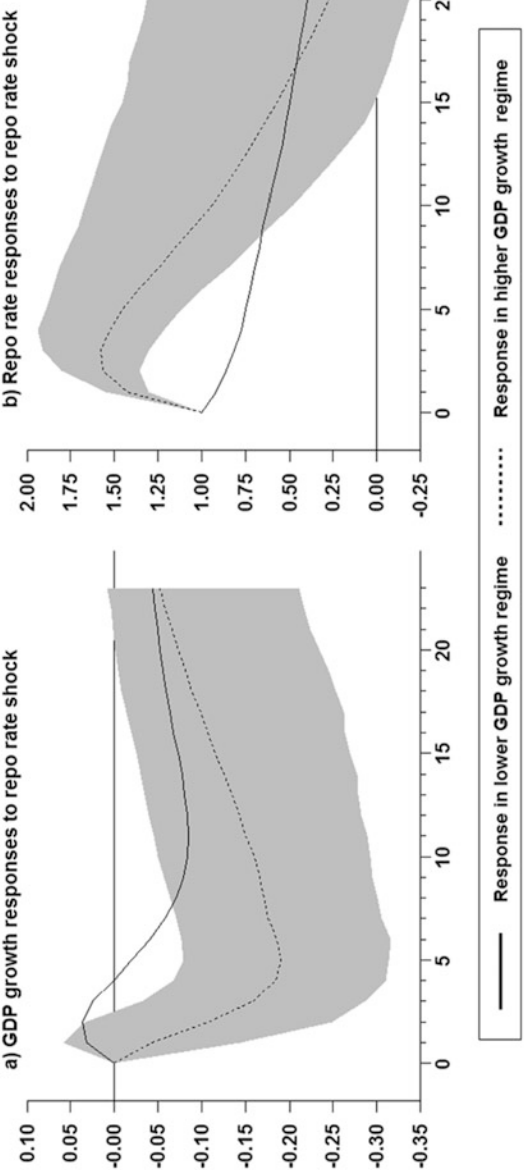

Fig. 22.3 Non-linear responses of GDP growth to an unexpected repo rate shock in different GDP growth regimes.
Source: Authors' calculations

22.6 GDP Growth Regimes and the Policy Effects

For the analysis of the policy effects and comparison of the responses, three models are estimated, namely: (i) without GDP growth regimes, (ii) lower GDP growth regime, and (iii) higher GDP growth regime. Fig. 22.4(a) shows that the positive policy rate shock effects are severe and potent when the non-linearities based on economic growth regimes are not considered in the models. What could be the cause of this difference? Some researchers such as Beaudry and Koop (1993), and Pesaran and Potter (1997) found that positive and negative shocks to output have different persistence properties and these depend on the phase of the cycle.

In addition, the repo rate shock paths differ across specifications. There are differences in magnitudes after the initial impact of the shock and the adjustment path returning to the pre-shock level. However, it is evident that the repo rate increases significantly in the high growth regime relative to results from the other models. The results are in line with evidence that in high growth regimes, the economy is characterised by overly confident economic agents, economic excesses and overheating that exert pressure on production capacity, prices and credit markets. Therefore, in cases of strong GDP and credit growth the effects of contractionary monetary policy shocks tends to be more potent. Overall, the results suggest that policy consideration should take into account GDP growth regimes. Policy rate adjustments in high and low GDP growth regimes have different effects.

22.7 To What Extent Do Economic Growth Regimes Lead to Asymmetric Policy Rates Shock Effects?

The preceding sections focused on the impact of the positive repo rate shock subject to GDP growth regimes. The analysis did not assess whether the effects of a contractionary monetary shock depend on the

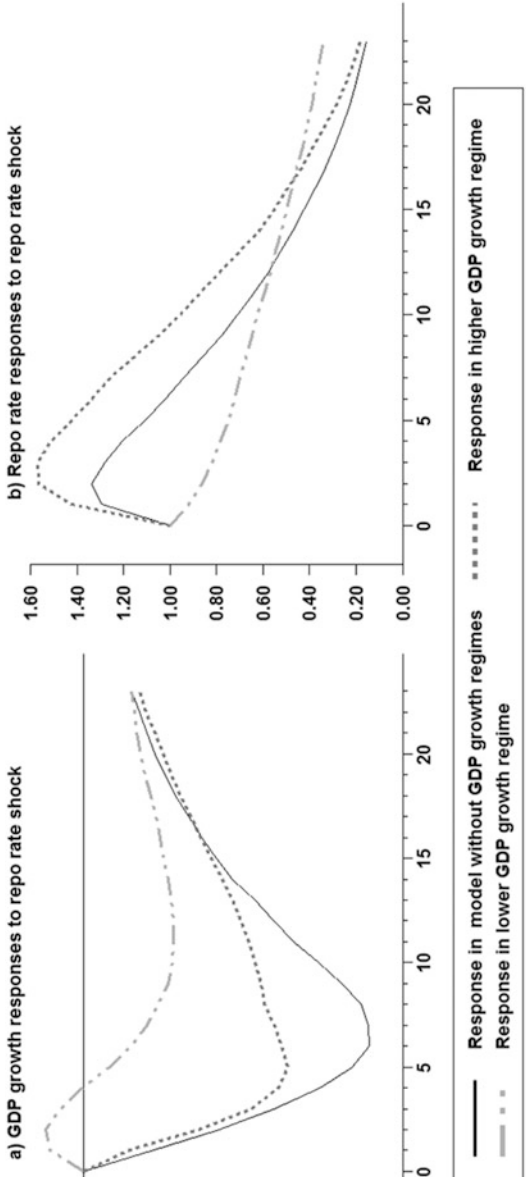

Fig. 22.4 Economic growth response and repo rate dynamics. *Source*: Authors' calculations

sign and the size of the repo rate shock as well as the GDP growth regime at the time of the shock. This section uses the standard approaches in literature such as Balke (2000), and one and two standard deviation shocks to assess the asymmetry introduced by the size of the adjustment and the effects of policy rate shock.[3] This is done within a threshold vector autoregression model that changes structure if economic growth conditions cross the estimated threshold using two lags and 1000 bootstrap draws.

The estimated threshold for GDP growth is 2.4 per cent and a lower (higher) growth regime refers to growth rate below (above) 2.4 per cent. The repo rate effects that represent contractionary policy stance are denoted by +1 SD and +2 SD (standard deviation) shock. The repo rates that denote an expansionary stance are denoted by −1 SD and −2 SD (standard deviation) shock. Fig. 22.5 shows that consistent with theoretical predictions and vast empirical literature a contractionary monetary policy shock has adverse effects on economic growth and this is visible in the lower and higher growth regimes. However, given that the main objective was to ascertain which policy stance has highly potent effects on economic growth in each growth regime, the peak effects show that a contractionary monetary policy shock has severe adverse effects relative to an expansionary policy stance in each growth regime. In addition, the results of the two standard deviation policy shocks have even large effects than the one standard deviation policy shock.

This evidence shows the existence of very strong asymmetry in the effect of monetary policy irrespective of the magnitudes of the policy rate shocks. Thus, a contractionary monetary policy shock generates a larger reduction in economic growth than acceleration in GDP growth that is induced by an expansionary shock. This finding is not unique to South Africa. Balke (2000) reports that large contractionary policy rate shocks have larger effects on output growth than expansionary shocks. Da Silva and Nunes (2007) found that the real effects of negative monetary shocks[4] are larger than those of positive shocks in an expansionary business phase and that real effects of negative shocks are greater in an

[3] This differs to a 1 per cent repo rate shock used in earlier sections.

[4] Negative (positive) monetary shocks refer to an unexpected reduction (increase) in growth in monetary aggregates.

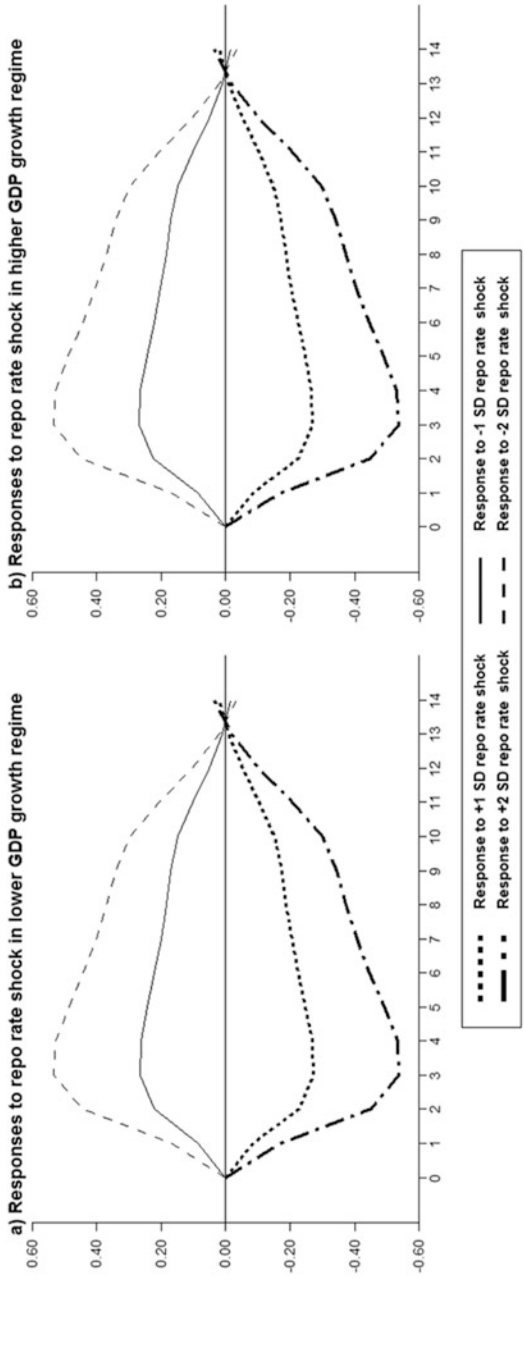

Fig. 22.5 Asymmetric effects of policy shocks in different GDP growth regimes. *Source*: Authors' calculations

expansionary phase. In addition, Thoma (1994) found that negative monetary policy shock effects have in generally had stronger effects on output than positive shocks. Barnichon and Matthes (2014) found that a contractionary monetary policy shock generates a large and significant reduction in output, but an expansionary shock has a small and insignificant effect.

What theoretical channels can explain this finding? This possibly points towards the role of credit frictions during periods of very low economic growth. Due to credit frictions, monetary policy impacts interest rate and external finance premium, which accentuates the effects of policy shocks on borrowing costs and real economic output. The lower collateral values during the periods of low GDP growth weakens the financial stance of economic agents. Credit supply by lending institutions would be stricter accompanied by higher external finance premium during periods of low economic growth than during expansionary phases. The combined effects of both higher interest rates and higher external finance premium imply monetary policy shocks will have greater effects on output during periods of low economic growth.

During periods of low economic growth and when credit constraints are binding, corporates and households find it harder to obtain funds. Monetary policy may have pronounced real effects as credit frictions propagate the initial policy shocks through the credit and lending channels. If the explanation lies in credit dynamics, then in which GDP growth regime does credit have asymmetrical effects? In which GDP growth regime does credit have a bigger impact on economic growth? These aspects are explored in the following sections.

22.8 Do Credit Growth Shocks Exert Asymmetric Effects on GDP Growth in Different GDP Regimes?

Authors such as Balke (2000) found that the interaction between monetary shocks and credit generate asymmetry. Are the asymmetric effects of expansionary and contractionary credit growth shocks on economic growth subject to GDP growth regimes? The expansionary credit growth shock is denoted by +1 SD and +2 SD (standard deviations) credit growth shocks. In contrast, the contractionary credit growth shock is denoted by −1 SD and −2 SD (standard deviations) credit growth shocks. Fig. 22.6 (a) and (b) show similar responses of growth to credit shocks. Expansionary credit growth shocks raises economic growth for a prolonged period and this is followed by declines. Contractionary credit growth shocks lower economic growth for an extended period and this is followed by a considerably long lag in the recovery of growth. The peak effects suggest that tighter credit growth shocks have bigger effects relative to expansionary credit shocks on economic growth. These indicate evidence of asymmetric effects in both lower and higher economic growth regimes.

22.9 Conclusion and Policy Implications

The analysis showed the asymmetric effects of the policy rate shock subject to the GDP growth threshold. A GDP growth threshold bounded between 2.3 and 2.4 per cent was established. Evidence suggests that the repo rate exerts significantly different effects between GDP growth regimes. This means that the repo rate affects GDP growth in a non-linear way. A one per cent unexpected increase in the repo rate shock leads to a less pronounced decline in GDP growth in the low economic growth regime relative to when the policy rate is tightened by the same magnitude in the high growth regime.

Two factors explain the differences. First, the trajectories of repo rate to the 1 per cent repo rate shock differ. Secondly, the repo rate shock induces more fluctuations in economic growth in the high GDP growth regime than in the low economic growth regime. In the high GDP growth regime, the initial increase is followed by further increases of different magnitudes, suggesting aggressive tightening possibly due to elevated inflationary pressures that exist in line with an overheating economy and excesses in credit markets.

Consistent with theoretical predictions and vast empirical literature, evidence indicates that a contractionary monetary policy shock has adverse effects on economic growth in both the lower and higher growth regimes. In addition, evidence points towards the existence of very strong asymmetry in the effect of monetary policy irrespective of the magnitudes

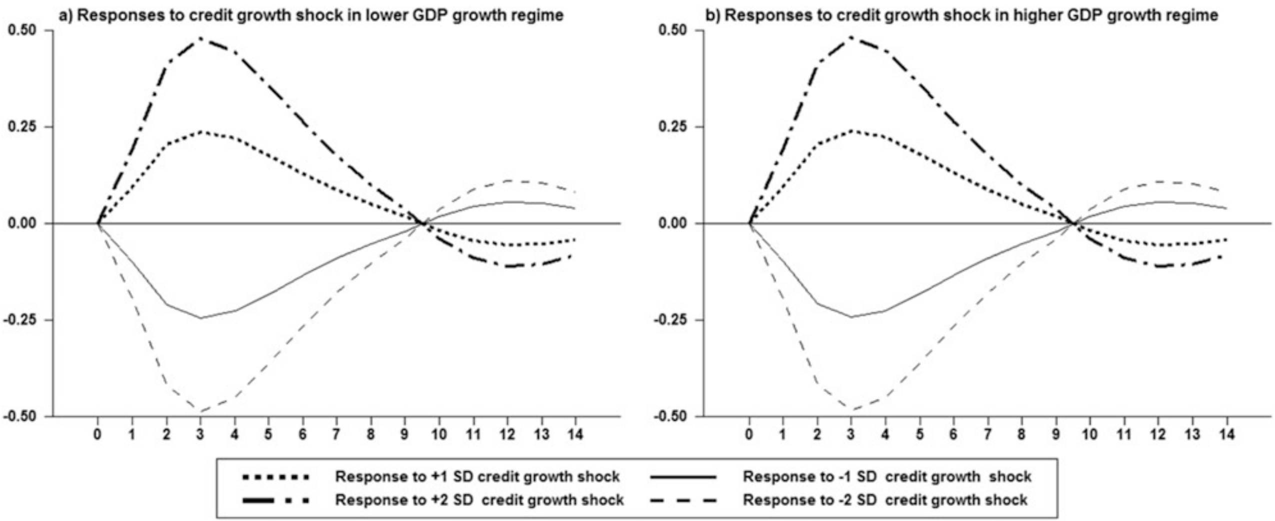

Fig. 22.6 GDP growth responses to credit growth shocks in different GDP regimes. *Source*: Authors' calculations

of the policy rate shocks. Thus, a contractionary monetary policy shock generates a larger reduction in economic growth than an expansionary shock. This finding that economic growth declines significantly in the low growth regime relative to the high growth regime possibly points towards the of role credit frictions during periods of low economic growth. Due to credit frictions, monetary policy impacts interest rates and the external finance premium. This in turn accentuates the effects of policy shocks on borrowing costs and economic activity, suggesting that credit constraints are binding in the low growth regime relative to the high growth regime and therefore play an even important role as drivers of growth shocks. In policy terms, the results set out in this chapter show that in low GDP growth regimes a gradual pace of tightening and in small magnitudes, may be an appropriate approach to reinforcing the price stability mandate.

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23

Asymmetric Effects of the Repo Rate and Inflation Rate Shocks on Economic Growth

Learning Objectives

- Inflation threshold matters for the effects of the repo rate and inflation on economic growth
- Inflation threshold leads to asymmetric effects of the repo rate and inflation on economic growth

23.1 Introduction

Does the inflation threshold matter with regard to the effects of the repo rate and inflation shocks on economic growth? If it does matter, does the established inflation threshold lead to asymmetric effects of the repo rate and inflation shocks on economic growth? Theory postulates the existence of a direct link between inflation and output in the form of the Phillips curve. Furthermore, vast empirical evidence has established that the Phillips curve is non-linear (convex), hence the costs of disinflation differ. In addition, the persistence of inflation may be linked to expected inflation. In turn, persistence may reflect the credibility of monetary policy (Mandler 2012).

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This chapter aims to answer these questions by focusing on the role of non-linearities and threshold effects by identifying (i) the extent to which the inflation threshold matters for the effects of the repo rate and inflation shocks on economic growth, and (ii) the extent to which the inflation threshold leads to asymmetric effects of the repo rate and inflation rate shocks on economic growth. Mandler (2012) argues that changes in the monetary policy reaction function can also depend on the existing level of inflation as the central bank might decide to respond differently to shocks depending on the size and the direction of the deviation of inflation from its target. In addition, Cukierman (1992) argues that it is possible that the central bank might respond more aggressively to sizable inflationary excesses than to small ones.

23.2 Are There Asymmetric Effects Between Inflation, the Repo Rate and Economic Growth? Inferences from the Balke (2000) Threshold VAR Approach

Theory suggests unexpected increases in inflation and the repo rate are negatively related to GDP growth. This suggests that increases in inflation and the repo rate have an adverse effect on economic growth. This means that when the policy rate is tightened in response to the worsening inflation environment, GDP growth declines. The asymmetric effects of the repo rate and inflation rate shocks on economic growth in this chapter are estimated via a threshold VAR model that allows for different inflation regimes determined at a point where inflation exceeds a given inflation threshold value. We use the Balke (2000) threshold VAR approach to test for regime dependency in macroeconomic dynamics based on the threshold VAR. The quarterly (Q) data from 1995Q1 to 2014Q4 is used. The threshold VAR uses three variables, namely, economic growth, inflation and the repo rate, and two lags as selected by Schwarz Bayesian criteria (SBC) and 1000 bootstrapping draws. Based on the Balke (2000) approach the threshold VAR model determines an inflation threshold of 4.64 per cent. The focus is on the non-linear effects of a one and two positive and negative standard deviation shocks to the repo rate on GDP growth.[1]

Fig. 23.1 shows that a contractionary monetary policy lowers economic growth for less than ten quarters. The recovery of economic growth to above zero suggests the long-run neutrality effects of monetary policy on economic growth. In addition, an expansionary monetary policy has stimulatory effects on economic growth but the effects also dissipate in the long run. Evidence concludes that the effects of contractionary and expansionary monetary policy are consistent with theoretical predictions.

Evidence indicates that small shocks (a small standard deviation) lead to a smaller decline in GDP growth relative to large shocks (two standard deviations). Contractionary monetary policy (positive standard deviation) has adverse effects, while expansionary policy (negative standard deviation) has stimulatory effects in both high and low inflation regimes. Furthermore, Fig. 23.2 shows that the peak responses of GDP growth to changes in the policy rate in a lower inflation regime indicate that expansionary monetary policy shock has bigger effects compared to those of a contractionary monetary policy.

Two policy conclusions on the amplifications stand out from the results presented in this section. The policy effects and responses are different across regimes. Contractionary monetary policy shock has relatively significant effects as opposed to an expansionary monetary policy shock in a high inflation regime.

23.3 Asymmetric Responses of GDP Growth to Inflation Shocks

Fig. 23.3 shows the responses of economic growth to both positive and negative inflation shocks. A positive inflation shock lowers economic growth in both high and low inflation regimes. In contrast, an unexpected decline in inflation leads to positive economic growth.

[1] A one negative and positive standard deviation shock is equivalent to 0.95 per cent increase or decline in the repurchase rate.

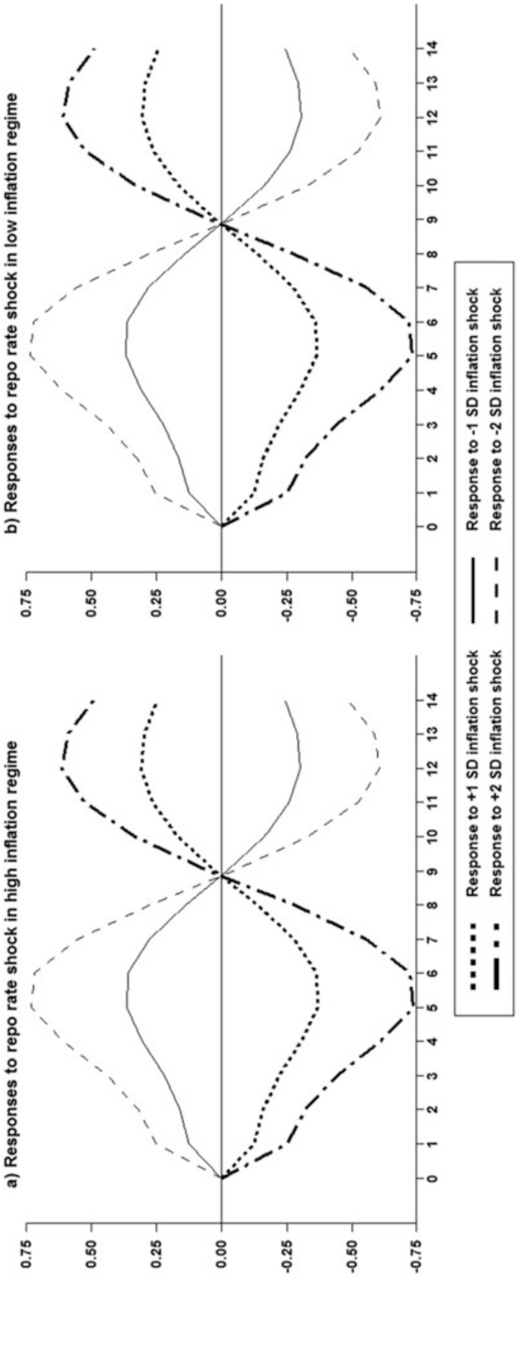

Fig. 23.1 Non-linear effects of contractionary and expansionary monetary policy on growth. *Source*: Authors' calculations

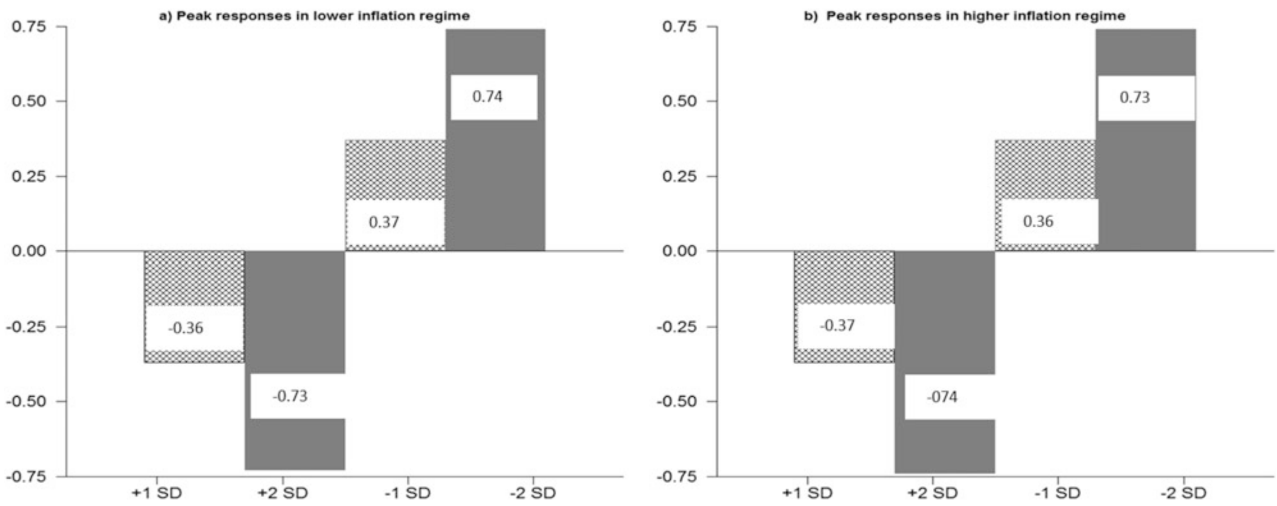

Fig. 23.2 GDP growth peak responses to repo rate effects depending on inflation regimes. *Source*: Authors' calculations. *Note*: +1SD refers to one positive standard deviation shock, +2SD refers to two positive standard deviation shocks, −1SD refers to one negative standard deviation shocks and −2SD refers to two negative standard deviation shocks

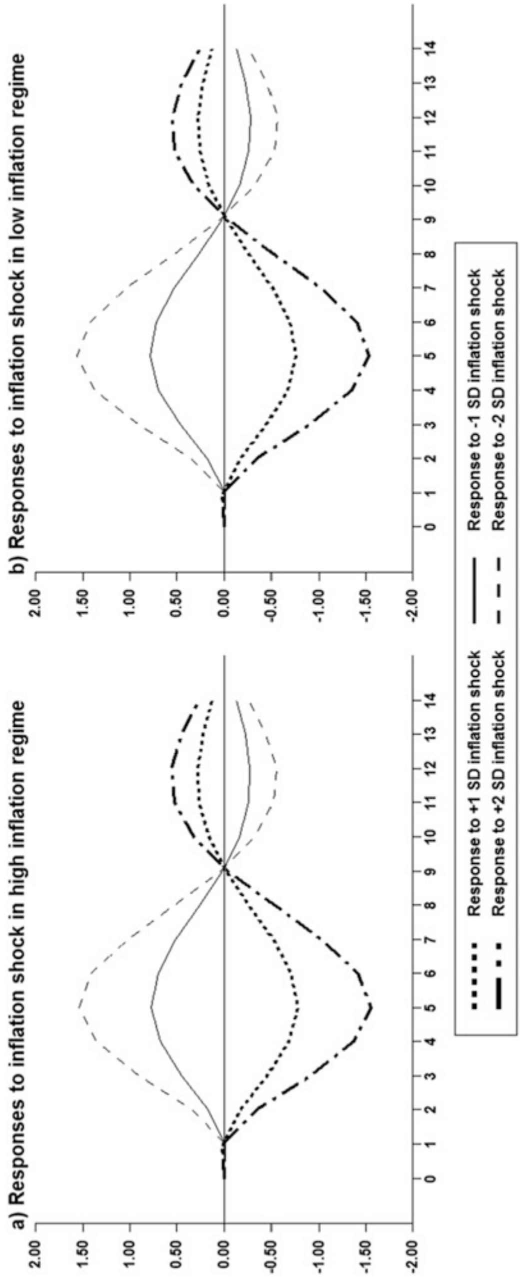

Fig. 23.3 Asymmetric effects of inflation rate on economic growth. *Source*: Authors' calculations

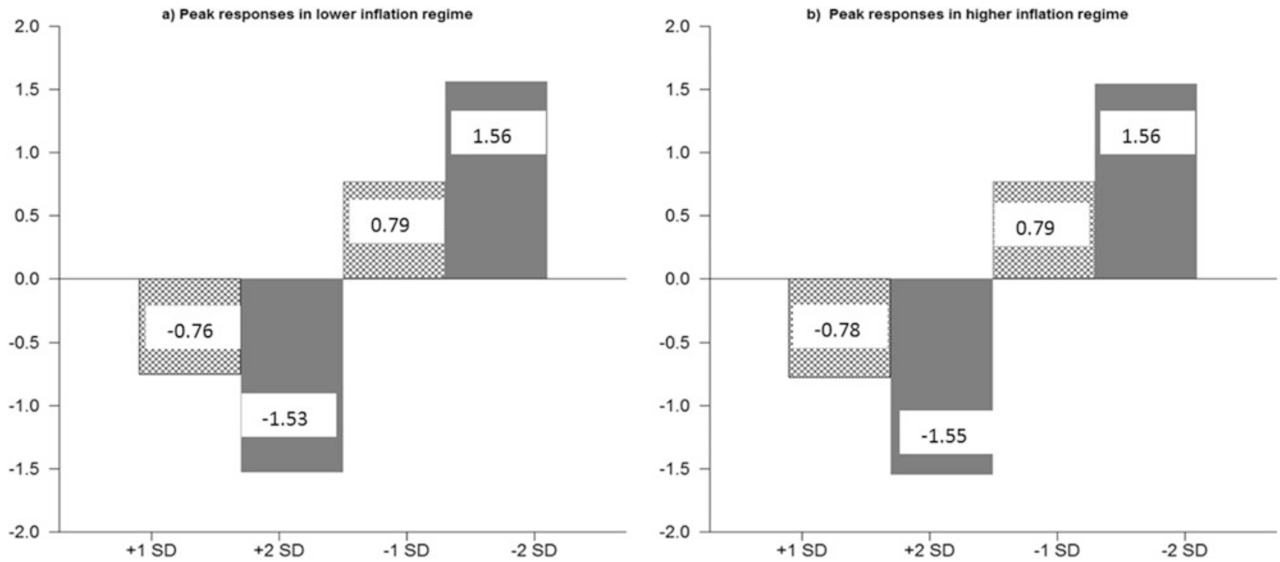

Fig. 23.4 GDP growth peak effects to inflation shocks according to inflation regimes. *Source*: Authors' calculations. *Note*: +1SD refers to one positive standard deviation shock, +2SD refers to two positive standard deviation shocks, −1SD refers to one negative standard deviation shocks and −2SD refers to two negative standard deviation shocks

In addition, a negative inflation shock has a bigger effect on economic growth than effects emanating from a positive inflation shock in the high inflation regime in Fig. 23.4(a). An unexpected decline in inflation has larger beneficial effects on economic growth in a low inflation regime than in a higher inflation regime Fig. 23.4(b).

A comparison of the peak effects to the same magnitude of shock (that is, a one standard deviation) in repo rate and inflation shows that inflation has larger effects relative to the repo rate on economic growth. This implies that while monetary policy may not generate economic growth directly, it does so indirectly by lowering inflation to facilitate the proper functioning of relative prices and the efficient allocation of resources.

23.4 Conclusion and Policy Implications

This chapter applied a threshold technique based on Balke (2000) approach to examine the role of the inflation regime. Based on the established threshold, we find evidence that a contractionary monetary policy shock has more potent effects relative to an expansionary monetary policy shock in a high inflation regime. Furthermore, an unexpected increase in inflation in both high and low inflation regimes has negative effects on economic growth. On the contrary, an unexpected decline in inflation has more beneficial effects on economic growth and has a larger impact in a high inflation regime than in lower inflation regime. A positive inflation shock exerts more adverse effects on economic growth relative to the repo rate shock of same magnitude. In policy terms, the results suggest that inflation thresholds and the non-linear transmission of shocks can assist the policymaker in sharpening the communication and transparency in an effort to lower inflation expectations. The credibility problem cannot be solved by transparency alone.[2]

[2] Furthermore, literature shows that in assessing competing approaches about how the policymaker can induce lower inflation expectations, the focus should be on how effective each alternative is in affecting expectations. In this respect, it unclear how effective the release of the interest rate forecast is in affecting inflation expectations. So far, indications are that it is likely to be much less effective.

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24

Do Deteriorating Business Cycle Indicators and Tight Credit Conditions Affect the Repo Rate Adjustment to Positive Inflation Shock?

Learning Objectives

- Show the implication of negative shocks to credit conditions, business cycles, and leading and coincident indicators on the policy adjustments to positive inflation shocks since 2007M8
- Show the different impact credit conditions and business cycle indicators exert on the policy adjustments

24.1 Introduction

Despite significant fiscal and monetary stimulus in the recent past, Fig. 24.1 shows that the annual changes in the business cycle leading indicators (BCLI) and coincident (BCCI) indicators have trended downwards and fluctuated around zero for the most part of the period post-2009 recession. At the same time the credit condition index (CCI) fluctuated around the neutral state with a tightening bias. What do the current trends in the BCCI mean for the evolution of inflation and the outlook? Do these conditions impact the policy rate adjustments towards positive inflation shocks, in particular since 2007M8?

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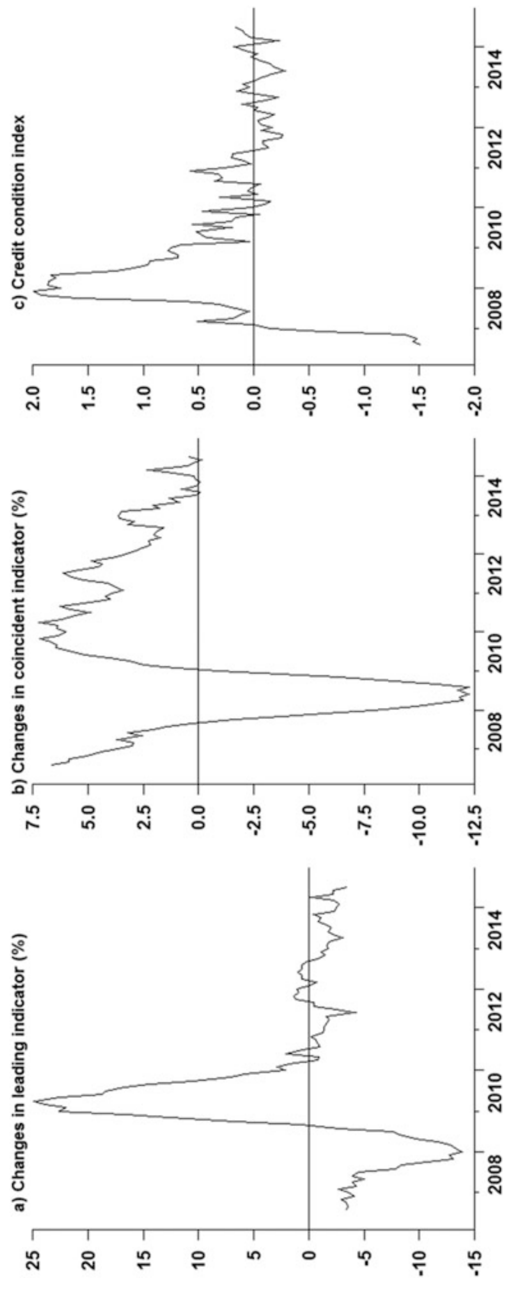

Fig. 24.1 Changes in the BCLI, BCCI and CCI. *Source*: SARB and authors' calculations

Furthermore, policy uncertainty has been heightened whilst consumer and business confidence have declined, as shown in Fig. 24.2.

This chapter assess how the negative effects of BLCI and BCCI differ from those of tight credit conditions. How has the coincident indicator influenced the evolution of inflation since 2009? In addition, the period post 2007Q1 has been characterised by heightened policy uncertainty, low consumer and business confidence. All these factors possibly played a part in neutralising the stimulatory effects of monetary and fiscal policy on the real economy.

24.2 How Have Selected Macroeconomic Indicators and Policy Changes Evolved since 2008?

Fig. 24.3 shows the relationship between inflation and the repo rate since late 2007. The scatterplots indicate that a positive, but not perfect, relationship exists between inflation and the repo rate. Inflation explains about 73 per cent of changes in the repo rate adjustments. This suggests that the repo rate does not adjust one-to-one or more than changes in inflation. In addition, the implication of the trends displayed in Fig. 24.3(c) is that the monetary policy stance has been stimulatory post-2007. The trend real repo rate, turned positive in 2015 but remains below the long-term trends in the recent past. However, it is evident that the return to positive real repo rate is mostly due to the adjustment in the policy rate as opposed to sustained inflation below the target band.

Furthermore, as stated earlier, the fiscal policy and monetary policy settings were loosened considerably post-2009. But, despite the counter-cyclical fiscal policy stance and an increase in both the level of debt and its ratio of GDP, there has not been commensurate GDP growth as can be seen in Fig. 24.4. The bilateral relationships based on the scatterplots and cross correlation indicate a negative association between changes in government debt (Gov_debt) and GDP growth in Fig. 24.4(b) and (c).

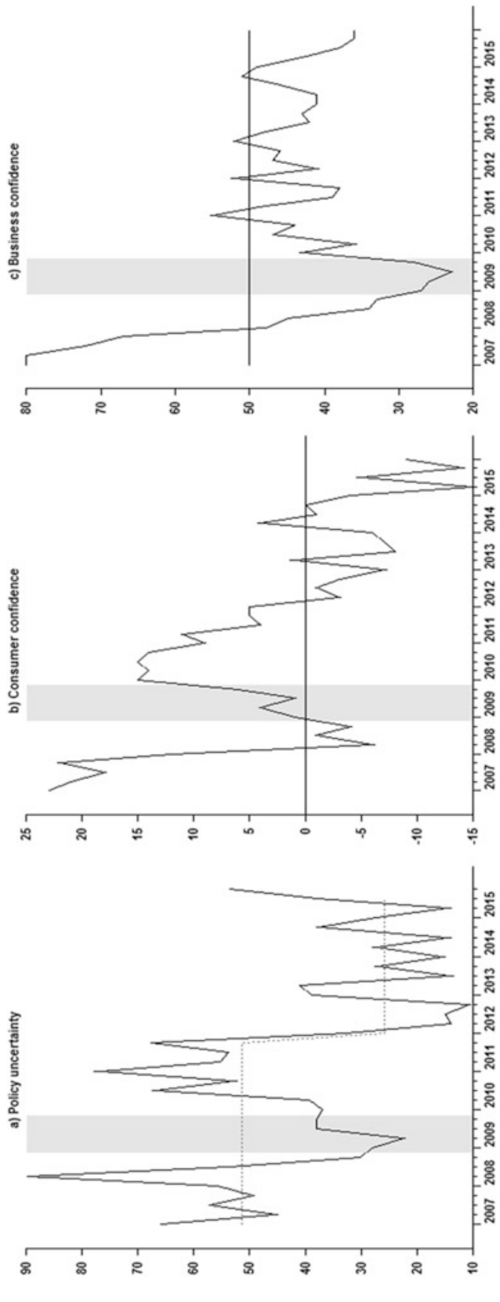

Fig. 24.2 Evolution of policy uncertainty, consumer and business confidence. *Source*: SARB and authors' calculations

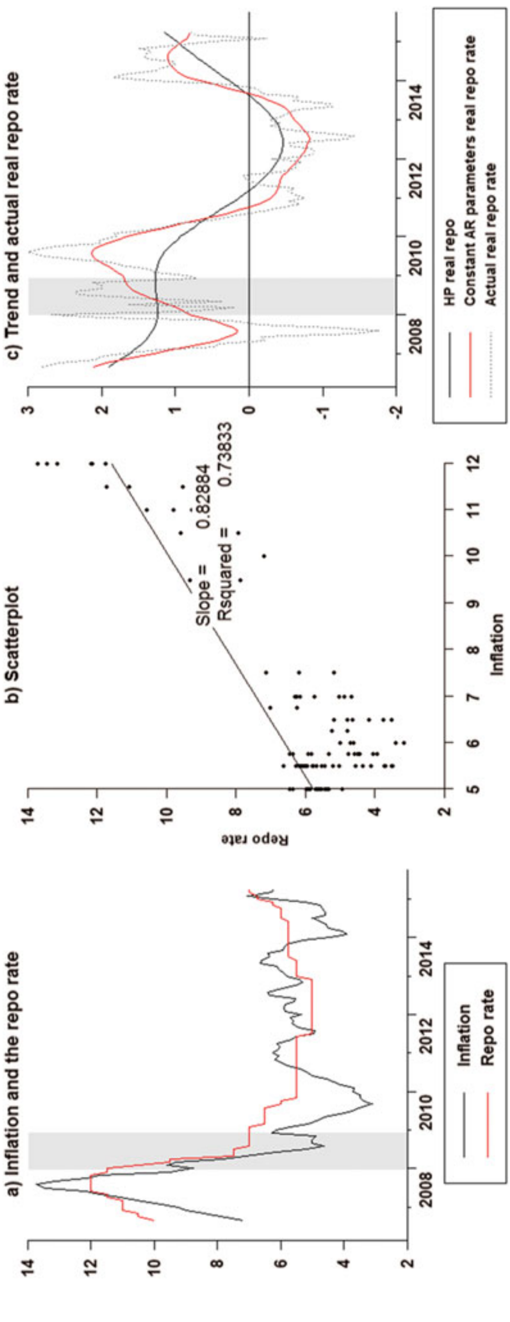

Fig. 24.3 Inflation, nominal and real repo rate. *Source*: SARB and authors' calculations

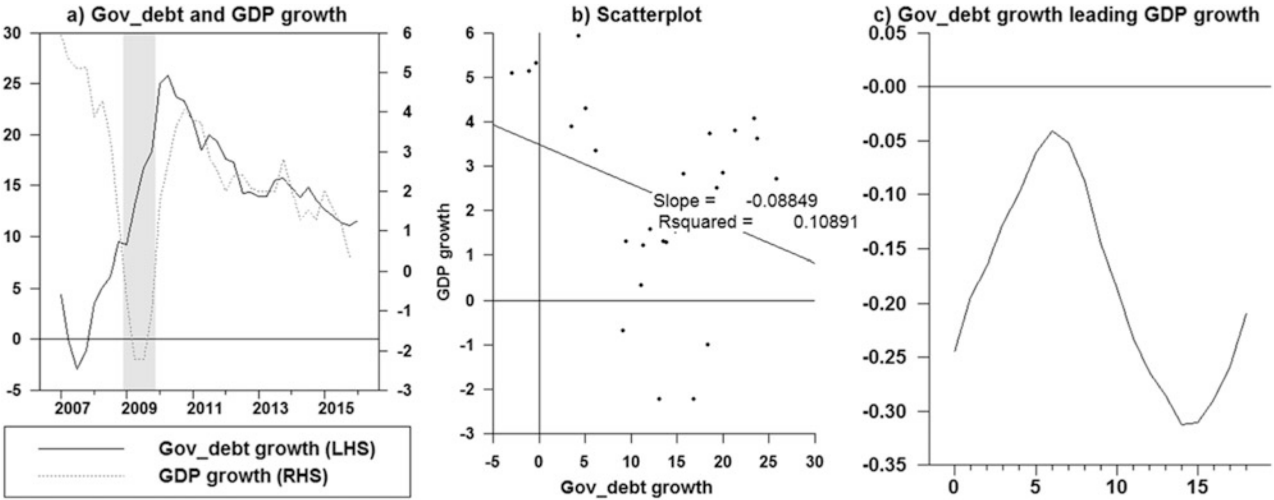

Fig. 24.4 Government debt and GDP growth. *Source*: SARB and authors' calculations

How is a negative association between changes in government debt and GDP growth possible? Vast literature shows that the output multipliers associated with fiscal stimulus differ depending on high and low debt regimes or states. First, some studies show that there are instances where debt accumulation and a high-debt environment can neutralise fiscal policy as an effective tool to combat recession or as a countercyclical policy tool. When debt is high, the policy expectations channel can dominate such that economic agents' expectations of high future taxes can neutralise the expansionary effects of fiscal policy, thus dampening investment and output growth.

In addition policy uncertainty can neutralise the fiscal stimulus. It is possible that the confidence, sentiment and uncertainty channels also played a role in neutralising the transmission of the fiscal spending shocks. There is a negative relationship between elevated policy uncertainty and GDP growth, which suggests that GDP growth will slow down when preceded by high policy uncertainty.

24.3 What are the Effects of Negative Shocks Due to the BCLI, BCCI and CCI?

The economic conditions as captured by the BCLI, BCCI and CCI trends have deteriorated. The BCLI, BCCI and CCI trends embody most of the individual variables presented in the earlier section. We examine the effects of negative shocks due to the BCLI, BCCI and CCI. Do developments in the BCLI, BCCI and CCI have an impact on the adjustment of the repo rate to inflationary pressures? To derive policy implications, the analysis applies a counterfactual VAR analysis to determine the repo rate responses to positive inflation shocks. The credit conditions, leading and coincident indicators are shut off in the inflation equation in the model, respectively.

The empirical analysis is based on the VAR model estimated using three monthly variables, namely, inflation, repo rate and annual growth rates in the BCLI, BCCI indicators and the CCI. The sample spans the period 2007M8 to 2015M12. The annual changes in BCLI, BCCI and

CCI are included separately in the model. The model is estimated using two lags as selected by HQ criteria and 10 000 Monte Carlo draws. Impulse responses refer to a one standard deviation shock.

Fig. 24.5(a), (e) and (c) shows that tight credit conditions shock; negative BCLI and BCCI indicator shocks reduce inflation significantly for long periods. At most, in peak response the inflation should be lower by 0.3 percentage points due to tight credit conditions and negative coincident indicator shocks. These magnitudes of response exceeding the peak of 0.15 percentage points decline due to negative leading indicator shock. This means that developments in these indicators have implications for inflation and require a different approach, which applies a counterfactual approach as described in the next section. Fig. 24.5(b), (d) and (f) shows that the repo rate is loosened in response to these adverse shocks. Fig. 24.5(g) shows that negative BCCI shock induces more fluctuations in inflation than BCLI shock.

24.4 Do the CCI, BCLI and BCCI Impact the Conduct of Policy?

This section considers the role of BCLI, BCCI and CCI in amplifying the repo rate responses to positive inflation shocks. The counterfactual analysis begins by examining the role of changes in the BCCI indicator in the way repo rate responds to positive inflation shocks. Fig. 24.6(a) shows that repo rate rises irrespective of whether changes in the coincident indicators are shut off or not in the model.

However, the gap between the counterfactual and actual repo rate response show that the pace of policy rate adjustment differs. The repo rate response is more aggressive when these conditions are shut off after 2007. This suggests that the deterioration in the coincident indicator leads to a slightly slower policy rate adjustment than what it would otherwise be.

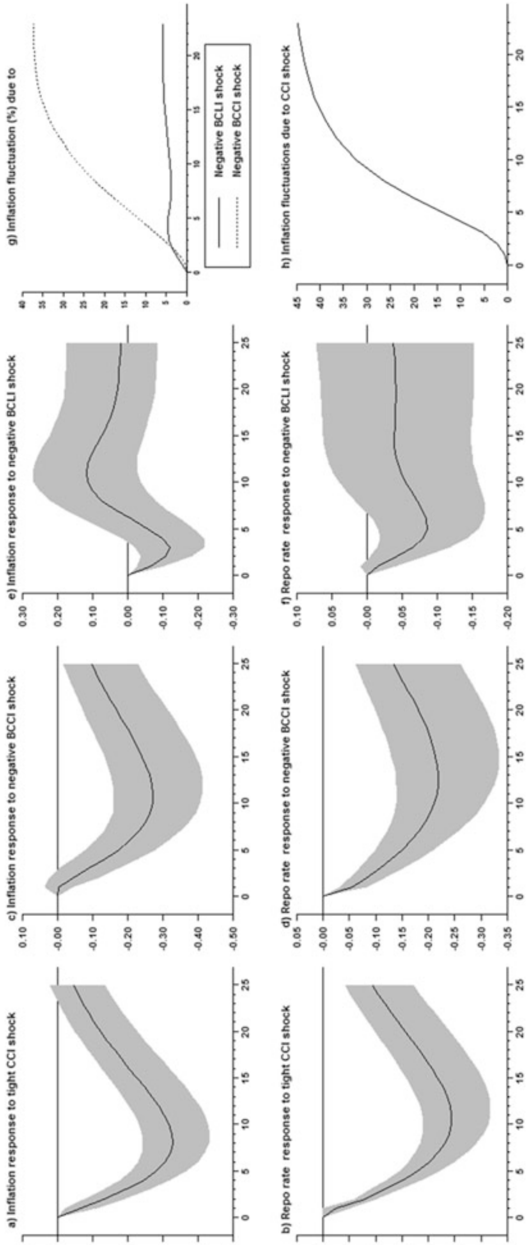

Fig. 24.5 Responses to tight CCI, negative BCLI and BCCI shocks. *Source*: Authors' calculations

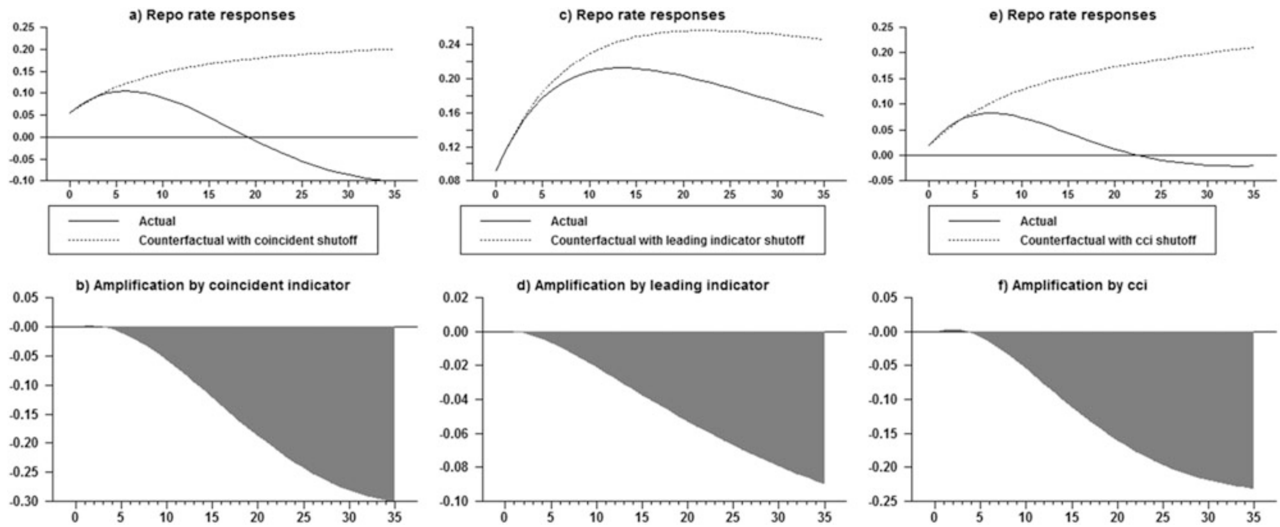

Fig. 24.6 Repo rate responses to positive inflation shocks and the amplification by changes in coincident indicator. *Source*: Authors' calculations

24.5 The Role of the Leading Indicator in Amplifying Repo Rate Responses to Inflation Shocks

What about changes in the leading indicator? Do they influence the repo rate adjustment to positive inflation shocks? Evidence shows that the repo rate would be much higher if the leading indicator is shut off in Fig. 24.6 (b). This suggests that changes in leading indicator after 2007 have had an impact on the pace of repo rate adjustment. Similarly, credit conditions influence the repo rate adjustments in Fig. 24.6 (c). Evidence shows that the counterfactual repo rate exceeds the actual repo rate suggesting that tighter credit conditions lead to slightly lower changes in repo rate magnitudes than what would prevail in their absence. The negative differences suggest that tighter credit conditions slow down the pace of repo rate adjustment and magnitudes. This is evidence that the credit market developments do impact the pace of repo rate adjustment.

Furthermore, evidence in Fig. 24.5(g) indicates that at the longer horizons, changes in the BCCI indicator induce more variations in inflation than the BCLI. This means that the BCCI leads to bigger movement in inflation than the BCLI indicator and it also leads to larger amplifications of the repo rate reaction due to positive inflation shocks in Fig. 24.6(b) and (d). Based on these two findings, what does the historical decomposition approach suggest the contributions of the coincident indicator to inflation are? The historical decomposition approach separates inflation into own trend, own contribution and contributions by repo rate and changes in coincident indicator.

Fig. 24.7(a) shows that the counterfactual inflation would be outside the inflation target band if changes in the coincident indicator are shut off in the model. This means that current developments in the coincident indicator lead to low actual inflation than otherwise.

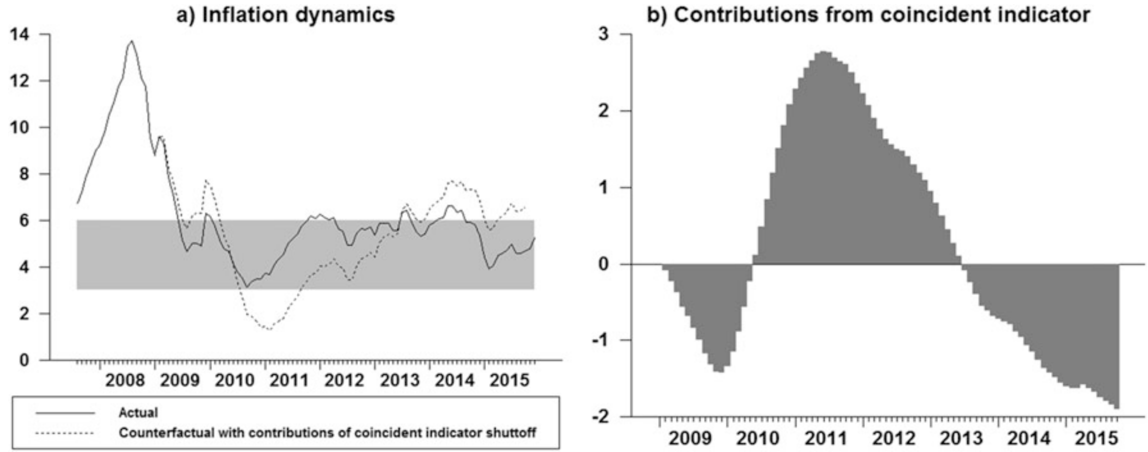

Fig. 24.7 Inflation dynamics and the role of coincident indicators. *Source*: Authors' calculations. *Note*: The grey shaded area denotes the 3–6 per cent inflation target band

24.6 Conclusion and Policy Implications

Low growth and inflation at above the upper band of the target range continue to characterise the monetary policy landscape. In addition, forecast and business cycle indicators of economic activity indicate that growth will remain subdued and can slow down further. Labour market conditions have also deteriorated. With this in mind, this chapter explored whether deteriorating business cycle indicators and tight credit conditions affect the repo rate adjustment to positive inflation shock.

Evidence shows that tight credit conditions shock; negative BCLI and BCCI indicator shocks reduce inflation for long periods. For example, tight credit conditions and the negative leading indicators shock can lower inflation by 0.3 and 0.15 percentage points, respectively. The policy implications are that the repo rate response to inflation is slightly slower in the presence of tight credit conditions and subdued labour market and economic conditions.

25

Rand/US Dollar Exchange Rate Pass-Through and the Inflation Environment

Learning Objectives

- Establish the inflation threshold for the R/US$ exchange rate pass-through exchange (ERPT)
- The degree of ERPT and half-life of exchange rate shocks in different inflation regimes
- The degree of inflation persistence in different inflation regimes

25.1 Introduction

Does the R/US$ exchange rate pass-through (ERPT) depend on the level of the existing inflation rate? The speed and the degree of the ERPT is influenced by the exchange rate volatility, whether the exchange rate depreciates above a certain threshold, average inflation and inflation volatility, the degree of openness and the business cycle phase including the extent of the output gap. Supply-side shocks associated with food, fuel and energy price shocks can also affect the ERPT to inflation, and when favourable, they present "opportunistic disinflation" and can influence

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monetary policy conduct. Hence, this chapter explores the possibility that the ERPT does not exclusively depend on the exchange rate changes.

The chapter argues that there exists an inflation threshold which results in non-linearity in the ERPT. In such instances, it is possible that the ERPT will be high if the rand depreciates (sharply) at a time when inflation is (well) above this threshold level. The implication is that the ERPT coefficients may differ between high and low inflation environments. Furthermore, this may reflect the persistence of inflation and the path of the exchange rate shock.

25.2 Why Does the Distinction of the Degree of the ERPT Based on the Inflation Regimes Matter?

Knowledge of how the ERPT behaves in different inflation regimes enables us to assess whether there are episodes of reduced ERPT and if so, under what circumstances they tend to prevail. The nonlinear ERPT matters and is worth considering in the monetary policymaking decision process. Furthermore, it is necessary to distinguish between the impact of macro and microeconomic factors on the ERPT as they have substantially different implications for the policy stance. For instance, if the pass-through is a "macro" phenomenon largely associated with inflation or exchange rate volatility, the implication is that a given decline in the degree and speed of the ERPT may not necessarily be a permanent phenomenon and can dissipate if highly accommodated by monetary policy.

In contrast, if the changes in the degree of the ERPT are related mostly to structural or "micro" factors, such as the industry composition of trade and market structure, monetary policy is less capable of addressing the issue.

Three microeconomic factors feature prominently to explain this possibility via the exchange rate changes. These theories suggest that if the market share objective is a binding constraint, then the ERPT to inflation differs during appreciation and depreciations. If foreign producers preserve competitiveness in order to maintain market share, then an appreciation of the domestic currency might cause a higher pass-through than depreciation.

In contrast, the capacity constraints argument suggests that quantities may be rigid upwards in the short run. Knetter (1994) argues that, if exporting firms are subject to binding quantity constraints, then an appreciation of the currency of the importing country might cause a lower pass-through than depreciation. Last but not least, the menu costs arguments underscores that due to costs associated with changing prices, foreign exporters may leave their price in the importer's currency unchanged, especially if exchange rate changes are small. The menu costs hypothesis also embraces the fact that the ERPT may be asymmetric with respect to the size of the exchange rate shocks. Price adjustments are more frequent with large exchange rate changes relative to small ones.

Prior to determining the existence of the inflation threshold, this chapter shows that there exists a breakpoint in the inflation series as indicated by various appropriate tests. The implication is that when a threshold exists and is established, the ideal approach to model the ERPT to the inflation process is a non-linear rather that a linear approach. This means that the ERPT coefficient is not a static value but is time-varying (or regime dependent) and can be dependent on whether the inflation is in a high or low regime. This chapter applies a smooth transition model to establish the threshold above which inflation leads to a higher degree of the ERPT. Thereafter, a non-linear threshold VAR model is estimated to assess whether inflation responds differently to the R/US$ depreciation shock in high and low inflation regimes. In addition, evidence shows that the half-life taken by a depreciation shock, which is the time taken by the shock to lose its initial value, differs between the high and low inflation regimes.

25.3 Is It Possible That the Exchange Rate Pass-Through is Reduced in a Lower Inflation Environment?

Yes, there are a number of studies, such as Taylor (2000), Choudhri and Hakura (2006), and Shintani et al. (2009) that have confirmed that the ERPT is reduced in a lower inflation environment. Choudhri and Hakura (2006) showed that the dependence of consumer price inflation ERPT on the inflationary environment arises because the degree of the ERPT reflects the expected effects of monetary shocks on current and future costs. In this model, a low inflation regime will reduce the ERPT by weakening the expected future effect of shocks, which is accompanied by less variable monetary shocks. Less variable monetary shocks will decrease the information content of the ERPT in predicting monetary shocks.

Taylor (2000) suggests that, as firms set prices for several periods in advance, their prices respond more to cost increases due to the exchange rate depreciation. In this model, if cost changes are perceived to be more persistent this implies that regimes with higher inflation tend to have more persistent costs. A high inflation environment would thus tend to increase the ERPT. Taylor argues that the ERPT depends on the policy regime; hence, a credible low inflation regime will achieve a low ERPT. This view further suggests that a shift towards a lower inflation regime, brought about by more credible monetary policies, can give rise to a reduced degree of the exchange rate pass-through.

25.4 Is the Inflation Process Linear or Non-linear?

There are a number of competing approaches to estimating the degree and speed of the ERPT. The approaches range from assessing the ERPT from the nominal effective exchange rate (NEER) or the real effective exchange rate (REER) to inflation. This chapter uses the R/US$ exchange rate because the US$ remains an anchor and invoicing currency for a number of emerging market economies and therefore plays important role in calculation of the trade-weighted exchange rates. Hence, changes in the US$ also have an effect on the international trade transactions of countries invoicing a large share of their trade in US$, irrespective of the trading partner.[1]

[1] See Gopinath et al. (2007, 2010) for the role of the invoice currency in determining the degree and speed of the ERPT.

Furthermore, the relationship between annual inflation and annual changes in the R/US$ is characterised by close movement and evidence shows that when inflation is low (high) it is accompanied by the appreciation (depreciation) in the R/US$ exchange rate. This means that the depreciation in the R/US$ exchange rate is usually accompanied by a rise in the inflation rate. Furthermore, the inflation process exhibits signs of persistence which decays very slowly.

The empirical analysis begins by examining whether the inflation process is characterised by a linear or non-linear behaviour. This includes examining various aspects of inflation rates, such as establishing the existence of breaks in the inflation series, the existence of the threshold value and determining whether we can use a linear or non-linear model to assess whether the degree of the ERPT to inflation is regime-dependant. The estimations are conducted Monthly (M) data for the period spanning January 2000 to June 2014. The specification used to estimate the linear part is that inflation depends on the constant, the first and second lags of inflation, contemporaneous and second lag of annual growth in manufacturing production, contemporaneous and second lag of annual growth in foreign producer prices, and first and third lags of the R/US$ exchange rate. The non-linear part is dependent on the first and third lags of the R/US$ exchange rate.

A number of techniques to determine whether the inflation rate can be characterised by a non-linear process are used, namely, the Andrews-Quandt test, Andrews-Ploberger test and the Arranged autoregression test.[2] These tests will be used to determine whether there is a break in the inflation equation. The objective is not to determine the specific dates of exactly when the breakpoints occurred but rather to determine if the different tests converge and arrive at the same conclusion. The inflation equation used to test for the existence of a breakpoint suggests that the inflation rate depends on a constant and its twelve lags. All the tests in Table 19.1 suggest that there exist a breakpoint in the inflation series. This means that we can apply further techniques in the next section to determine whether there is a threshold or not (Table 25.1).

[2] These are used to determine structural breaks in time series.

Table 25.1 Break tests for the inflation series

Null hypothesis	Test used	*F*-value		Decision
Testing for a break in inflation	Andrews-Quandt Test	25.33	(0.06)**	Yes, there is a break in inflation
Testing for a break in inflation	Andrews-Ploberger Test	9.41	(0.05)**	Yes, there is a break in inflation
Testing for a break in inflation	Arranged autoregression test	3.97	(0.00)*	Yes, there is a break in inflation

Source: Authors' calculations

Note: The numbers in parentheses (.) denote the *p*-value. *Denote significance at 1 per cent; **denotes significance at 10 per cent

25.5 Where Does a Threshold for Inflation Occur?

This section uses the Hansen test, which trims the higher inflation values from influencing the threshold value. The accompanying trimmed percentages and the results of the tests for the thresholds are shown in Table 25.2.

The null hypothesis that there is no inflation threshold is rejected. This indicates that there is an inflation threshold. But as much as the Hansen test assists in determining the threshold value, it does not determine the differential effects on the ERPT below and above the established inflation threshold. Furthermore, it does not tell us whether the exchange rate effects should be estimated in a linear or nonlinear way. Hence, the next section determines which model is appropriate to estimate. As a consequence the functional model (i.e. linear or nonlinear) in which inflation has to be estimated or modelled has to be determined. If the tests chose a nonlinear model, the modelling technique can assume two functional forms, namely the logistic smooth transition autoregressive (LSTAR) model or the exponential smooth transition autoregressive (ESTAR) model.

Table 25.3 shows the various tests based on different lags of the transition variable, which determines the inflation threshold value. To ascertain the conclusions made, the modelling approach uses the current and past period of inflation or various lags of inflation as thresholds in the

Table 25.2 Testing existence of threshold in inflation rates

Null hypothesis	% of inflation values trimmed	Max *F*-test		Decision
*H*0: no threshold vs. *Ha*: Threshold	0	3.753	(0.002)*	Reject *Ho*
*H*0: no threshold vs. *Ha*: Threshold	10	3.753	(0.001)*	Reject *Ho*
*H*0: no threshold vs. *Ha*: Threshold	15	3.753	(0.003)*	Reject *Ho*
*H*0: no threshold vs. *Ha*: Threshold	20	3.565	(0.004)*	Reject *Ho*
*H*0: no threshold vs. *Ha*: Threshold	30	2.246	(0.058)**	Reject *Ho*

Source: Authors' calculations

Note: The numbers in parentheses (.) denote the *p*-value. *Denote significance at 1 per cent; **denotes significance at 10 per cent. The values shown in the second column correspond to when the inflation rate was not trimmed (i.e., 0 per cent) and when 10, 15, 20, and 30 per cent of inflation values were trimmed

estimation to determine between linear and nonlinear models. The results show that all the test statistics reject the linear model in favour of the nonlinear model. This means that inflation should be modelled in a nonlinear way.

Furthermore, the test statistics shown in Table 25.3 suggest the rejection of the ESTR model in favour of the LSTR model. Table 25.4 shows that the inflation threshold is estimated to occur at 4 per cent.

Fig. 25.1 shows the estimated transition function from a lower inflation regime to a higher inflation regime. This level is within the 3–6 per cent inflation target band as denoted by the light grey shaded area. It is visible that based on the estimated transition function, by the time inflation reaches 6 per cent we are already in higher inflation regime. A lower inflation regime refers to inflation rates in the region where the transition function is between zero and where this function cuts the inflation threshold. Higher inflation regime refers to inflation rates in the region where the transition function is between where this function cuts the inflation threshold and one as shown on left hand axis. The transition function also captures the transition from low ERPT to partially complete or full ERPT depending on inflation regimes.

Table 25.3 Threshold tests for inflation

Hypothesis	Lags of inflation	*F*-value		Decision
H0 : Linearity versus Ha : LSTAR or ESTAR	1	2.4607	(0.003)*	*Reject Ho*
H0 : Linearity versus Ha : LSTAR or ESTAR	2	2.5757	(0.0019)*	*Reject Ho*
H0 : Linearity versus Ha : LSTAR or ESTAR	5	3.3786	(0.0001)*	*Reject Ho*
H0 : Linearity versus Ha : LSTAR or ESTAR	8	1.4367	(0.0778)**	*Reject Ho*
H0 : Linearity versus Ha : LSTAR or ESTAR	11	1.4455	(0.0744)**	*Reject Ho*
Hypothesis	*F*-statistics	Decision		
Linearity	6.69 (0.0000)*	Reject linear model in favour of non-linearity		
H01	6.44 (0.0000)*	Reject absence of first power		
H02	5.84 (0.0001)*	Reject absence of second power		
H03	5.05 (0.0003)*	Reject absence of third power		
H12	6.63 (0.0000)*	Reject absence of interaction of second and third power		
		Final decision : Accept LSTR model and reject ESTR model		

Source: Authors' calculations

Note: The numbers in parentheses (.) denote the *p*-value. *Denote significance at 1 per cent; **denotes significance at 10 per cent. LSTAR denotes Logistic smooth transition autoregressive model and ESTAR denotes exponential smooth transition autoregressive model

Table 25.4 LSTAR model results

Variable	Coefficient	Standard error	Significance level
Linear part			
Constant	0.05	0.11	0.67
First lag period inflation rate	1.16	0.08	0.00*
Second lag period inflation rate	−0.20	0.08	0.01**
Foreign producer prices changes	0.28	0.04	0.00*
Third lag foreign producer prices changes	−0.23	0.04	0.00*
First lag period rand exchange changes	0.07	0.02	0.00*
Third lag period rand exchange changes	−0.05	0.02	0.00*
Non-linear part			
First lag period rand exchange changes	−0.05	0.02	0.00*
Third lag period rand exchange changes	0.06	0.02	0.00*
Transition slope	3.40	–	–
Threshold (%)	**4**	–	**0.00***

Source: Authors' calculations

Having established the threshold around which the low and high inflation regimes occur, the analysis tackles the question: What are the magnitudes of the R/US$ ERPT in the lower and higher inflation regimes? The estimations show that the magnitudes of the R/US$ ERPT to inflation when inflation is in the low and high regimes are 0.51 per cent and 0.54 per cent in the low and higher inflation regimes, respectively. The interpretation of the estimated magnitudes of the R/US $ ERPT is that in the long run, a 1 per cent R\US$ depreciation raises inflation by 0.54 percentage points in the high inflation regime compared to 0.51 percentage points in the low inflation regime.

How has the ERPT evolved over the inflation targeting period? The time-varying ERPT in Fig. 25.2 shows that periods of low inflation are accompanied by a lower degree of the ERPT to inflation. This evidence supports the view that there is a case for assessing time-varying effects over and above the fixed-coefficient of the ERPT. This conveys more infor-

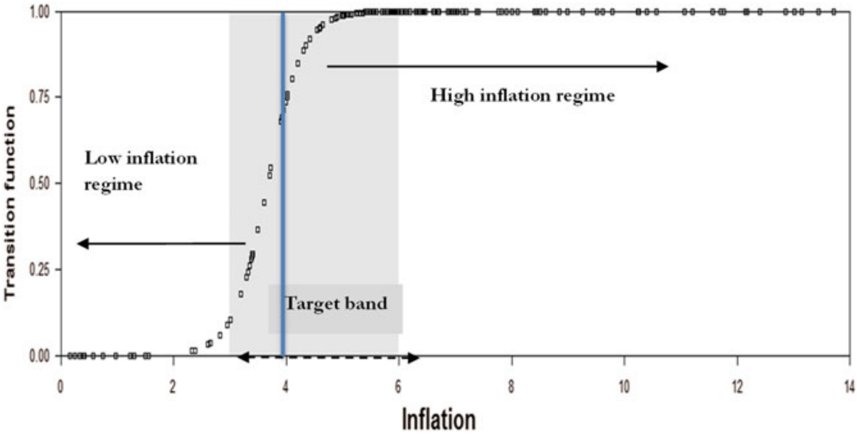

Fig. 25.1 The shape of the transition function for the inflation threshold. *Source*: Authors' calculations. *Note*: The vertical line in the shaded area denotes the estimated inflation threshold

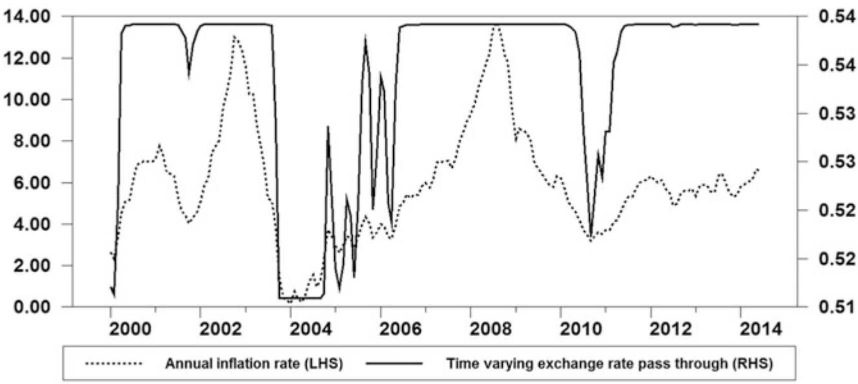

Fig. 25.2 Time varying exchange rate pass-through and inflation. *Source*: Authors' calculations

mation about possible changes in the transmission of the R/US$ exchange rate shocks and the prevailing inflation rate environment. Furthermore, evidence supports the view postulated by Taylor (2000) that a lower degree of the ERPT should not be taken as exogenous to the inflationary environment.

25.6 What Can Policymakers Infer from a Threshold VAR Model Framework?

This section estimates a bivariate threshold VAR model to enable us to demonstrate the threshold effects, identify periods when the R/US$ exchange rate depreciation shocks effects raise inflation and those periods when the effects are muted or insignificant. The estimated VAR model uses inflation, the R/US$ exchange rate changes. The foreign producer price is an exogenous variable. This approach allows for the estimation of a system where endogenous variables are simultaneously determined. The VAR model is estimated using two and four lags for the low and high inflation regimes, respectively. The model is estimated using 10,000 Monte Carlo draws. The inflation responses to rand depreciation shocks in the low and high inflation regimes are compared in Fig. 25.3(a) and (b).

Evidence indicates that the ERPT is high when the R/US$ exchange rate depreciates at the time when inflation exceeds the threshold level. This suggests that the R/US$ depreciation shock tends to be a big driver of inflation, particularly when inflation is above the inflation threshold value. What can possibly explain these differential responses? It is possible that the main reason may be due to the persistence of the R/US$ exchange rate depreciation shock, the inflation persistence and the R/US$ exchange rate changes in the low and high inflation regimes. Fig. 25.4 shows that the R/US$ shocks are persistently larger in the high inflation regime.

In the higher inflation regime, the depreciation shock is followed by a weaker exchange rate in next period. This finding is robust to different orderings. This means that the inflation regime not only matters for the R/US$ ERPT to inflation but also has an impact on the persistence of the R/US$ exchange rate depreciation shock. It is one source of the differential effects that has a significant impact on the ERPT to inflation.

What is the half-life (in months) of the depreciation shock between the high and low inflation regimes? The half-life measures the time taken by the depreciation shock to lose half of its initial value, in this case it is measured in months. Fig. 25.5(a) shows that the half-life is four months in the lower inflation regime relative to eight months in the high inflation regime. This is further evidence showing that the R/US$ exchange rate

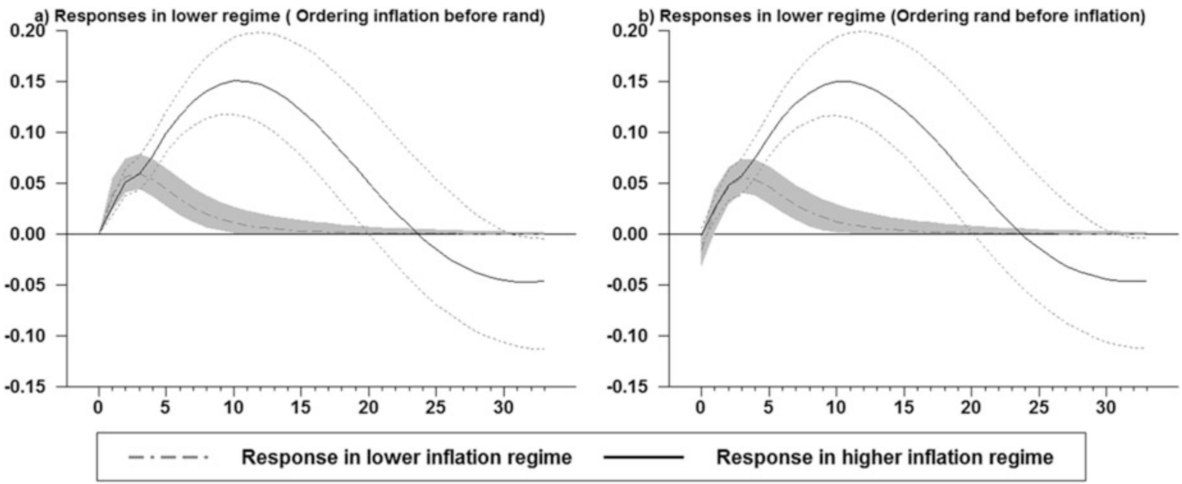

Fig. 25.3 Inflation responses to exchange rate depreciation shocks in different inflation regimes. *Source*: Authors' calculations. *Note*: The R/US$ exchange rate depreciation shocks have been normalised to 1 per cent

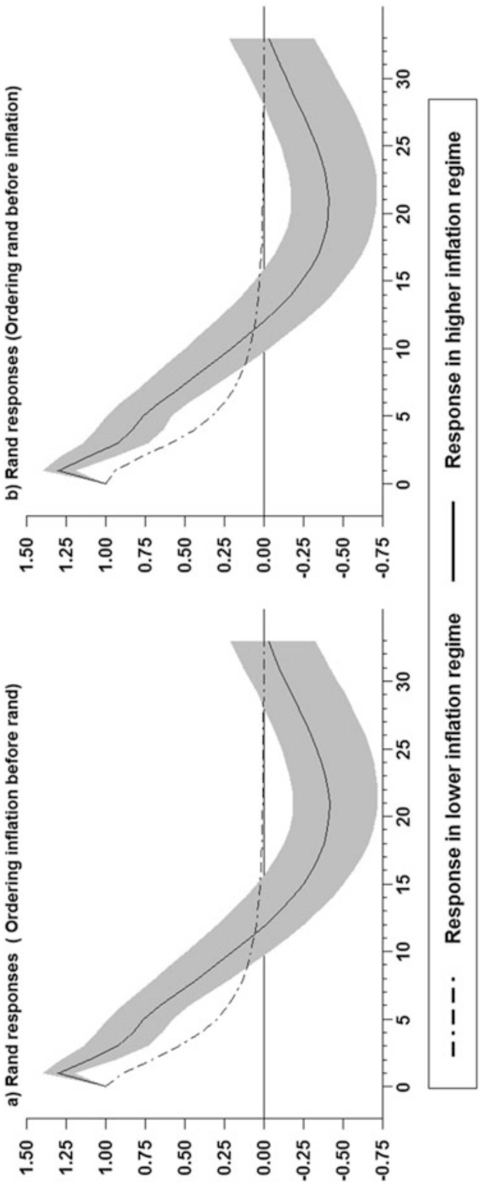

Fig. 25.4 The R/US$ exchange rate depreciation shocks in a low and high inflation regime. *Source*: Authors' calculations. *Note*: The R/US$ exchange rate depreciation shocks have been normalised to 1 per cent

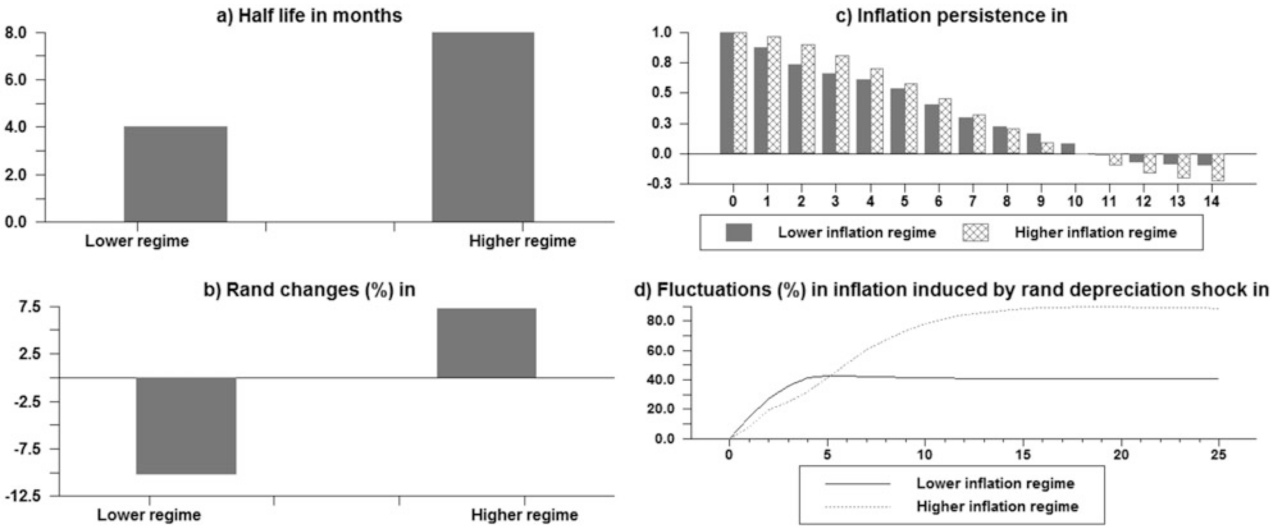

Fig. 25.5 The half-life of rand depreciation shocks in different inflation regimes. *Source*: Authors' calculations

depreciation shocks tend to be more persistent in the higher inflation regimes relative to lower inflation regimes.

Furthermore, Taylor (2000) argued that low and more stable inflation should be associated with less persistent inflation. Is that evident in the South African data? Evidence in Fig. 25.5(c) indicates that inflation decays very slowly across regimes. However, the inflation persistence tends to be slightly lower in the low inflation regime between lags one and seven. This is possibly another reason, which explains the differential R/US$ ERPT effects. In addition, the R/US$ exchange rate changes explain more fluctuations in inflation developments in the high inflation regime in Fig. 25.5(d). Fig. 25.5(b) indicates that the exchange rate appreciates in the lower regime and depreciates in the higher regime.

25.7 Conclusion and Policy Implications

This chapter established an inflation threshold that leads to a source of nonlinearity in the ERPT. Findings established that the ERPT is high when the R/US$ exchange rate depreciates at the time when inflation exceeds the threshold. This suggests that the R/US$ exchange rate depreciation is a significant driver of inflation, especially in episodes when inflation is above the threshold. Furthermore, findings conclude that the inflation regime has an impact on the persistence of the R/US$ exchange rate depreciation shock and inflation persistence. These are among the main sources of the differential effects affecting the ERPT to inflation. The half-life of the R/US $ exchange rate depreciation shocks in the higher inflation regime is double that in the lower inflation regime. The policy implication of the results is that the inflation threshold around 4 per cent carries economic and welfare benefits in many ways. The pass-through is lower below this threshold and the existing inflationary environment plays a central role.

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26

Sovereign Spreads and Non-linear Responses of Inflation to the R/US$ Exchange Rate Depreciation Shocks

Learning Objectives

- Establish the threshold at which sovereign spreads exert non-linear ERPT to inflation
- Distinguish between persistent and non-persistent exchange rate depreciation shocks and the impact on the ERPT to inflation in different sovereign spread regimes

26.1 Introduction

In the midst of a sharp decline in commodity prices, deteriorating fiscal position and expectations of credit ratings downgrades, South Africa experienced a significant negative shock to the already very fragile confidence. Recent literature on the European sovereign debt crisis has highlighted the interdependence between sovereign risk, macroeconomic activity, price and financial stability. For instance, Corsetti et al. (2009) show that sovereign risk amplifies the effects of negative cyclical shocks. Nogueira and Leon-ledesma (2011) establish that in periods when the economy faces a confidence crisis as measured by the widening sovereign

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spread, the exchange rate pass-through (ERPT) is expected to increase. Against this background, this chapter tests whether the changing macroeconomic conditions caused by the crisis of confidence via sovereign spreads affects the ERPT to inflation. Do widening sovereign spreads lead to a non-linear response of inflation to the rand/US dollar exchange rate depreciation shock? Does the sovereign spread amplify consumer price inflation responses to rand depreciation shocks?

Mishkin and Savatsano (2001) established that the ERPT is influenced by the credibility levels of macroeconomic policies. Taylor (2000) shows that low ERPT in a low inflation environment is due to monetary policy credibility gains. However, while the Taylor (2000) hypothesis has been widely tested and confirmed in many studies, the role of the sovereign spreads on the ERPT remains largely unexplored in South Africa, let alone using regime dependent impulse responses approaches. As a result, the policy implication of the important role of the interaction of market confidence and the stable macroeconomic environment in reducing the ERPT to inflation is still the missing link in South African academic and policy discussions. Furthermore, the effects of persistent and non-persistent rand depreciation shocks above and below the sovereign spread threshold on inflation dynamics are least understood.

The analysis in this chapter applies the Balke (2000) approach to determine the threshold and remove influence of outlying observations. This threshold method removes 15 per cent of large and small values at both ends of the sovereign spread time series. So the threshold is determined from the remaining 70 per cent of the observations. Thereafter, the regime dependent threshold VAR model is estimated, as opposed to the smooth transition model.

26.2 How Do Changes in the Sovereign Spreads Exert a Non-Linear Effect on the ERPT?

When the economy is experiencing a confidence crisis, it can happen that foreign firms decide to pass-through a larger proportion of exchange rate changes in view of the increased likelihood of a default by the importer.

The ERPT would be higher when exporters set their prices in their own currency (producer currency pricing); alternatively, exporting firms would absorb currency fluctuations within the mark-up by setting prices in the currency of the importing country (local currency pricing).

Evidence shows that the spread between South African (SA) and United States (US) ten-year bond yields have an impact on the rand/US dollar exchange rate and inflation Fig. 26.1. In addition, in Fig. 26.1 (b) and (d) the positive relationship and the slope suggest that the exchange rate is more sensitive than inflation to the spread movements. This means that periods of lower spread are associated with the strengthening of the exchange rate and lower inflation. Furthermore, in Fig. 26.1 (e) and (f) evidence shows that there is interdependence, which means that the spread has a direct and indirect impact on inflation via the exchange rate channel. Similarly, sovereign spreads benefit from low inflation and a stable exchange rate to the extent that they reflect macroeconomic stability.

Moreover, evidence suggests that the credit default swap (CDS) spread is not only positively related with the exchange rate but with inflation as well. Furthermore, commodity prices declining have implications for government finances, the corporate sector and macroeconomic performance. In line with findings for other emerging market economies, evidence indicates a negative correlation between commodity prices and spreads. The implication is that as commodity prices decline the cost of issuing debt increases. It is in this context that elevated sovereign spreads amplify adverse shocks that ultimately impact the exchange rate. Hence, this shows the need to examine the role of the sovereign spread threshold on the ERPT to inflation.

26.3 The Transmission of Sovereign Risk to the Banking Sector

Corsetti et al. (2009) show that through the sovereign risk channel, sovereign risk can induce a rise to belief-driven equilibria. A pessimistic shift in expectations can lead to heightened sovereign risk premium and spill over to higher private funding and borrowing costs resulting in a

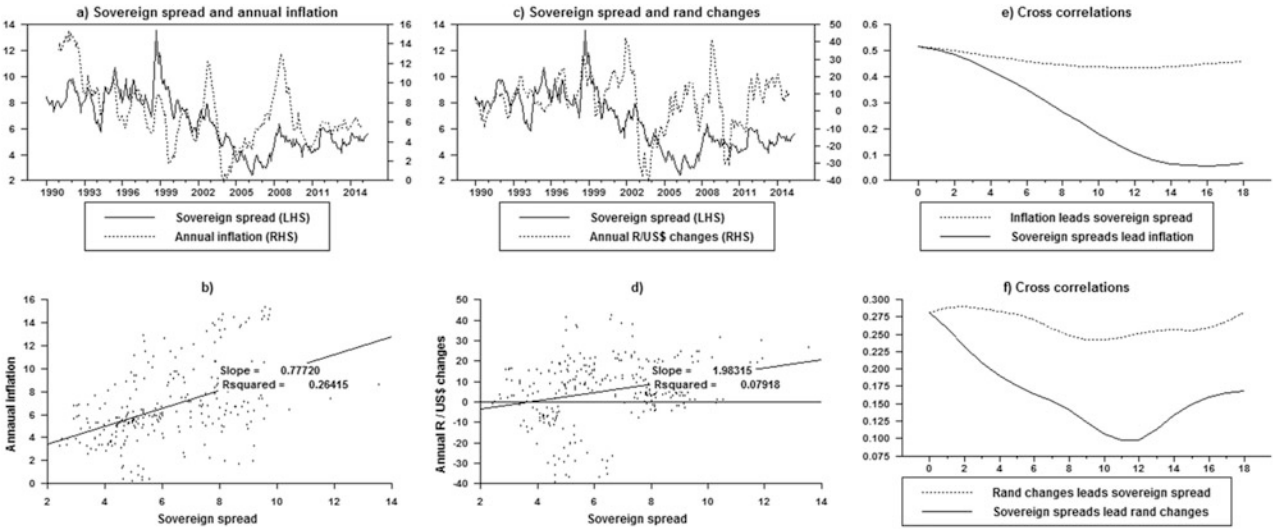

Fig. 26.1 Inflation responses to rand depreciation shock and the role of sovereign spreads. (a) Sovereign spread and annual inflation; (c) Sovereign spreads and rand changes; (e) Cross correlations; (f) Cross correlations. *Source*: Authors' calculations

slowdown in economic activity. Gennaioli et al. (2015) show that banks hold a healthy portion of their assets in sovereign debt for regulatory and other reasons related to investment decisions. The regulatory reforms under Basel III require banks to permanently hold higher liquidity buffers often in the form of high-quality government debt.[1]

In South Africa, banks hold roughly an equal proportion of liquid assets in the form of Treasury bills (T-bills) and government bonds. Furthermore, banks hold 80 per cent of all T-bills issued. The break-down of T-bills by maturity shows that the issuance of the 91-day rate has declined and is currently surpassed by the 273 day and 364-day rates. The flipside to this is that securities held by banks represent credit to government. Literature shows the important role that public debt held by the domestic financial sector plays in creating a bank–sovereign link that amplifies adverse shocks in the presence of fiscal stress. In the context of the euro area sovereign debt crisis, Engler and Steffen (2014) found that it is the domestic bank lending rate that turned out to be positively correlated with sovereign default risk due to the bank–sovereign link which unfolds, among others factors, via the collateral channel.

Furthermore, Correa and Sapriza (2014) argue that the euro area sovereign crisis showed that the close interdependence between sovereign risk, financial stability and economic activity increased the fragility of banks in countries with an elevated risk premium on government debt. The interest rates in the public and the private sectors started to be highly correlated in countries under fiscal stress. Higher funding costs for banks translated into higher interest rates on loans to the non-financial sector. Therefore, the implications of adverse shocks and widening of sovereign credit are wider than the exchange rate and the pass-through to inflation. Heinz and Sun (2014) show that the deterioration of the quality of underlying collateral assets affects bank funding costs, the bank lending and credit channel, and can exert further depressing effects on aggregate output and demand.

[1] The BIS defines Basel III as a comprehensive set of reform measures, developed by the Basel Committee on Banking Supervision, to strengthen the regulation, supervision and risk management of the banking sector. For further details see http://www.bis.org/bcbs/basel3.htm.

26.4 What Would the Inflation Reaction to Rand Depreciation Shock Be in the Absence of Sovereign Spreads?

The empirical analysis begins by examining the extent to which inflation responses are influenced by sovereign spreads. To determine this effect a three-variable VAR, which includes consumer price inflation, rand per US dollar changes and sovereign spreads, is estimated. The model is estimated using two lags selected by Akaike Information Criterion (AIC) and 10,000 Monte Carlo draws. The counterfactual impulse response refers to the inflation response to rand depreciation when the sovereign spread is shut off in the model. The gap between the actual and counterfactual denotes the magnitudes of amplification due to sovereign spreads.

Fig. 26.2(a) shows that rand depreciation shocks increase inflation but the actual responses exceed the counterfactual in the first 20 months following the shock. This shows that sovereign spreads amplify the inflation responses to rand depreciation shocks in Fig 26.2(a) and (b) shows that sovereign spreads increase following a rand depreciation shock.

Does the persistence of rand depreciation shock matter for sovereign spread responses to rand depreciations shock? Fig. 26.2(c) shows the two scenarios depicting the non-persistent and persistent rand depreciation shock. The persistent rand depreciation leads to a persistent rise in sovereign spreads: in Fig. 26.2(d) this reaction is in contrast to the effect of non-persistent shock.

26.5 Does the Sovereign Spread Induce Differential Inflation Responses to Rand Depreciations Shocks?

This section uses the Balke (2000) approach to determine the threshold of sovereign spreads. The estimated VAR model includes rand changes, the sovereign spread, inflation and the repo rate. The Monthly (M) data spans the period 1990M1 to 2015M11 and the estimated VAR uses two lags. The model is estimated with 10,000 Monte Carlo draws. The rand/US

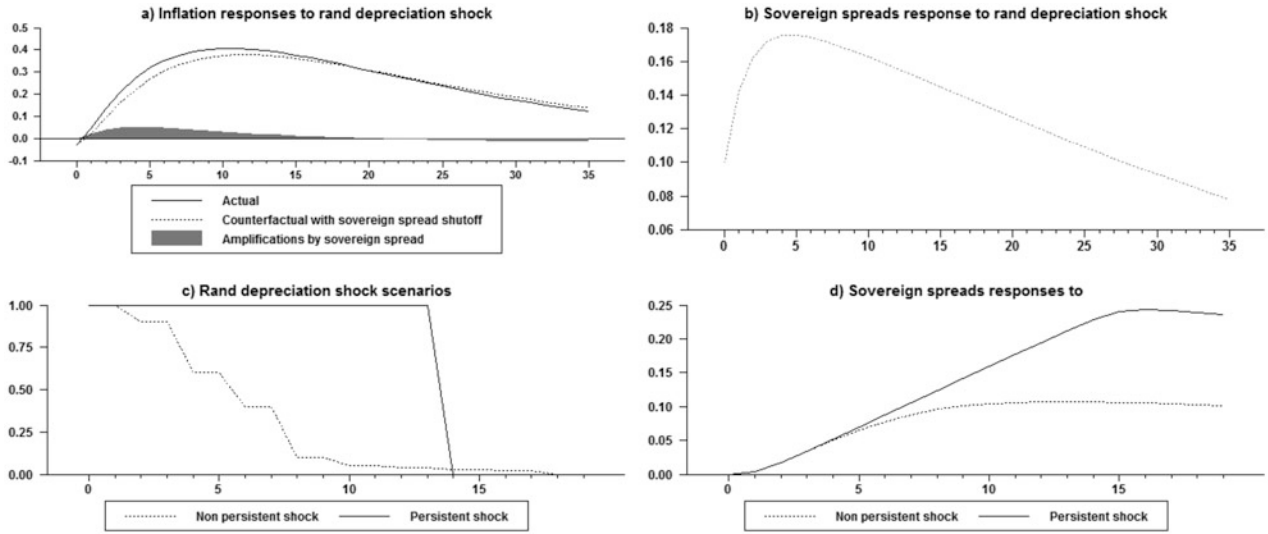

Fig. 26.2 Disentangling the effects of persistent versus non persistent shocks. *Source*: Authors' calculations

dollar exchange rate depreciation shocks refer to an unexpected 1 per cent rand weakening. The Balke (2000) approach establishes a threshold of 7.3 per cent in the sovereign spread. This threshold is used to estimate the regime dependent impulse reponses. The analysis starts by examining whether there is evidence that the ERPT is high in periods of a high sovereign spreads regime than in a low sovereign spread regime.

This means that we can expect that the transmission of the exchange rate changes to inflation in periods of macroeconomic instability and sovereign distress to be more pronounced than in periods of good macroeconomic conditions. Evidence in Fig. 26.3(a) indicates that the sovereign spread threshold leads to different inflation responses to rand depreciation shocks. Inflation is more responsive in the high sovereign spread regime than in the low regime.

What could explain the large inflation increase in first few months in the high sovereign spread regime relative to the low sovereign spread regime? The explanation lies in the variables within the model. The response of the rand/US dollar exchange rate to the depreciations shock in Fig. 26.3(b) is larger in first two months following the shocks in the high sovereign spread regime than in the low regime. However, the quick decline suggests that the rand trajectory is less persistent. Overall, this evidence supports that the ERPT is high in the high sovereign spreads regime.

This means that sovereign spreads do play a role in the pass-through of the exchange rate to inflation. How is it possible? According to Cheikh and Rault (2015) in periods of macroeconomic instability it is possible that foreign firms can decide to pass-through a larger portion of their cost changes in view of the increased likelihood of default from importers. Under strained macroeconomic conditions economic agents have no incentive to absorb exchange rate fluctuation in their profit margins. This leads to a high degree of the exchange rate pass-through. Furthermore, producers might shift their currencies for invoicing transactions.

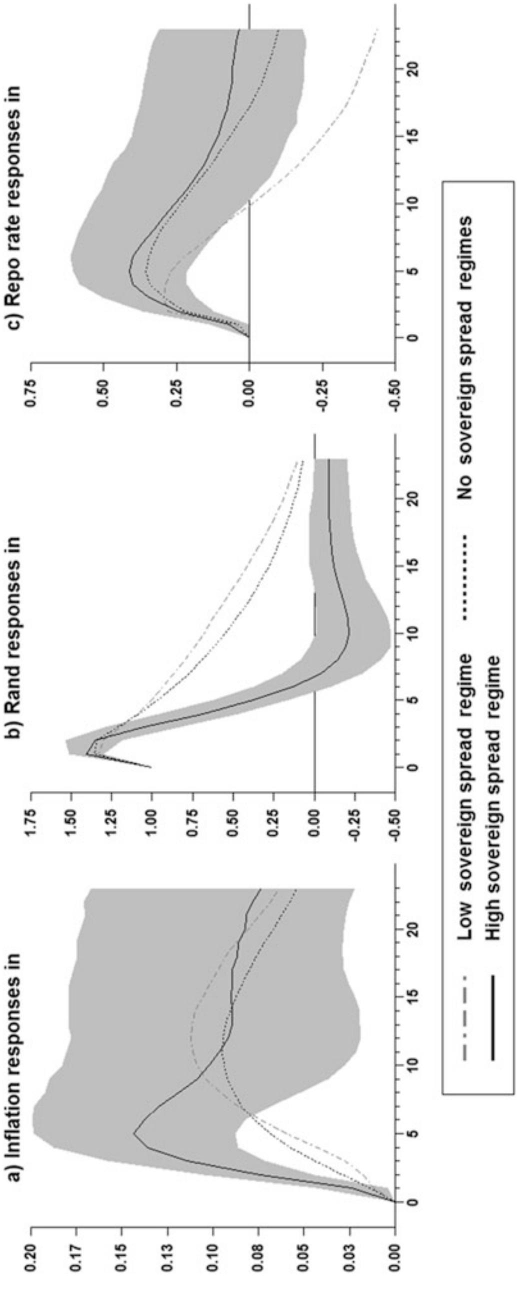

Fig. 26.3 The responses of inflation in low and high sovereign spreads regime to rand depreciation shocks. *Source*: Authors' calculations

26.6 Do the Inflation Responses Depend on Whether the Rand Depreciation shock is Persistent or Non-persistent?

The analysis is cognisant that monetary policy makers do not target sovereign spreads and is therefore not constrained by any level of sovereign spreads. Nonetheless, the sovereign spread matters to the extent that it destabilises attaining the desired objectives of price and financial stability. Hence, this requires assessing evidence of the repo rate movements due to positive inflation shocks in the low and high sovereign spread regimes. Evidence shows that monetary policy raises rates to curb inflation. The magnitudes of change are larger to positive inflation shocks in the high sovereign spread regime. This suggests that the adjustment of the policy rate is slightly aggressive when inflation rises in the higher sovereign spread regime due to the rand/US dollar depreciation shock. Furthermore, the responses of inflation to persistent and non-persistent rand/US dollar exchange rate depreciation shocks in the low and high sovereign spreads regimes are shown in Fig. 26.4. These show that inflation responds more to highly persistent exchange rate shocks in the absence of regimes and low and high sovereign spread regimes.

The impulse responses arrive at a similar conclusion, that sovereign spreads matter for the inflation responses. Inflation increases more in the high sovereign spread regime in Fig. 26.5. This indicates that sovereign spreads and their regimes matter for the responses of inflation to rand/US dollar exchange rate depreciation shocks.

Inflation rises to both persistent and non-persistent shocks. But the increases are larger to persistent rand depreciation shocks. This shows the importance of distinguishing between persistent and non-persistent rand depreciation shocks and the role of sovereign spreads for appropriate monetary policy responses.

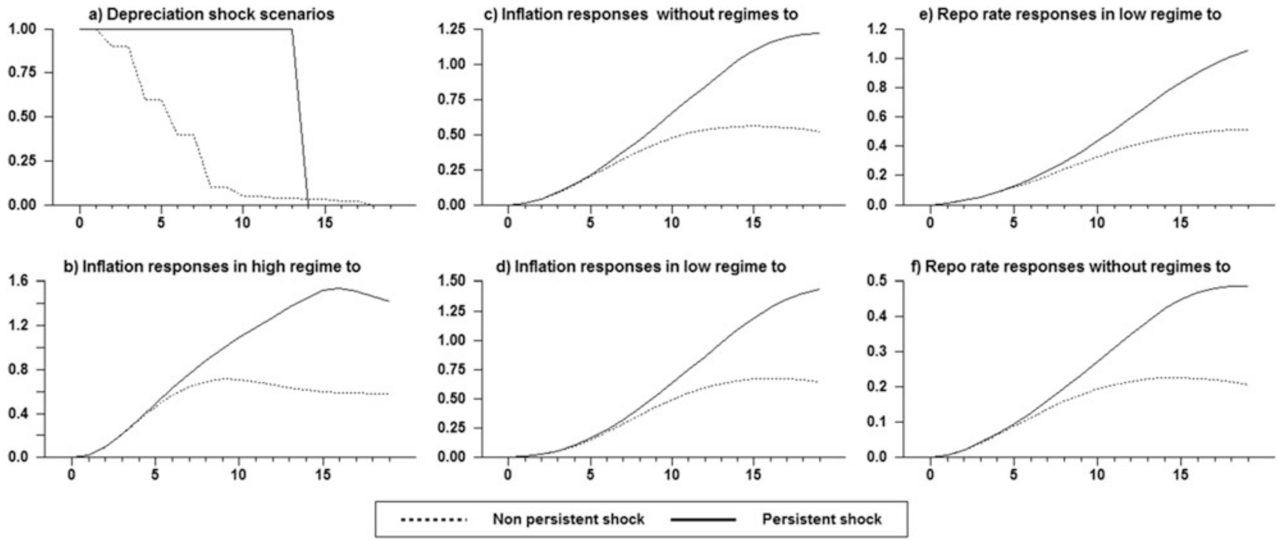

Fig. 26.4 Rand-US dollar depreciation scenarios and inflation responses to rand depreciation shocks. *Source*: Authors' calculations

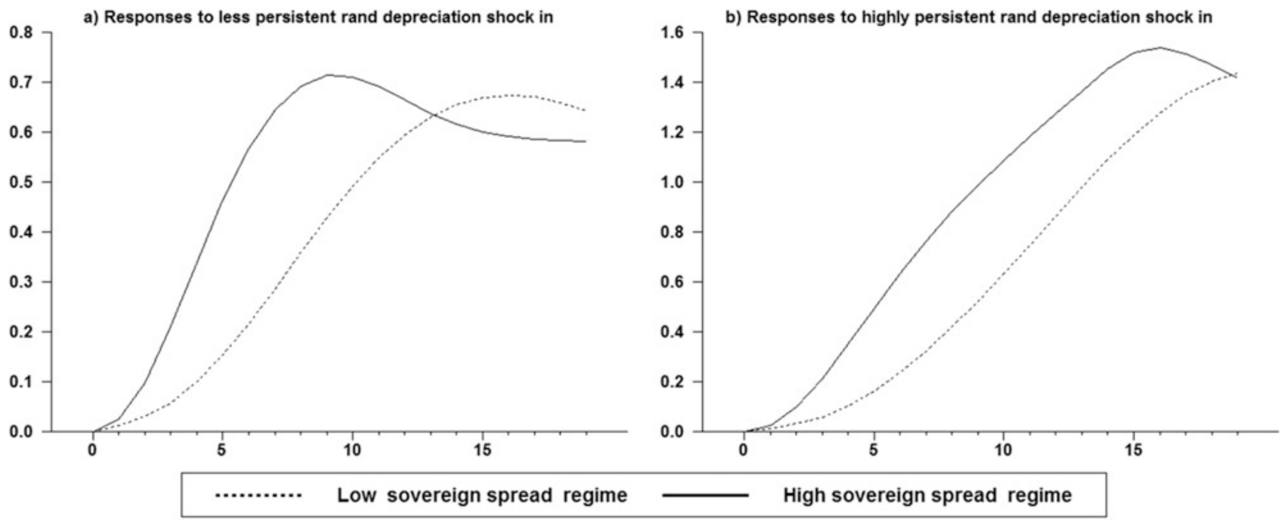

Fig. 26.5 Inflation responses to persistent and non-persistent rand depreciation shock. *Source*: Authors' calculations

26.7 What Does the Regression Approach Suggest?

As a robustness test of earlier results a dummy variable approach is used to capture the effects of sovereign spread exceeding the estimated threshold of 7.3 per cent. A dummy variable is created and is interacted with the rand/US dollar exchange rate changes to determine if the responses increase when sovereign risk enters a high regime. Table 26.1 shows that the rand/US dollar changes have a positive effect on the inflation rate. But the response is magnified after isolating the effect of the high sovereign spread regime.

The results show that the long run pass-through increases after focusing on the effect of rand/US dollar in the higher sovereign spread regime in models 1 and 2. Overall, all the approaches used in this analysis arrive at the same conclusion that the inflation response to exchange rate depreciation is more heightened in high sovereign spread regime than in low regimes.

Table 26.1 Results from regression equation

	Baseline model		Model 1		Model 2[a]	
Variable	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Rand changes	0.013	0.00[b]	0.009	0.00[b]	0.010	0.00[b]
Spread threshold × Rand changes			**0.013**	**0.016**	**0.015**	**0.02**
Long-run	0.329	0.01[b]	0.552	0.000[b]	0.578	0.00[b]

[a]Means model estimated with instruments
[b]Means Significance at 5 per cent
Note: The main variables of interest in the analysis are displayed in bold
Source: Authors' calculations

26.8 Conclusion and Policy Implications

This chapter investigated the role of sovereign credit spreads on the ERPT by estimating a threshold at which the sovereign credit spreads exert non-linear effects on the ERPT. Evidence suggests that inflation increases more due to persistent rand/US dollar depreciation shocks in the high sovereign spread regime. This means that sovereign spreads do play a role in the pass-through of the exchange rate to inflation. The evidence implies that the simultaneous occurrence of persistent exchange rate shocks in heightened sovereign spreads regime calls for a different monetary policy response relative to the low spread regime. Monetary policy is tightened more in the high sovereign spread regime relative to the small tightening in the low spread regime to dampen inflationary pressures from the exchange rate depreciation shocks.

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27

Do Credit Regimes Play a Role in the Pass-Through of the Exchange Rate Depreciation Shocks to Inflation?

Learning Objectives

- Show the differential effects of the credit threshold on the ERPT to inflation
- Show the role of GDP growth on the ERPT post 2009Q1 subject to credit regimes

27.1 Introduction

Do credit regimes play any meaningful role in the pass-through of the exchange rate depreciation shocks to inflation? Does GDP growth impact the exchange rate pass-through (ERPT) to inflation and is this dependent on credit regimes? It is possible that macroprudential and financial regulatory tools aimed at curbing the supply and demand for credit while pursuing financial stability objective may indirectly spill over to the price stability objectives. Koo and Rogoff put the role of credit growth, balance sheets and the hangover from the super-cycle of imprudent debt accumulation as key factors underlying the sluggish growth post the financial crisis. These authors argue that this period of subpar growth requires

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painful deleveraging and an effective macroprudential regulatory framework to prevent a repeat performance.

This chapter links credit growth to the ERPT to inflation. A possible indirect link exists for role of macroprudential and monetary policy. It is possible that credit growth regimes impact the pass-through of the exchange rate depreciation shocks to inflation.

27.2 Is There a Direct Link Between Credit Extension and Exchange Rate Movements?

The theory by Caves et al. (1996) shows that in a floating exchange rate regime, reserves accumulation and foreign currency interventions if not sterilised increase the money supply and credit extension with ultimate inflationary effects. In addition, Copeland (2005) shows that money supply can be decomposed into an identity made up of foreign exchange reserves and credit as in Eq. (27.1).

$$Money\ supply = Foreign\ exchange\ reserves + domestic\ credit \tag{27.1}$$

The identity shows that domestic credit generated by the banking system plus the value of the country's foreign currency reserves is equivalent to money supply. Depending on the assumptions of no and high capital mobility in Fig. 27.1(a) and (b), credit extension leads to a balance of payments deficit and different sizes of exchange rate depreciation. Notice that within this model, it is not increased credit extension per se that results in the depreciation of the exchange rate. The depreciation is induced by the balance of payments deficit.

Fig. 27.1 shows the theoretical link between credit extension and exchange rate movements. However, the main purpose of this investigation is to establish a threshold of growth in credit that leads to the non-linear effects of the rand depreciation shocks to inflation. This kind of analysis helps in putting perspective on credit growth thresholds not only from the financial stability view but the critical role it plays in

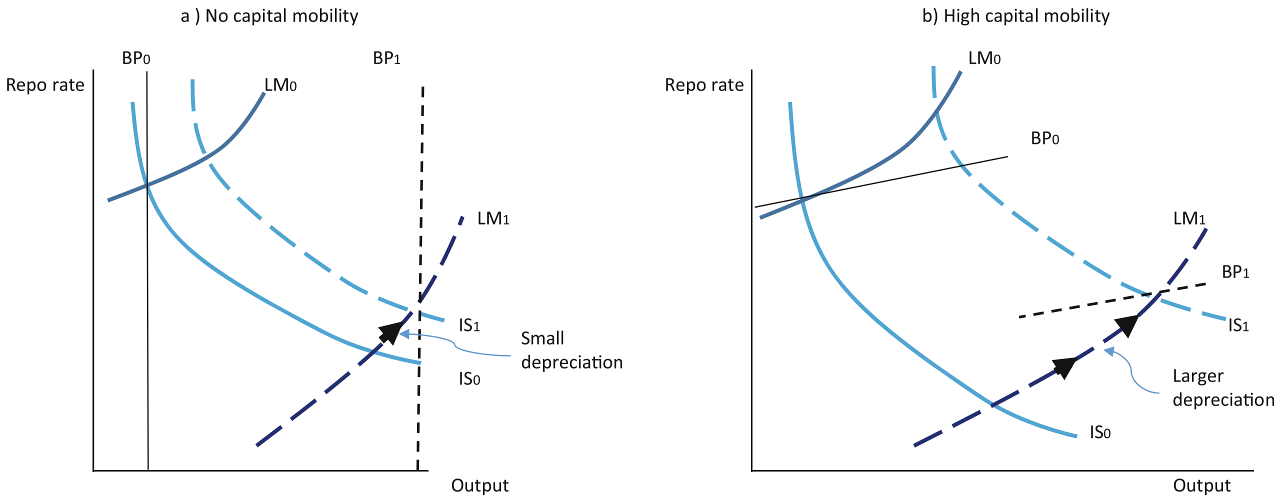

Fig. 27.1 Link between credit extension and exchange rate depreciation. *Source*: Authors' drawings and adapted from Caves et al (1996). *Note*: BP refers to Balance of Payments

demand-driven inflationary pressures. This approach also contributes to the ongoing policy endeavours which may integrate financial stability considerations in the conduct of monetary policy. In addition, the chapter sheds new insights on the role that GDP growth dynamics play in the ERPT to inflation post 2009Q1.

27.3 Is There a Positive Link Between Credit Growth and the R/US$ Annual Changes?

Evidence indicates a positive relationship between credit growth and the R/US$ annual changes. The rand increase in response to positive credit growth shocks. How do the dynamics between credit growth and rand changes compare between pre- and post-inflation targeting? Are there meaningful differences? As a consequence, the analysis further distinguishes between positive effects of credit shocks on the rand between the pre- and post-inflation targeting framework. The analysis uses quarterly (Q) data that spans 1990Q1 to 2015Q2 for credit growth, rand changes and inflation. The bivariate VAR model is estimated using the credit growth and rand changes. The model estimated using 10 000 Monte Carlo draws. Fig. 27.2(a) shows that positive credit shocks lead to rand depreciation in the first year followed by a slight appreciation and the return to pre-shocks pre-inflation targeting.

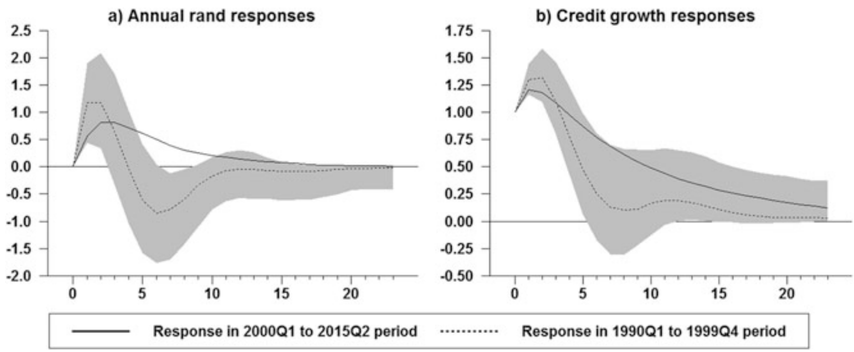

Fig. 27.2 Rand reaction to positive credit growth shocks between pre- and post-inflation targeting period. *Source*: Authors' calculations

In contrast the rand depreciates and returns to pre-shock level in the inflation targeting period. Fig. 27.2(b) shows that trajectories of credit growth are slightly more persistent in the inflation targeting regime than in pre-inflation targeting.

27.4 Is Growth in Credit a Linear or Non-Linear Process?

This question is examined by applying three techniques which assess different non-linearity aspects. These include the existence of a break point, the threshold and non-linearity in credit growth dynamics. The results in Table 27.1 reject the null of no break point in favour of the existence of a break point in the growth of credit series.

This evidence suggests that growth in credit should be modelled in non-linear way. The empirical analysis uses the threshold of 9.5 per cent for credit growth determined by the Balke (2000) approach.

27.5 Are There Non-linear Reactions of Inflation to Rand Depreciation Shock in Different Credit Regimes?

This section establishes the extent to which the pass-through of rand depreciation to inflation varies according to credit regimes. The effects are then compared to those where there are no credit regimes. Yes, evidence in Fig. 27.3 shows the differences, meaning that the rand depreciation

Table 27.1 Non-linearity tests for credit growth

Method used	Null hypothesis	F-test	p-value	Decision
Test (Tsay, 1998)	No break point	11.03	0.0[a]	Exist a break point
Hansen threshold	No threshold	7.43	0.0[a]	Exist a threshold
Smooth transition autoregressions	Linearity	18.95	0.0[a]	Exist non linearity

[a]Implies significant at 1 per cent
Source: Authors' calculations

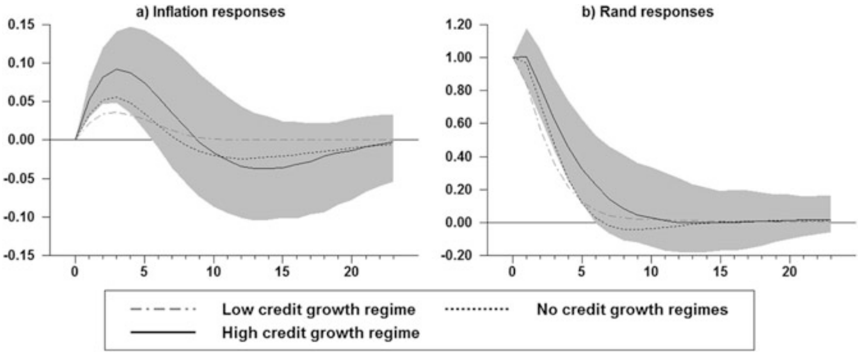

Fig. 27.3 Inflation and rand responses to rand depreciation shocks in different credit regimes. *Source*: Authors' calculations

shocks increase inflation more in the high credit regime within a year. The peak response of the inflation rate in the high credit regime is more than double in the low regime.

Furthermore, evidence in Fig. 27.3(b) shows that there are non-linearity effects induced by rand depreciation shocks in different credit regimes as it explains a higher proportion of inflation movements in the high credit regime. In the long-run, the rand depreciation shocks induce nearly double the size of fluctuations in inflation in high credit regimes than in lower regimes. Therefore, the evidence indicates that credit regimes matter in the fluctuations of the inflation rate to rand depreciation shocks.

27.6 What Does a Threshold Linear Model Suggest About the Role of Credit Regimes in the ERPT?

A third approach based on a threshold linear regression is applied as a robustness check of the earlier findings. This involves determining a threshold dummy, which is defined by a dummy variable that equals one when credit growth exceeds 9.5 per cent and zero otherwise. To determine the impact below and above the credit threshold, we interact the credit threshold dummy and the annual exchange rate (*Credit threshold* Rand changes*).

$$Inflation = f(lagged\ inflation\ rate, Annual\ rand\ changes\ and\ Credit\ threshold{*}Rand\ changes)$$

The instrumental variables approach is adopted to deal with the problem of feedback effects or endogeneity between rand changes and inflation in linear regressions. This is done in Model 2 in Table 27.2.

Across all models in Table 27.2 the results indicate that inflation is driven by high inflation persistence. The persistence magnitudes are in the range between 0.84 and 0.97 as measured by impact of lagged inflation rate. The estimates for the long-run ERPT range between 0.255 and 0.343, suggesting incomplete ERPT. The rand depreciation (annual rand changes) in the baseline model has a significant effect on inflation but this disappears in Models 1 and 2 after isolating the effects of credit regimes. In Models 1 and 2, controlling for endogeneity or not, evidence indicates that credit regime plays a significant role and the exchange rate has a bigger impact on inflation in the higher credit growth regime.

Furthermore, the robustness analysis of the results using the modified version of Pentecôte and Rondeau (2015) and Cerra and Saxena (2008) approaches in Eqs. (27.2) and (27.3) is conducted.

$$Inflation_t = constant + \sum_{i=1}^{4} \beta_i inflation_{t-i} + \sum_{i=0}^{4} q_i Creditabove9.5 * Rand_{t-i} + \varepsilon_t \tag{27.2}$$

$$Inflation_t = constant + \sum_{i=1}^{4} w_i inflation_{t-i} + \sum_{i=0}^{4} k_i Creditbelow9.5 * Rand_{t-i} + \varepsilon_t \tag{27.3}$$

where, ε_t denotes an error term and *Creditabove* 9.5 * *Rand* denotes a dummy that equals the value of the exchange rate when the credit

Table 27.2 Results of linear regressions models

Dependent variable: Inflation						
	Baseline model (GMM)		Model 1		Model 2 (GMM)	
Variable	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value
Constant	0.752	0.004*	0.469	0.06***	0.769	0.002*
Inflation$_{t-1}$	0.844	0.000*	0.897	0.00*	0.840	0.000*
Annual Rand changes	**0.040**	**0.000***	**0.008**	**0.36**	**0.012**	**0.443**
Credit threshold* Rand changes	–	–	0.027	0.06***	0.043	0.087***
Long run pass-through[a]	**0.255**	**0.004***	**0.343**	**0.00***	**0.343**	**0.048****
Over identification test	**5.847**	**0.321**	–	–	**3.2093**	**0.523**

Source: SARB and authors' calculations

Note: [a]Long run pass-through of one per cent rand depreciation. *, ** and *** refers to 1, 5 and 10 per cent significance levels. The instruments include a constant, inflation$_{t-2}$, inflation$_{t-3}$, Rand changes$_{t-1}$, rand changes$_{t-2}$, threshcpi$_{t-1}$, threshcpi$_{t-2}$ and threshcpi$_{t-3}$. The main variables of interest in the analysis are displayed in bold growth exceeds threshold of 9.5 per cent and zero otherwise. *Creditbelow* 9.5 * *Rand* denotes a dummy that equals the value of the exchange rate when the credit growth is below threshold of 9.5 per cent and zero otherwise. The shocks we examine are for the dummy variables. Thereafter derive the impulses responses of inflation to these dummy shocks. Evidence shows that inflation increases more due to the rand depreciation shocks in the high credit regime.

Did the period 2009Q1 to 2015Q2 impact the transmission of rand depreciation shock to inflation? The analysis adds a dummy $2009Q1_{t-i}$ in Eq. (27.2). This dummy equals one for the period beginning in 2009Q1 to end of the sample and zero otherwise.

$$Inflation_t = constant + \sum_{i=1}^{4} z_i inflation_{t-i} + \sum_{i=0}^{4} d_i 2009Q1_{t-i} + \sum_{i=0}^{4} q_i Creditabove9.5*Rand_{t-i} + \varepsilon_t \tag{27.4}$$

To determine the counterfactual inflation responses, the estimated coefficients of $2009\mathrm{Q}1_{\mathrm{t}-\mathrm{i}}$ are set to zero. The actual and counterfactual inflation impulse responses in Fig. 27.4(b) show that the rand depreciation shock did not increase inflation post 2009Q1 more than when this period is shut off in the model. Fig. 27.4(c) shows that the economic developments since 2009Q1 lowered the ERPT of rand depreciation shock to inflation in high credit regimes.

Furthermore, Fig. 27.4(d) GDP growth played a significant role in transmitting the rand depreciation shock effects into inflation dynamics post-2009Q1. The analysis of the effects of GDP growth dynamics beginning in 2009Q4 on the ERPT of rand depreciation shock to inflation is conducted via Eq. (27.5). The *GDP_2009Q4* is the dummy which equals value of GDP growth since the beginning of 2009Q4 and zero otherwise. The *credit_dummy* refers to dummy which equals one when credit is below threshold and zero otherwise.

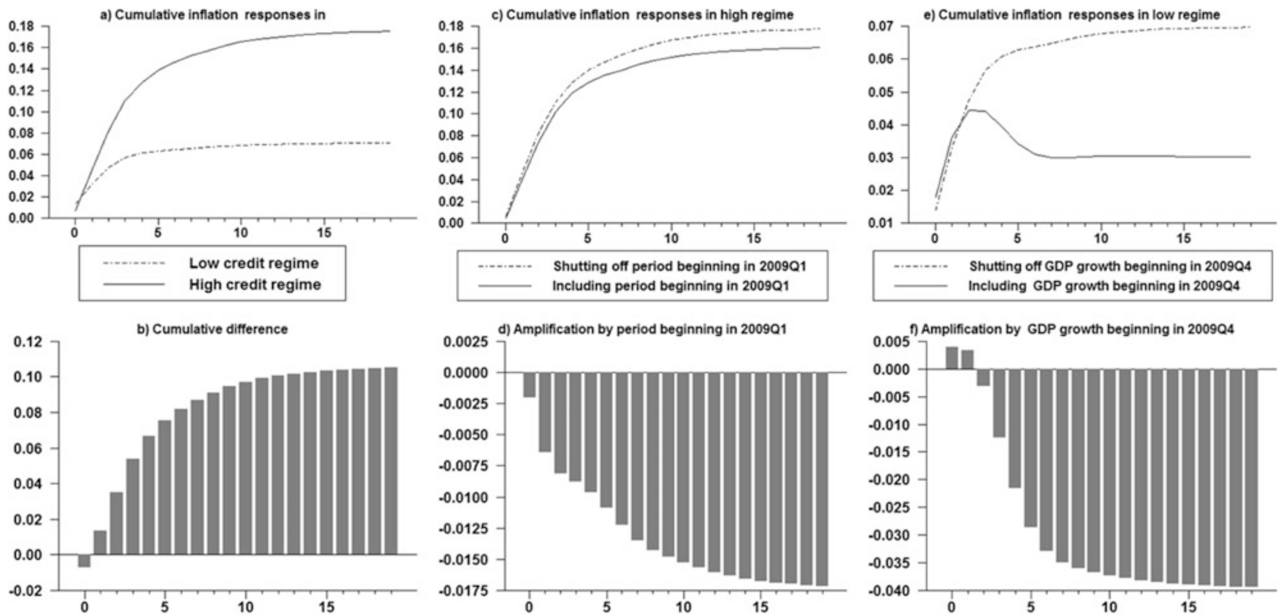

Fig. 27.4 Inflation responses to rand depreciation shock according to credit regime and role of post 2009Q1 period.
Source: Authors' calculations

$$Inflation_t = constant + \sum_{i=1}^{4} h_i inflation_{t-i} + \sum_{i=0}^{4} s_i GDP\_2009Q4_{t-i}$$
$$+ \sum_{i=0}^{4} t_i Credit\_Dummy * Rand_{t-i} + \varepsilon_t \qquad (27.5)$$

Evidence shows that GDP growth developments beginning in 2009Q4 reduced the pass-through of rand depreciation to inflation in Fig. 27.4(f). Similarly, the inflation rate is much lower when taking into account the role of credit. This means that GDP growth development beginning in 2009Q4 reduced the pass-through of rand depreciation shocks to inflation irrespective of whether credit growth is in a higher or lower regime.

27.7 What Would the Inflation Rate Be in the Absence of Rand Dynamics in 2009?

This last section applies a historical decomposition approach to determine the influence of rand dynamics on inflation. The rand depreciation shocks contributions can give an indication of what the exchange rate appreciation and depreciations episodes did to the evolution of inflation. Fig. 27.5 shows that rand appreciation between 2009 and 2011 lowered inflation more than it would have in its absence. In contrast, the rand depreciation uplifted inflation since the beginning of 2012. In the absence of the rand depreciation shocks, inflation would be within the target band for most periods since 2012.

Similarly, a historical decomposition of inflation purged of credit contributions suggests that inflation would be higher and breached the upper part of the target for most of the periods between 2011 and 2014. The implication is that the current low credit growth regime helped in containing much of the demand-driven inflationary pressures.

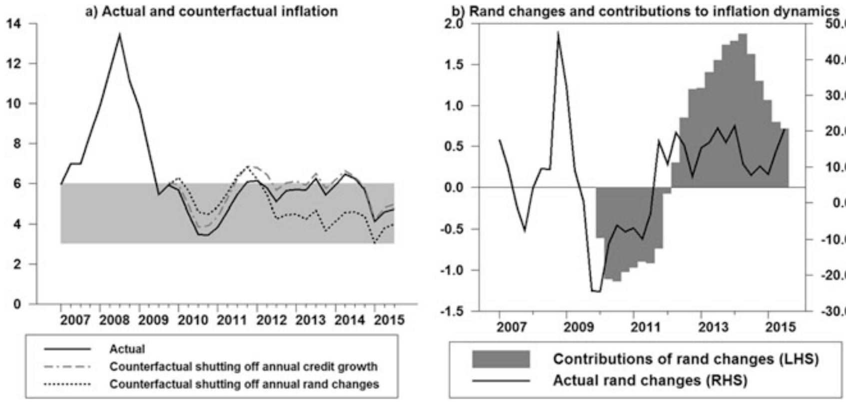

Fig. 27.5 Rand changes and contributions to inflation rate dynamics. *Source*: Authors' calculations

27.8 Conclusion and Policy Implications

This chapter contributes to the debate on the ERPT to inflation by considering the role of credit growth regimes. Regime-dependent VAR and linear threshold approaches were used to determine the extent to which credit regimes impact the pass-through of rand depreciation shocks to inflation. Evidence from the regime-dependent VAR approach and threshold linear regression establishes that rand depreciation shock increases inflation in the high credit regime. Furthermore, the rand depreciation shocks explain more variation in inflation in the high credit regime than in the lower regime. Overall, evidence confirms that credit regimes matter, and influence the effect of rand depreciation shock on the inflation rate.

The policy implication is that credit growth below the threshold of 9.5 per cent assists in containing demand-driven inflationary pressures and thus plays a role in neutralising the degree of the ERPT of the rand depreciation shocks to inflation. Within the context of the interaction of price and financial stability, it seems to be the case that such a threshold can serve as one of the benchmarks to assess the build-up of potential threats to both policy objectives. In a policy perspective, it can assist within the financial regulatory framework as one of the reference points to activate tools aimed at restricting credit-driven demand pressures and overheating, whilst assisting in lowering the degree of the ERPT to inflation in the process.

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Part V

Inflation Expectations and Monetary Policy

28

The Propagating Effects of Inflation Risk Factors and the Implications for the Inflation Outlook

Learning Objectives

- Demonstrate the propagation effects of risk factors to inflation in the short run
- Show inflation trajectories can be different depending on the abilities of risk factors to magnify or stifle inflation response

28.1 Introduction

Risk factors to the inflation outlook are important and it is not only the adverse shocks to these variables that matters. For instance, there are shocks to the exchange rate, eight-year breakeven inflation rates, commodity prices and food prices, and oil prices that can move these variables in different directions and can net out some of the extreme values along production value chains. Hence, the manner in which these variables propagate the responses of inflation to inflationary shocks matters. This chapter shows the prevalence of the propagating abilities of different shocks. How do key inflation risk factors propagate (magnify) inflation response to inflationary shock? The objective is not to investigate whether these factors

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Table 28.1 Granger causality

Null hypothesis	*F*-statistic	*P*-value	Decision
Break-even inflation does not Granger-cause inflation	4.24	0.02	Granger Cause
Commodity price inflation does not Granger-cause inflation	11.56	0.00	Granger Cause
Rand changes does not Granger-cause inflation	4.13	0.02	Granger Cause
Food inflation does not Granger-cause inflation	11.79	0.00	Granger Cause
Food inflation does not Granger-cause core inflation	6.07	0.00	Granger Cause
White maize price inflation does not Granger-cause inflation	3.83	0.02	Granger Cause
Oil price inflation does not Granger-cause inflation	29.52	0.00	Granger Cause

Source: Authors' calculations

cause inflation but to show that irrespective of the source of the inflationary shock, the inflation trajectories may be different depending on the abilities of these factors to magnify or stifle inflation reaction.

28.2 Break-Even Inflation Rates, Oil Prices, Commodity Prices, Food Inflation and the Exchange Rate

It is undeniable that break-even inflation, oil prices, commodity prices and the exchange rate are linked to inflationary pressures and the outlook. Evidence in Table 28.1 shows that the risk factors Granger-cause[1] inflation. This means that a heightening in factors that are a risk to the inflation outlook in the short-run will increase inflation. Similarly, the cross-correlation in Fig. 28.1(b) and (d) shows a positive relationship, meaning that elevated risk factors to short-term inflation outlook are

[1] Granger causality measures precedence and information content but does not by itself indicate causality in the more common use of the term (Eviews)

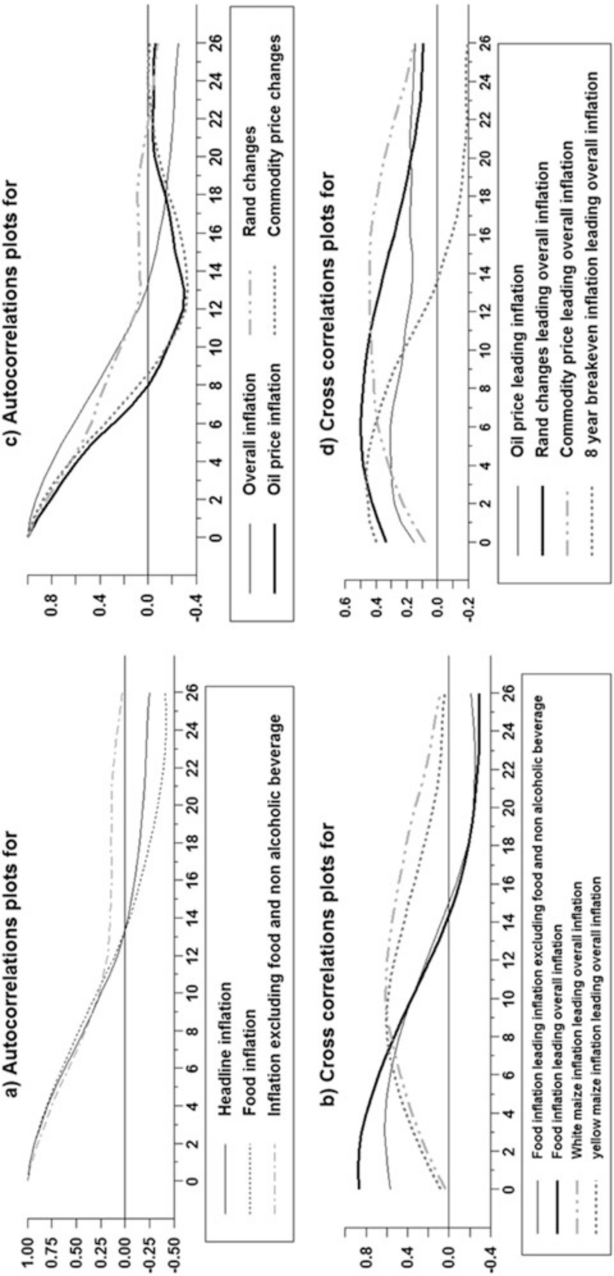

Fig. 28.1 Inflation persistence and lead relationships. *Source*: Authors' calculations

accompanied by inflation pressures Fig. 28.1(a) shows that the inflationary processes are slightly persistent.

On the other hand, the persistence of food inflation and core inflation do not differ much from those of headline inflation in the first 12 months. But thereafter core inflation persists around zero, whereas headline inflation and food inflation become negative. Headline and core inflation exhibit a positive relationship with food inflation. Thus headline and core inflation rates tend to rise when preceded by elevated food inflation.

Headline and core inflation increases when preceded by food and grain prices takes a big knock on impact but converges to the same level as core around 9 months.

28.3 What are the Propagating Effects of Risk Factors to Inflation?

The preliminary analysis is based on the modified Pentecôte and Rondeau (2015) approach based on Cerra and Saxena (2008) applied to the inflation Eq. (28.1).

$$Inflation_t = constant + \sum_{i=1}^{4} \beta_i\, inflation_{t-i} + \sum_{i=0}^{4} w_i\, Variable_{t-i} + \varepsilon_t \quad (28.1)$$

where ε_t denotes an inflationary shock and *Variable* denotes the exchange rate, eight-year break-even inflation rate, commodity price changes, oil price change, food prices and retail sales growth. Each of these variables is used individually in the model to assess its role in propagating the inflation response to inflationary shocks. To measure the influence of each of the variables requires the estimation of the actual and counterfactual inflation responses. The actual (counterfactual) inflation responses refer to inflation responses when a specific transmission channel from that variable is included (excluded) in the model. The propagating (magnifying) or restraining (stifling) ability of the specific variable and channel is determined by the gap between actual and counterfactual responses. The study uses monthly (M) data for the period 2001M6 and 2015M10. This coincides with beginning of break-even inflation rates series.

Fig. 28.2 is based on the gaps between the actual and the counterfactual responses and there is evidence that some of the short-term risk factors to inflation outlook propagate the effects of the inflationary shocks on the inflation outlook.

Inflation responses to a 1 per cent inflationary shock are magnified in most cases in the first 18 months, as in Fig. 28.2. This means that inflation tends to be higher in the first 18 months due to the propagation effects of the (i) rand exchange rate, (ii) commodity prices, and (iii) break-even inflation rates. Retail sales growth seems to play a small propagation role. Food inflation in Fig. 28.3 also magnifies the inflation responses to inflationary shock.

The longer time series offers enough degrees of freedom but longer samples can hide policy relevant to changes in relationships. Hence Fig. 28.4 shows the comparison over different periods to capture the changes and assess how they have impacted the relationships.

28.4 The Role of the Rand Exchange Rate, Break-Even Inflation Rates and Commodity Price Shocks

Have the propagation effects of the rand exchange rate, break-even inflation rate and commodity price shocks changed pre-2007M7 and post-2009M10? This section compares the propagation effects of these variables during the two periods as they may be influenced by different conditions. To avoid the cyclical swings in the impulses the analysis uses accumulated responses as these will reveal if there is convergence over longer horizons. Fig. 28.4(b) and (d) shows the propagation impact exerted by break-even inflation rates. The inflation responses are extremely large when break-even inflation rates are included in pre-2007M7 and post-2009M10. Break-even inflation rates propagated inflation responses considerably more before the crisis than after the recession as shown in Fig. 28.4(f). Thus evidence still suggests that break-even inflation rates propagate inflation responses after the recession in 2009M10. In addition, inflation is higher in the presence of commodity prices than in the absence of commodity prices before 2007M8 in

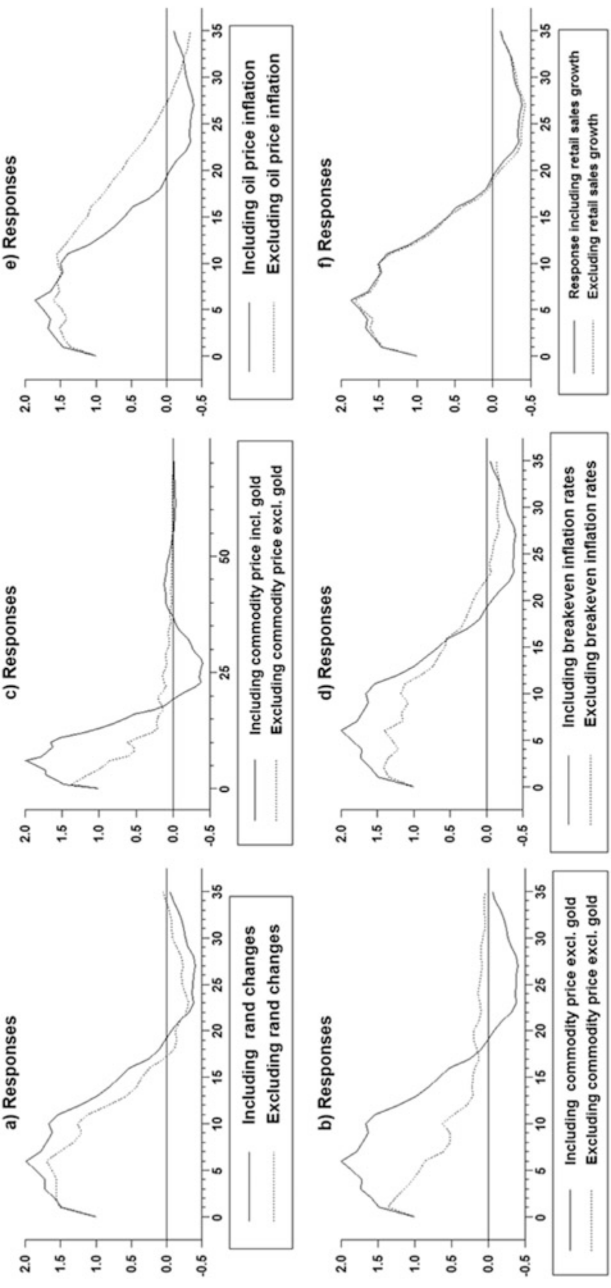

Fig. 28.2 Inflation responses to inflationary shocks. *Source*: Authors' calculations

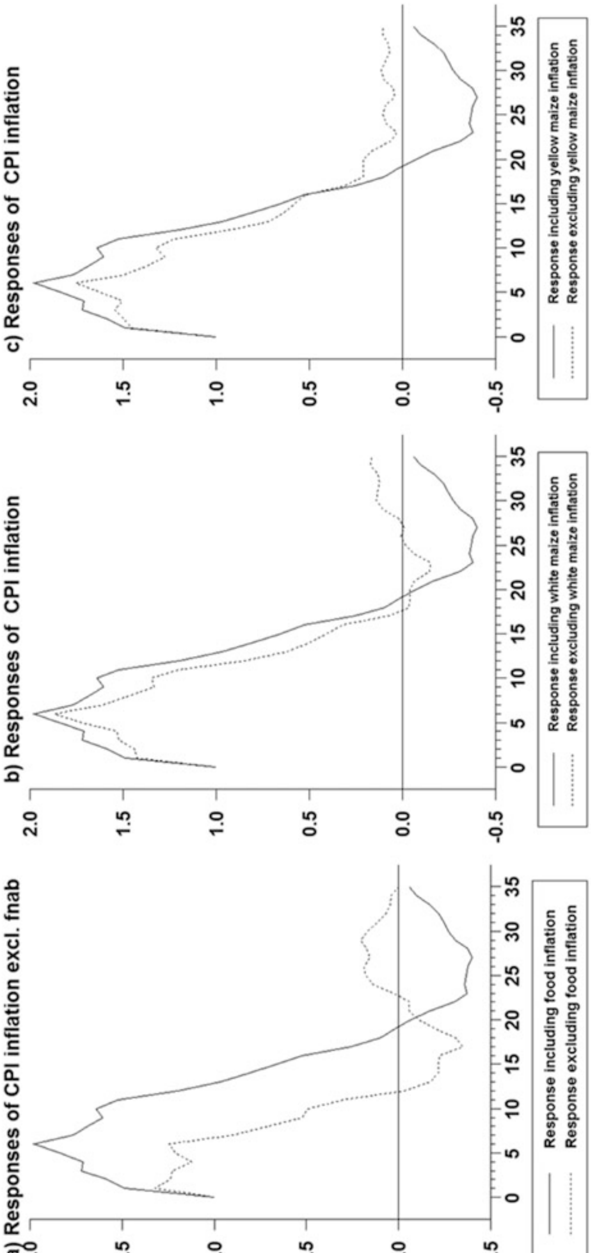

Fig. 28.3 The role of food inflation in the inflation responses to inflationary shocks. *Source*: Authors' calculations. *Note*: CPI inflation exlc. food is an abbreviation for excluding food and non-alcoholic beverages

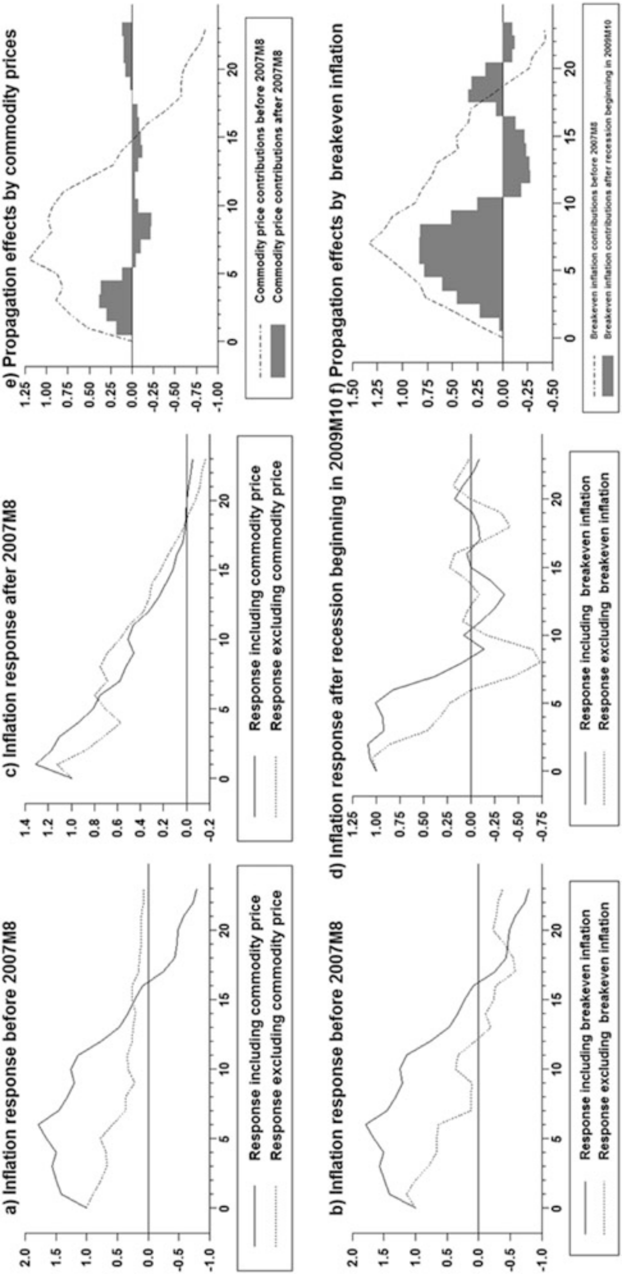

Fig. 28.4 Inflation responses and the role of break-even rates and commodity prices

Fig. 28.4(a). Commodity prices exerted upward pressure on inflation in first five months and the effects weakened thereafter. This suggests that commodity prices have a weakened effect on inflationary pressures beginning in 2007M8 shown in Fig. 28.4(e), hence the propagating effects of the commodity price effects are weaker.

Furthermore, the rand propagated the inflation responses to a large degree pre-2007M7 and post-2009M10. This is indicative that the rand exchange rate has propagating effects. However, these have changed slightly after the recession. This evidence does not mean that the rand exchange rate depreciation shock does not cause inflationary pressures. Rather that the degree to which it propagates inflationary shocks to inflation is lower compared to the periods in pre-recession in 2009.

28.5 The Role of Oil Prices and Demand Pressures Pre-2007M7 and Post-2009M10

Fig. 28.5(a) shows that pre-2007M8 oil prices changes propagated inflation responses to inflationary shocks. However, this changed post-2007M8 as in Fig. 28.5(c) as the oil price exerted downward pressure on inflation. This means that oil price changes do propagate inflation responses to inflationary shocks. When they decline they mitigate heightened inflationary pressures.

The cumulative impulse responses show that oil prices have been a drag on the inflation pressures as shown in Fig. 28.5(e). Thus in cumulative terms the oil prices were pulling down inflation responses post- 2009. The focus shifts towards examining demand-related effects captured by role of retail sales as a proxy for consumption. The gaps in Fig. 28.5(b) to (d) between the unaccumulated impulse responses in pre-2007M7 and post-2007M8 suggests that retail sales play a role in propagating inflation responses to inflation shock. The propagating role of demand pressures is more evident in the accumulated impulse, as retail sales propagated inflationary pressures prior 2007M8 in contrast to adverse effects post 2007M8 in Fig. 28.5(f). This suggests that consumption growth as a

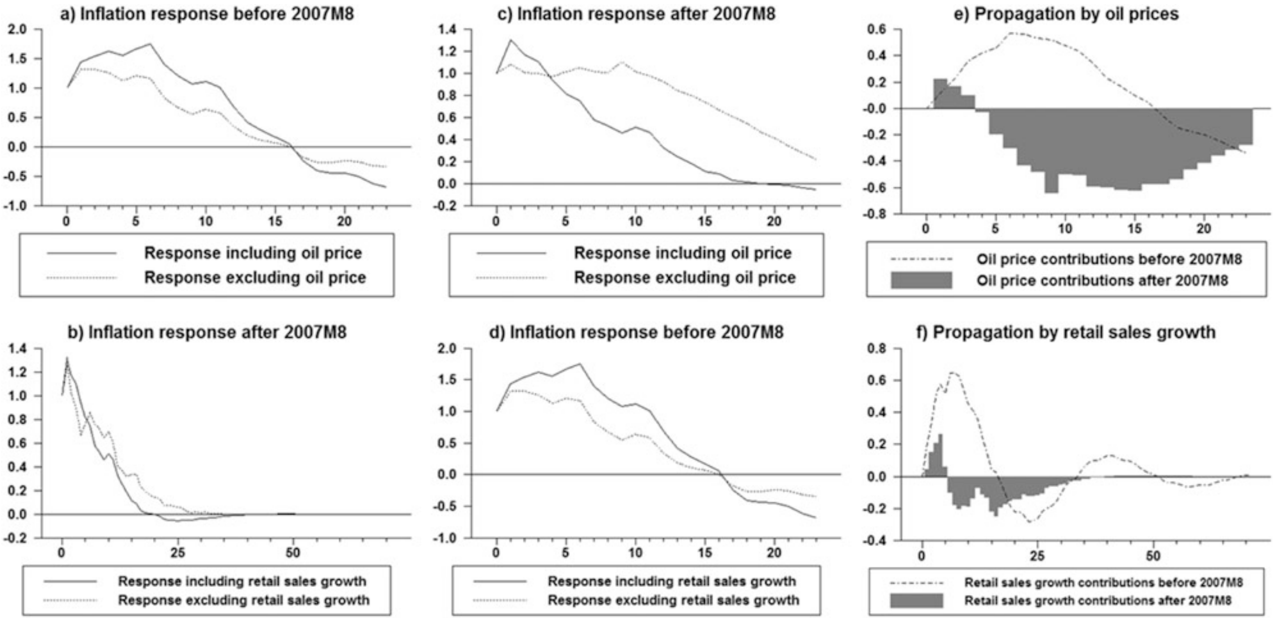

Fig. 28.5 Inflation responses and the role of oil pices and retail sales. *Source*: Authors' calculations

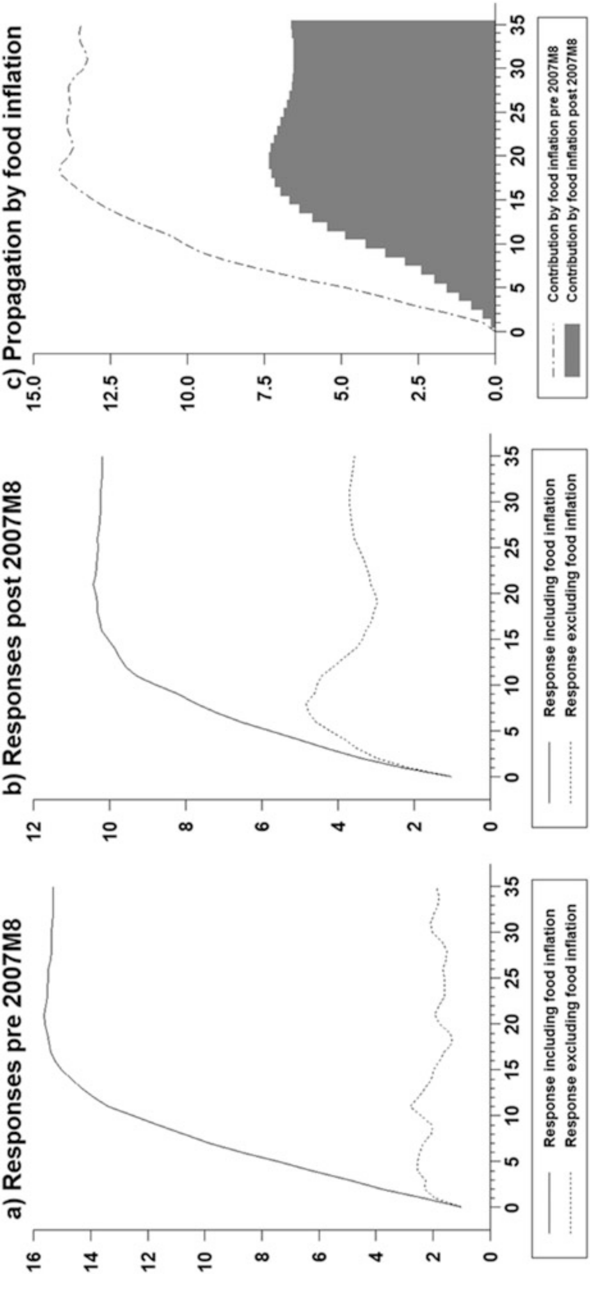

Fig. 28.6 Cumulative inflation excluding food and non-alcoholic beverages responses and the accumulated role of food inflation. *Source*: Authors' calculations

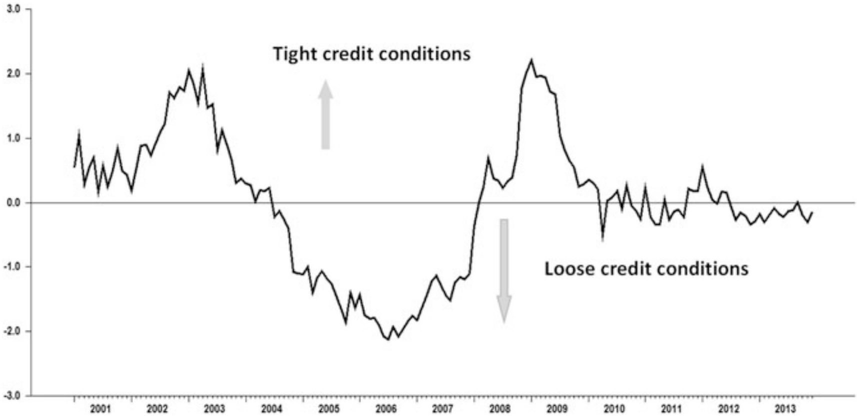

Fig. 28.7 The credit conditions index. *Source*: Authors' calculations

Table 28.2 Components of the credit conditions index

Debt market indicators	Banking indicators
Five-year spread between SA and US government bond	Non-performing loans
Spread between 10-year government bond and 28-day SARB debentures	Return on equity
Spread between corporate and government bonds	Tier 1 capital adequacy ratio
Bond market liquidity ratio	Spread between banks and government bonds
Five-year SA banks credit default swap	Spread between bank lending and deposit rate

Source: Authors' calculations

proxy for demand had a dampening effect on the inflation process evolution in the post-2007 period.

28.6 The Role of Food Prices

The investigation further shows the responses to inflation excluding food and non-alcoholic beverages before 2007M8 and after 2007M8. The accumulated inflationary responses in Fig. 28.6(a) and (b) are higher

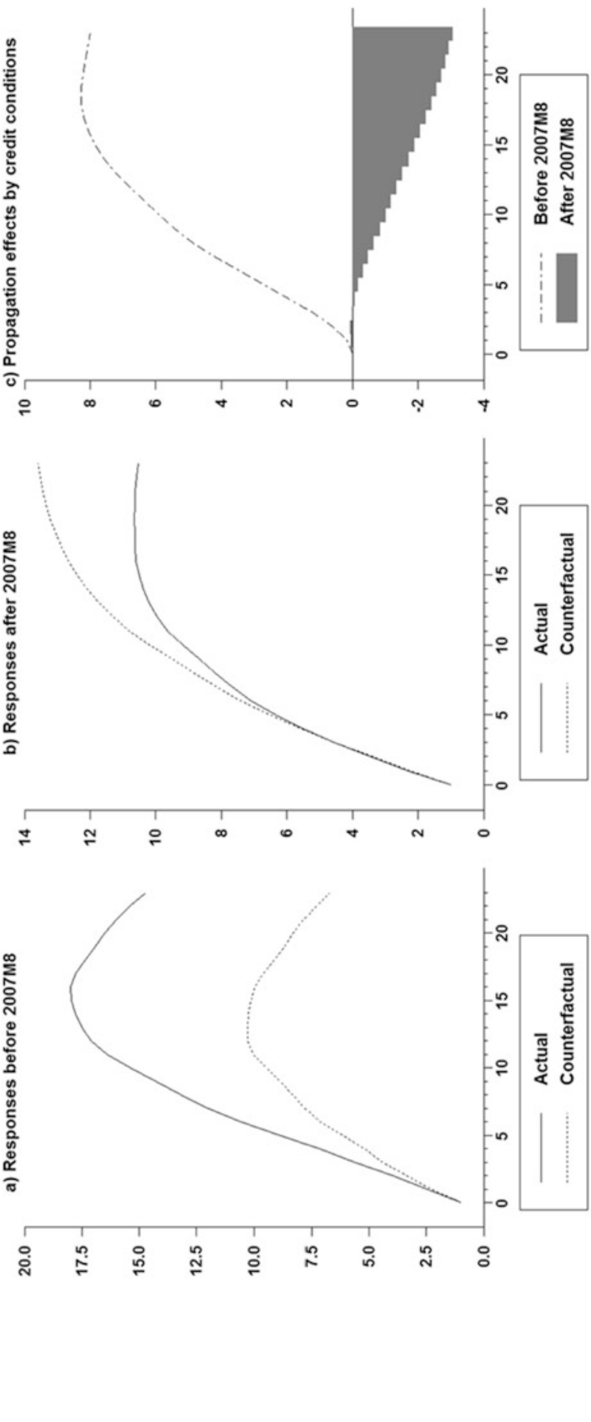

Fig. 28.8 Cumulative inflation responses and the role of credit conditions. *Source*: Authors' calculations

when food inflation is included in the model than when it is excluded. It is evident that food inflation had big propagation effects on inflationary pressures before the beginning of the financial crisis in 2007M7 in Fig. 28.6(c).

28.7 The Role of Credit Conditions

The analysis concludes by examining the effects of the credit conditions captured as an index from various market indicators shown in Fig. 28.7 and Table 28.2.

Fig. 28.7 shows that credit conditions can be classified as tight to neutral post-2009.

Fig. 28.8(a) shows that loose credit condition amplified inflation response. This is in contrast to dampening effect in Fig. 28.8(b).

Furthermore, Fig. 28.8(c) shows that tighter credit conditions post-2007 mitigated the inflation response to inflationary shocks.

28.8 Conclusion and Policy Implications

This chapter assessed the extent to which risks to the inflation outlook in the short-term propagate inflationary shocks. Evidence shows that headline and core inflation would have responded differently in the absence of grain price inflation, food inflation, exchange rate, eight-year break-even inflation, commodity price changes, oil price changes and retail sales growth. Before 2007M8 grain prices, food prices, oil prices, credit conditions, and retail sales propagated inflation responses to inflationary shocks. But this changed after 2007M8 as these variables pulled down inflation. In addition, the rand exchange rate propagation effects changed slightly after the recession. The rand exchange rate and break-even inflation propagated the inflation responses to inflationary shocks to a larger extent prior the global crisis than after the recession in 2009.

Post-2007, the credit and demand factors as represented by the credit conditions index and retail sales helped in neutralising inflationary pressures. On the other hand, factors such as the oil price, break-even inflation rates, grain and food prices, to the degree that they are associated with the rand exchange rate changes, are making positive contributions and propagating inflationary pressures. However, their contributions to inflation are less relative to that pre-2007, suggesting that the ERPT is muted post-2007 and the main underlying factor is muted demand and credit growth. However, the sharp exchange rate depreciation-induced inflationary pressures have offset the benefits accruing from low demand.

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29

Upside Risk Factors to the Inflation Outlook and Long-Term Inflation Expectations

Learning Objectives

- Impact of upside risk factors to the inflation outlook on long-term inflation expectations
- Pass-through from long-term inflation expectations to headline inflation
- The role of monetary policy on inflation expectations

29.1 Introduction

Well-anchored long-term inflation expectations are central to a credible flexible inflation- targeting framework. In fact, Mishkin and Schmidt-Hebbel (2007) assert that when inflation expectations are well-anchored[1] the mean inflation rather than its volatility matters more in mitigating adverse costs associated with the volatility channel. This chapter assesses

[1] Bernanke (2003) defines well-anchored long-term inflation as those in which a one-off adverse shock to, for example, energy and food prices, does not lead to a permanent increase in inflation but only a change in relative prices. Similarly, if inflation expectations are well-anchored, changes in energy and food prices should have relatively little influence on core inflation.

E. Ndou, N. Gumata, *Inflation Dynamics in South Africa*,
DOI 10.1007/978-3-319-46702-3_29

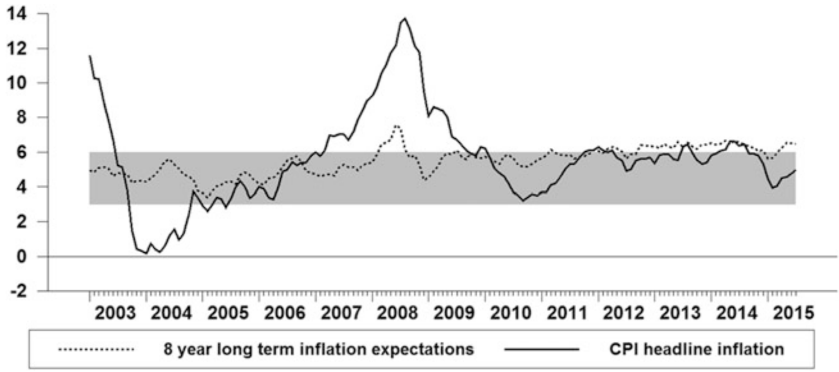

Fig. 29.1 Inflation and eight-year long-term inflation expectation. (The eight-year long-term inflation expectations are derived from the difference between the yields of the R186 nominal and the R197 inflation-indexed bonds.) *Source*: South African Reserve Bank. *Note*: Shaded area denotes the inflation target band

whether upside risk factors to the short-term inflation outlook impact long-term inflation expectations. Is there a pass-through from long-term inflation expectations to headline inflation? Fig. 29.1 shows the eight-year break-even inflation rates as a proxy for long-term inflation expectations and inflation.

Fig. 29.1 shows evidence of a positive interlinkage between inflation and break-even inflation expectations. What does this suggests regarding economic agents' behaviour? Primarily, this may reflect that as economic agents learn and acquire new information about the state of the economy, they reformulate and adapt to a new equilibrium (Cogley 2005).[2] Of course, the influence of inflation regimes cannot be underestimated. According to Bernanke (2003), as the economy gradually moves from one regime to another, agents learn and update their beliefs leading to poorly anchored inflation expectation. This chapter focuses on one aspect of the shock and argues that agents react and adjust their inflation

[2] In contrast to the traditional rational-expectations model of inflation and inflation expectations which implies that economic agents know the long-run equilibrium inflation rate. As such, their long-run inflation expectations do not vary over time in response to new information (Bernanke 2003).

expectations when experiencing periods of higher inflation, even if these episodes are short-lived.[3]

29.2 Market vs. Survey-Based Inflation Expectations

Why use market-based long-term inflation expectations given that vast literature relies heavily on survey-based measures of long-term inflation expectations? This is a valid question but, unfortunately, the analysis does not have a corresponding survey based on survey inflation expectations. Data limitations of the Bureau for Economic Research (BER) at the University of Stellenbosch long-term inflation expectations which start in 2011Q3 force us to use break-even inflation expectation. However, data limitations on their own do not have theoretical grounds to prevent us from using alternative measures of long-term inflation expectation measures. Nor does this mean that survey expectations are better. Had both measures of long-term inflation expectations been available, this would have been considered to determine the ideal measure to use, based on its ability to accurately forecast inflation. The objective of this chapter is not to forecast inflation based on the effect of long-term inflation expectations but to derive policy implications. Hence the absence of the alternative measures to enable a comparison of policy implications derived in this analysis. Therefore, it is difficult to pronounce whether break-even inflation expectations are a good or bad measure.

The data limitations articulated above do not inhibit us from using break-even inflation rates to investigate the following issues. To what extent are break-even inflation expectations driven by unexpected increases in oil and other commodity prices, or the depreciation of the rand against the US dollar? Does the unexpected increase in inflation spill over into break-even inflation expectations and would the effect differ from that of food inflation shocks? Or, should policymakers be concerned about possible effects of various measures of core inflation used as

[3] The persistence of shocks matters.

operational guides for the policy stance on shifting break-even inflation expectations?[4]

A key area of constant discomfort to policy makers is that when inflation is persistently near the upper band of the target for a prolonged period, adverse shocks that result in the breach of the target will result in economic agents revising their expectations about wage and price setting behaviour and spending decisions. Therefore, it is not only the linkage between inflation and long-term inflation expectations that matters for policy.[5]

The analysis shows the magnitudes related to own contributions, which can be interpreted as risk factors included in the level of break-even inflation rates (BEIRs). Thereafter, the analysis compares the derived measure of long-term inflation expectations purged off its own contributions to the BER financial analysts' two- and five-year-ahead inflation expectations. The comparison assists us in assessing whether the derived measure of break-even inflation expectations convergences to the survey measures and whether it is useful. Nonetheless, the analysis draws the attention of the reader to that fact that it does not determine whether inflation expectations derived from break-even inflation rates are unbiased and accurate predictors of future inflation rates.

29.3 What Is the Impact of Adverse Supply-Side Shocks on the Mean of Long-term Inflation Expectations?

Theoretically, a lower sensitivity of long-run inflation expectations to supply shocks implies that such shocks are much less likely to generate price and economic instability (Bernanke 2003). So, what is the impact of

[4] The Banks' quantitative definition of price stability refers to all-items headline inflation. However, the MPC does refer analyses the information contained in various measures of core inflation as operational guides for the policy stance.

[5] Break-even inflation rates are computed as the difference between the nominal bond yield and the real yield (yield of the inflation-linked bond) can be decomposed into inflation expectations and related premia from financial market participants.

adverse supply-side shocks (upside risks) to inflation on long-term inflation expectations. The analysis begins by purging the effects of volatile headline inflation, rand/US dollar exchange rate depreciation, and commodity and oil prices, to see what the mean long-term inflation expectations would be in their absence. What is their effect on the level of long-term inflation expectations and the degree to which they are anchored? Is there convergence on where inflation expectations must be? Linear regressions used to derive mean values in Fig. 29.2 shows a positive relationship between long-term inflation expectations and upside risk factors to inflation, suggesting that adverse supply shocks push up long-term inflation expectations. The mean values displayed in Fig. 29.2 suggest that on average long-term inflation expectations would be between 4.83 and 5.49 per cent when purging the effects of supply shocks such as volatility in headline CPI, oil and commodity prices. However, it is undoubtable that all the mean long-term inflation expectations are within the inflation target band.

Furthermore, the strength of the correlation between annual rand/US exchange rate changes and long-term inflation expectations is positive and became even stronger for the period starting in September 2010 to date. And the evidence on the decomposition of the effects of the rand/US dollar exchange rate changes into appreciation and depreciation episodes shows that rand depreciation (appreciation) tends to have a positive (negative) impact on long-term inflation expectations. Thus, controlling for the effects of rand/US dollar exchange rate depreciations (appreciations), the mean of long-term inflation expectation would be 5.79 (5.4) per cent Fig. 29.2.

What about upside risks to inflation associated with increases in oil and commodity prices? Evidence indicates that upside risks associated with increases in commodity and oil prices (i.e., after removing the effects of negative changes or declines) increase inflation expectations. The results show that the mean inflation would be around 5.3 per cent and 5.32 per cent due to increases in commodity and oil prices, respectively. The mean values are lower relative to those associated with the rand/US dollar exchange rate depreciation and appreciations, suggesting that exchange rate matters very much. Various mean levels of long-term inflation expectations derived from other supply shocks are shown in Fig. 29.2.

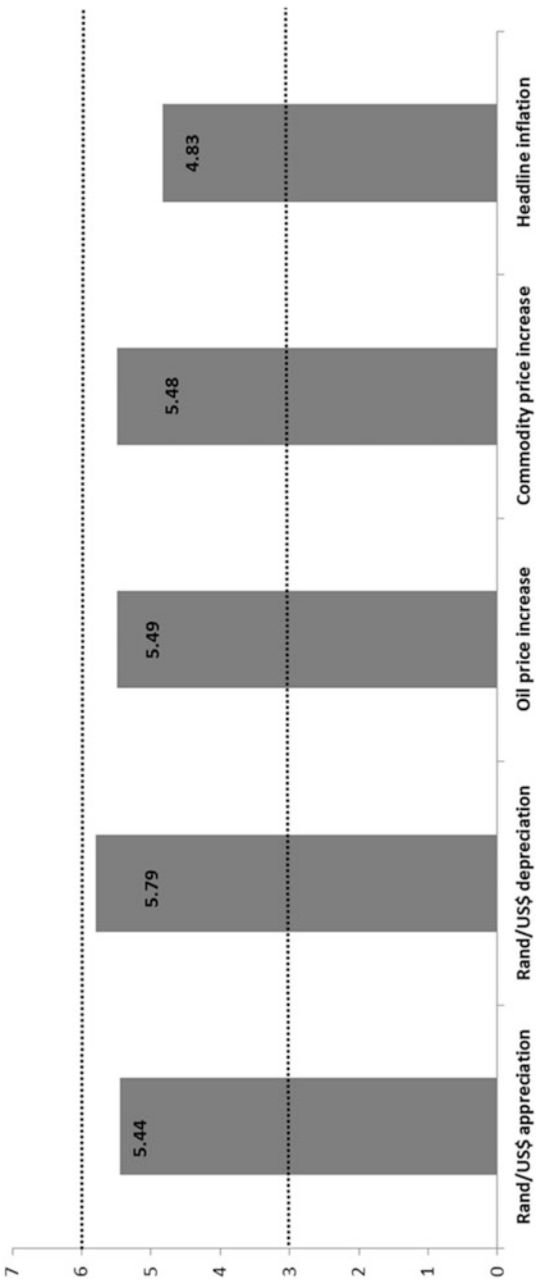

Fig. 29.2 Mean long-term inflation expectations from purged effects of selected upside risks to inflation. *Source*: Authors' calculations. *Note*: Dotted line shows 3–6 per cent target band

The comparison shows that although long-term inflation expectations would be within the target range, they are above 5 per cent with the exception of the headline CPI. In addition, headline inflation explains about 17 per cent of movements in long-term inflation expectations. This evidence suggests that inflationary developments themselves are a threat to inflation expectations.

Furthermore, evidence shows that elevated rand/US dollar depreciation is largely associated with an increase and persistent long-term inflation expectations over all horizons. Headline inflation leads to high inflation expectation but the strength of the correlation is slightly lower than that exhibited by the currency depreciation effects. Both oil and commodity prices exhibit a positive, albeit weak and transitory, relationship with long-term inflation expectations in the first 13 months.

Lastly, evidence shows that there is significant feedback because an increase in long-term inflation expectations is associated with rising headline inflation and the rand/US dollar exchange rate depreciation. Evidence shows feedback effects between long-term inflation expectations, headline inflation and the rand/US dollar depreciation.

29.4 Is It Possible That Long-Term Inflation Expectations Shocks Lead to Persistent Inflation?

So far the analysis has not revealed the nature of the pass-through from supply shocks to long-term inflation expectations and the extent of the persistence of these shocks. Why should persistence matter? The pass-through is regime-dependent and can be quick or delayed from the onset of shock. Given that the pass-through is not restricted only to supply shocks analysis, the analysis is extended to determine the effects of disaggregated inflation components, such as food and core inflation. This section estimates a VAR model with two lags using monthly data for retail sales growth, headline CPI inflation (or core inflation or annual food inflation), long-term inflation expectations, the repo rate and annual rand/US dollar exchange rate changes. The monthly (M) data spans 2000M5 to 2015M7. The impulse responses are based on 10,000 Monte Carlo draws.

To dissect the effects of different inflation measures, we replace headline inflation with the specific inflation component, i.e., core or food inflation. Thereafter, compare the responses from models with these inflation components to those with headline CPI inflation. The intention is to assess whether there is pass-through from headline, core, and food inflation shocks to long-term inflation expectations. Alternatively, does inflation pose risks to keeping long-term inflation expectation elevated or unanchored? Does the reverse causality hold?

Overall evidence shown in Fig. 29.3(a) indicates that there is pass-through from positive inflation shocks to long-term inflation expectations. The contemporaneous (impact) pass-through associated with the food inflation shock is large relative to core inflation. In the medium and long term (six months onwards), the pass-through of inflation shocks to long-term inflation expectations converges, although it is more persistent for core inflation.

Fig. 29.3(b) examines whether there is pass-through from long-term inflation expectations shocks to headline, food and core inflation. An unexpected increase in long-term inflation expectations significantly raises all the measures of core inflation at the peak effect relatively more than headline inflation. The peak responses show that a positive one standard deviation (0.25 percentage points increase) in long-term inflation expectations increases different inflation measures by between 0.25 and 0.36 percentage points. The responses are more pronounced for core inflation measure, namely headline CPI excluding food, non-alcoholic beverages, petrol and energy. It is not only the magnitude of the responses that matter but the proportions of fluctuations induced by these shocks as well. Fig. 29.3(c) shows that food inflation explains less than 30 per cent of movements in long-term inflation expectations after 10 months. This is higher than that explained by all other inflation shocks. In Fig. 29.3(d) long term inflation explains about 50 per cent of the variation in inflation excluding petrol and energy.

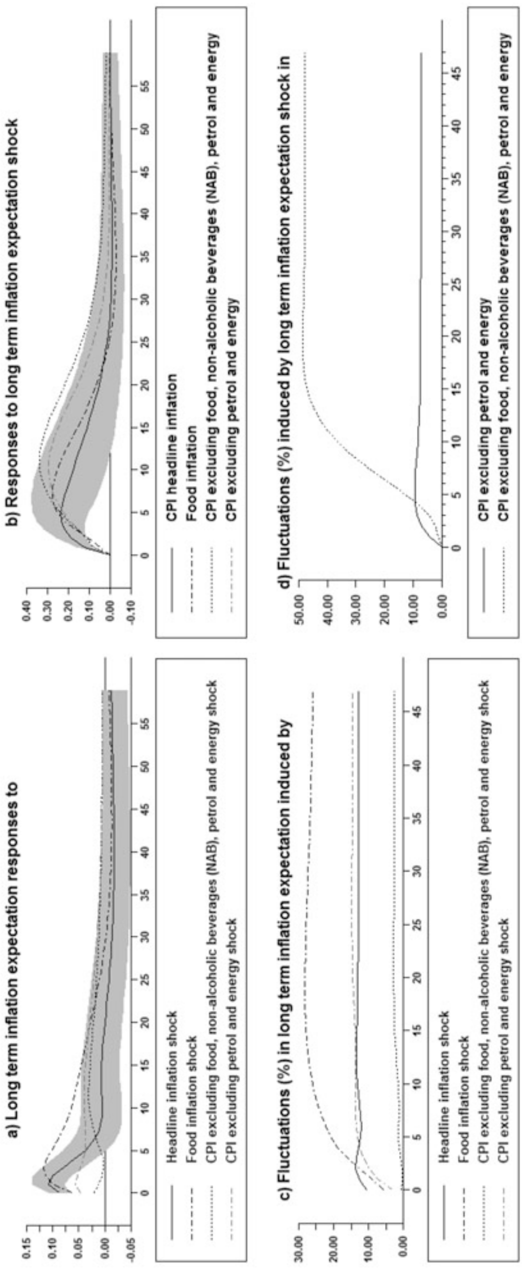

Fig. 29.3 Responses of various components of inflation and long-term inflation expectations. *Source:* Authors' calculations. *Note:* The grey shaded line in parts (a) and (b) denotes the 16th and 84th percentile confidence bands

29.5 Do Long-Term Inflation Expectations Reinforce Adverse Inflation Shock Effects on the Real Economy?

Evidence in the preceding sections indicates that there exist channels through which inflation expectations lead to persistent inflation pressures. This section explores these channels. Apart from the feedback effects shown in the preceding section, the analysis compares the effects of inflation shocks to long-term inflation expectations. This includes assessing whether there are additional effects of inflation shocks that operate through long-term inflation expectations. If so, could this be one of the key reasons as to why policymakers are concerned about long-term inflation expectations shocks?

The results in Fig. 29.4 show that positive long-term inflation expectations and inflation shocks depress retail sales, lead to tightening in the repo rate and rand depreciation on impact. The exchange rate appreciates in later periods. Is there a policy lesson? Yes, the reactions of the variables in the same direction suggest that inflation and long-term inflation expectations shocks display reinforcing tendencies on economic activity.

What is the policy implication? Fig. 29.4(d) shows that, assuming that policymakers did not adjust the policy rate, the real repo rate declines in response to inflation, long-term inflation expectations and rand/US dollar exchange rate depreciation shocks. The decline in real interest rates can support consumption and spending, leading to further inflationary pressures.

29.6 Do Long-term Break-Even Inflation Rates Propagate Inflation Shocks?

The analysis begins by determining the role of eight-year break-even inflation and consumer price inflation in propagating the shocks to retail sales growth. This will reveal the interdependence between consumer price inflation and long-term inflation expectations. Fig. 29.5(a) shows that positive consumer price inflation shock lowers retail sales growth.

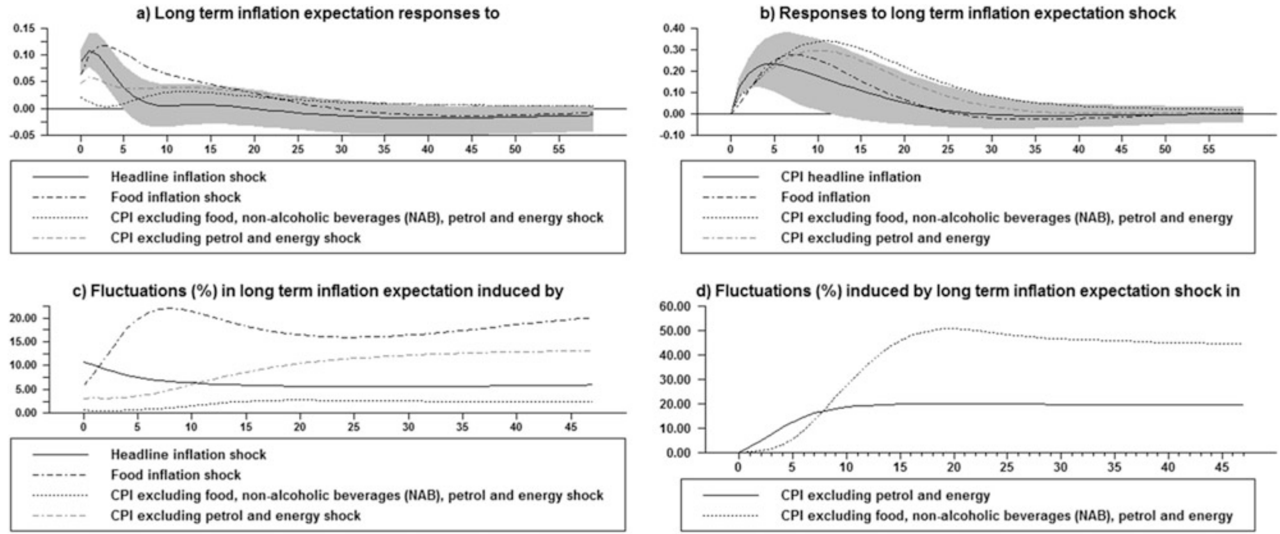

Fig. 29.4 Responses to upside risk factors. *Source:* Authors' calculations. *Note:* The grey shaded line in parts (a) and (b) denotes the 16th and 84th percentile confidence bands

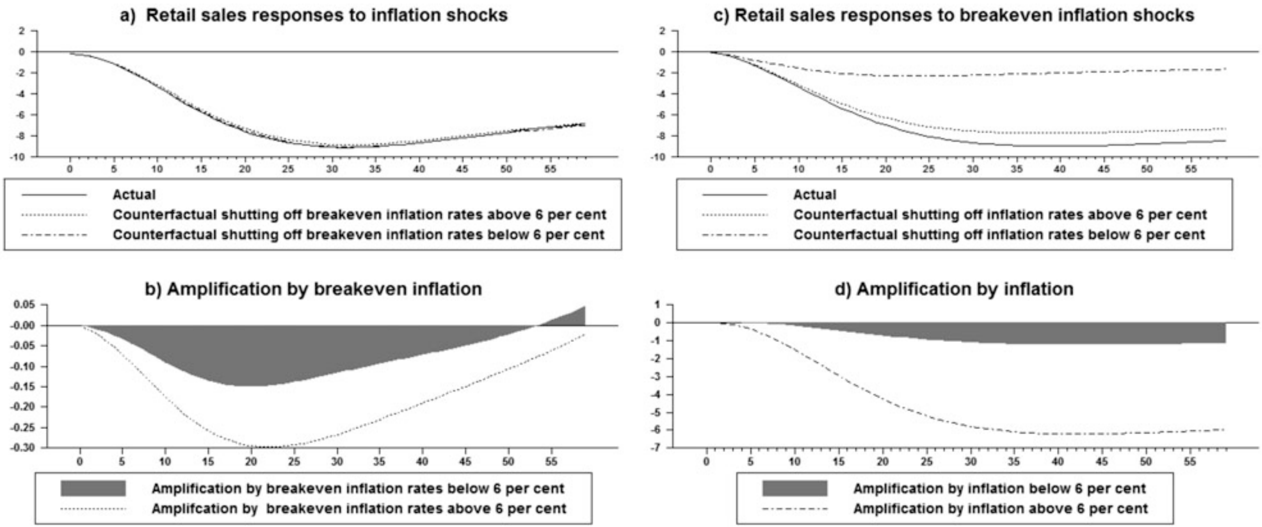

Fig. 29.5 Responses and the role of inflation and break-even inflation rate. *Source*: Authors' calculations

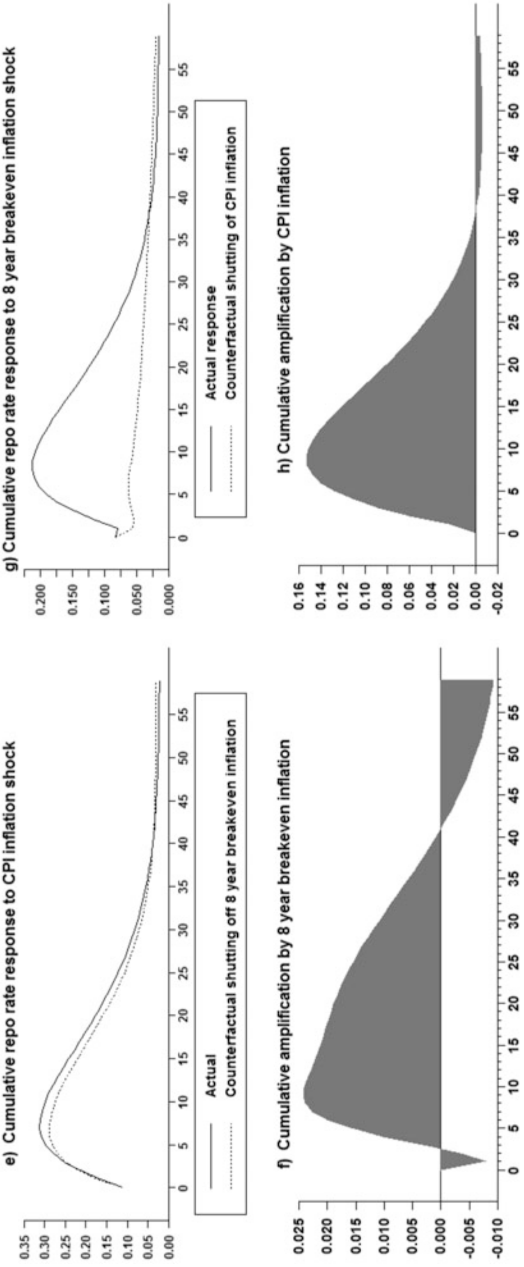

Fig. 29.5 (continued)

The actual retail sales response declines more than the counterfactual responses meaning that the eight-year break-even inflation rates worsen the retail sales growth decline as shown in Fig. 29.5(b). Retail sales growth would have declined very little due to positive break-even inflation shocks when consumer price inflation is shut off in the model. This suggests that the large decline in retail sales growth is due to the propagation effects of inflation and inflation expectations above six per cent in Fig. 29.5(d) and (b) respectively. This evidence of interdependencies and the amplification of worsening effects require enforcing price stability and the anchoring of inflation expectations.

Is the repo rate adjustment to positive long-term inflation expectation shock amplified by prevailing consumer price inflation and long-term inflation expectations? Evidence in Fig. 29.5(e) and (f) suggests that the eight year break-even inflation rates propagate the repo rate responses to positive consumer price inflation shock. Inflation is a potent propagator of repo rate tightening to positive inflation expectation shocks as shown in Fig. 29.5(g) and (h). High inflation leads to aggressive tightening of the repo rate to positive long-term inflation expectations shock. This means that maintaining price stability and the disinflationary cost of monetary policy may be limited when inflation expectations are anchored and inflation is within the target band.

In addition, to show the role of price stability in the transmission of inflation expectation shocks, Fig. 29.6(a) shows that the exchange rate depreciates more due to positive inflation expectations shock when inflation is not shut off in the model. This means that inflation is a propagator of long-term expectations shock to exchange rate depreciation shock. This evidence suggests that price stability should be enforced by anchoring long term inflation expectations and lowering inflation. Fig. 29.6(c) and (d) show inflation below six per cent has dampening effect on pass-through of positive inflation shocks to exchange rate.

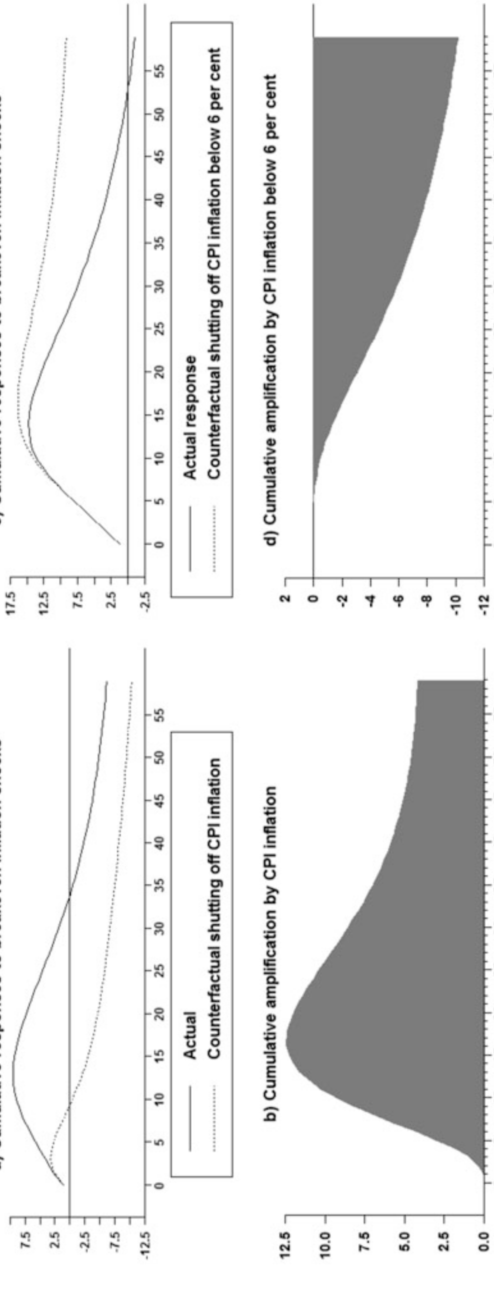

Fig. 29.6 Exchange rate responses to positive breakeven shocks and the role of inflation *Source:* Authors' calculations

29.7 Sensitivities of Inflation and Long-Term Inflation Expectations to Upside Risk Factors to the Short-Term Inflation Outlook

To what degree are long-term inflation expectations anchored following economic shocks? This section estimates a VAR model with two lags using monthly data for annual changes in oil prices or commodity prices, annual retail sales, headline inflation, long-term inflation expectations and the repo rate. The model is estimatd using 10 000 Mont Carlo draws. The modelling assumes that oil and commodity prices are determined in external markets. Fig. 29.7(b) shows that a one positive standard deviation shock to each upside risk factor to the inflation outlook raises long-term inflation expectations at the peak before the twelve month. This suggests that upside risk factors to the inflation outlook also pose risks to long-term inflation expectations. Amongst the responses to the three shocks, long-term inflation expectations are persistently higher due to the rand/US dollar exchange rate depreciation shock.

What do these responses tell us about anchoring of long-term inflation expectations? If long-term inflation expectations are well-anchored, these do not expect have to be highly sensitive to upside risk factors to the inflation outlook. The impulse responses should be insignificant or react in a very transitory manner. The impulse responses confirm that long-term inflation expectations are "poorly" anchored to all shocks.

The fact that the rand depreciation makes inflation expectations to be persistently less anchored accords well with assertions that the depreciation of various measures of the exchange rate matter for policy decisions. In addition, the depreciation poses upside risks to the inflation outlook despite the seemingly unusually low exchange rate pass-through to headline inflation.

So, does it matter which upside risk factor to the inflation outlook is included in the model? To assess for the relative effects requires comparing the individual responses to those of the rand/US dollar exchange rate depreciation shock. Yes, the prevailing shock at the moment matters. Evidence suggests that a positive inflation shock raises long-term inflation

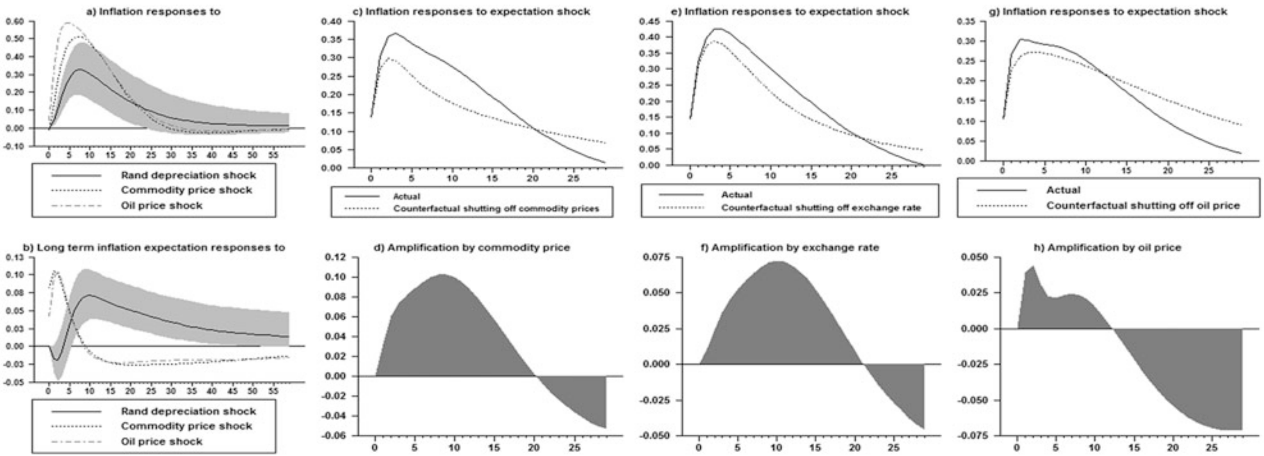

Fig. 29.7 Responses to upside risk factors and positive inflation expectation shocks. *Note:* The grey shaded line in parts (a) and (b) denotes the 16th and 84th percentile confidence bands. Commodity price, oil prices and exchange rate are annual percentage changes. *Source:* Authors' calculations

expectations more in the presence of an adverse oil price. Supply shocks matter for the response of long-term inflation expectations to inflation shocks. The repo rate is tightened to combat inflationary pressures.

Furthermore, the exchange rate plays an indirect role in the transmission of shocks to long term inflation expectations. This means that currency stability matters as long-term inflation expectations increase more in presence of exchange rate channel. The magnitudes of amplification effects by the exchange rates show that long-term inflation expectation can remain unanchored following positive consumer price inflation when exchange is very stable. This means that the stability of the currency matters and it can play a role in the anchoring of long-term inflation expectations. This evidence suggests that price stability matters in connection with anchoring long-term inflation expectations, containing inflation and currency stability.

In Fig. 29.7(c), (e) and (g) commodity price, oil price and exchange rate also propagate the long-term inflation expectations shock to consumer price inflation. Evidence shows that inflation would be much lower when the commodity and exchange rate channels are shut off in the model. The oil price has small amplification effect compared to commodity price and exchange rate channels in Fig. 29.7(d), (f) and (h). This means that commodity price, oil price and exchange rate indirectly impact the responses of inflation to long-term inflation expectation shock.

29.8 What can be Inferred from the Rolling Regression Approach?

Do inflation outturns pose the risk of keeping long-term inflation expectations unanchored? The answer to this question involves assessing the extent to which inflation outturns impact long-term inflation expectations by using the 18-month rolling regression. The chosen lag length is consistent with the expected lag effects of the monetary policy transmission. Fig. 29.8(a) shows that periods of heightened inflationary pressures result in elevated long-term inflation expectations. Moreover, inflation shocks have contributed positively to long-term inflation expectations

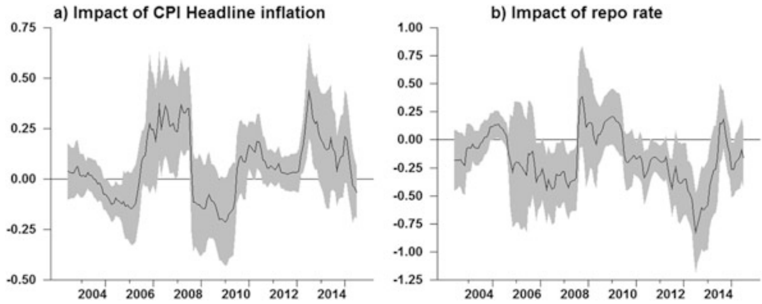

Fig. 29.8 Inflation and repo rate shocks effects on long-term inflation expectations. *Source*: Authors' calculations

since mid-2010. However, this has reversed since mid-2015, suggesting that other factors other than actual inflation itself are driving long-term inflation expectations.

Literature points out that lack of monetary policy credibility can be a source of unanchored expectations, so how did the policy rate impact inflation expectations? Does the policy stance induce variability in long-term inflation expectations? Yes, especially to the down side. In Fig. 29.8 (b) for the large part since-mid 2010, the repo rate has been depressing long-term inflation expectations. The negative contributions have been pronounced and persistent between 2010 and 2013. This suggests policy conduct does lower inflation expectations.

29.9 Long-Term Inflation Expectations and Own Movements in Inflation Expectations

It is plausible to suggest that own inflation expectations contributions encompass the influence of the risk premium and other factors not explained by the model. Fig. 29.9 shows the decomposition of long-term inflation expectations into aggregated contributions from other variables in the model and own contributions (as these encompass all of the risk factors). At this moment how big are these own contributions

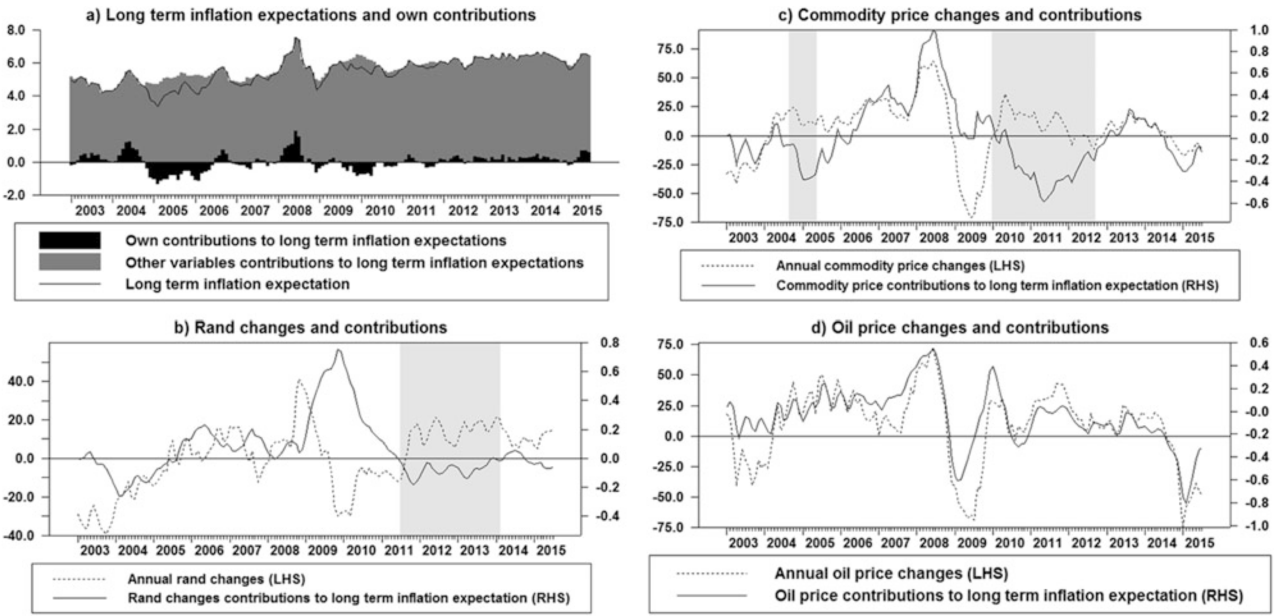

Fig. 29.9 Long-term inflation expectations and own contributions. *Source*: Authors' calculations

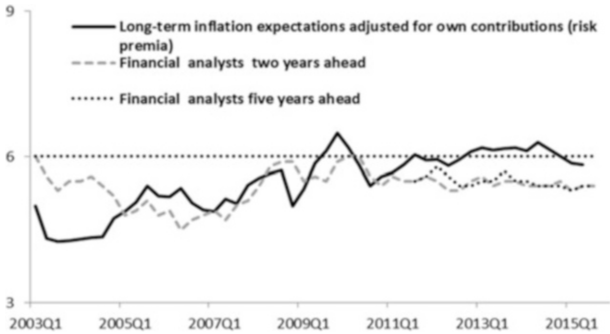

Fig. 29.10 Long-term inflation expectations purged of own contributions and BER financial analysts two- and five-year-ahead inflation expectations. *Source*: BER and authors' calculations

relative to aggregate contributions from other variables? Should these be a concern for policy discussions?

Evidence in Fig. 29.9 indicates that what is not explained by the variables in the model, and attributed to own movements in long-term inflation expectations, is very small. Evidence indicates that own long-term inflation expectations contribute on average around 0.01 per cent to the observed level. However, since the beginning of 2015, they have contributed on average 0.3 per cent to the observed increase in long-term inflation expectations.[6] Based on the disaggregate contributions in Fig. 29.9, can own inflation expectation contributions be given a large weight with intention to discard the relevance of these long-term inflation expectation in policy discussions? No, analysis extends a step further to show policymakers' long-term inflation expectations excluding own contributions relative to the two-year and five-year-ahead inflation expectations. Thus, how does the trend in long-term inflation expectations purged of own contributions (possibly including risk premium) fare compared to the BER financial analysts' inflation expectations? Due to the lack of BER financial analysts' inflation expectations of comparable

[6] Hördahl (2008) finds larger risk premia for the euro area. As a result, the euro area adjusted break-even rate is also lower relative to the unadjusted rate. Furthermore the adjusted break-even rate is much closer to the survey forecasts than the unadjusted rate.

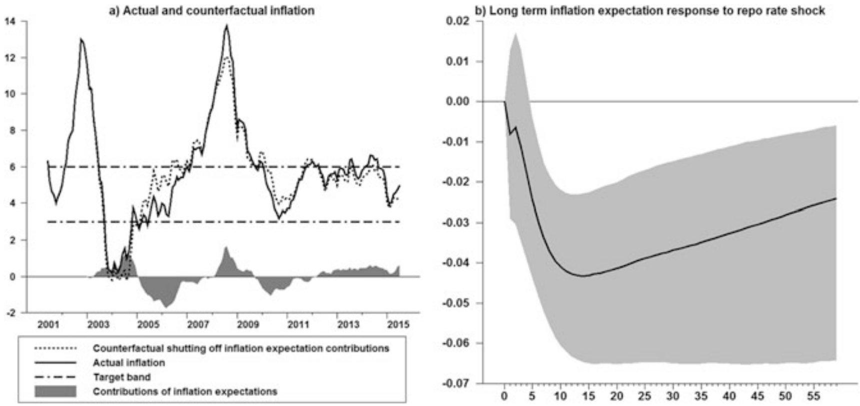

Fig. 29.11 Long-term inflation expectations dynamics. *Source*: Authors' calculations

duration to the eight-year break-even inflation, Fig. 29.10 shows the two- and five[7]-year-ahead inflation expectations instead.

From Fig. 29.10 it is evident that there is little difference between the BER two- and five-year-ahead inflation expectations. The implication is that there is limited disagreement among surveyed financial analysts as to where inflation will be in two and five years. The trends show that there is co-movement between long-term inflation expectations derived from break-even inflation rates and those of the BER analysts. All these measures of inflation expectations have been persistently close to 6 per cent post-2008. As such, they are poorly anchored. Furthermore, as measures of monetary policy credibility and aides to inflation forecasting, they possibly convey a view of "imperfect policy credibility" and that agents expect that future inflation to be near 6 per cent at best.

[7] We also note that the BER five-year-ahead financial analysts' inflation expectations are only available for the period starting 2011Q3. We are also cognisant of the weaknesses and criticism of survey-based inflation expectations. However, survey measures of inflation expectations are the main alternative source of information on inflation expectations for policymakers. Furthermore, they are not subject to inflation uncertainty, liquidity risk, and other risk factors embedded in break-even inflation rates (Christensen et al. 2004).

29.10 What Is the Contribution of Long-Term Inflation Expectations to Inflation?

To show the role of long-term inflation expectations we apply a counterfactual scenario based on historical decomposition approach to disaggregate inflation into trend and contributions from other variables. Fig. 29.11 shows the counterfactual inflation that would prevail after removing the contributions of long-term inflation expectations to headline inflation.

Fig. 29.11(a) shows that long-term inflation expectations made positive contributions to headline inflation since April 2012. The contributions have averaged 0.37 percentage points. Furthermore, the rand/US dollar exchange rate induces more fluctuations in long-term inflation expectations, corroborating earlier evidence. Tight monetary policy stance does impact break-even inflation expectations decline significantly in Fig. 29.11(b) over long periods due to an unexpected positive repo rate shock.

29.11 Conclusion and Policy Recommendations

This chapter explored the information content of long-term inflation expectations inferred from break-even inflation rates and the policy implications thereof. Evidence established that actual and counterfactual[8] long-term inflation expectations are "poorly" anchored. The mean long-term inflation expectations after controlling for influence of effects of supply shocks which include headline CPI inflation, oil and commodity price is around 5 per cent, which is within the target band. When purged off the effects of appreciation and depreciation of the rand/US dollar exchange rate, the mean levels of long-term inflation expectations are 5.4 and 5.8 per cent, respectively. Long-term inflation expectations are highly sensitive to upside risk factors to the inflation outlook.

[8] Counterfactual refers to long-term inflation expectation which exclude the contributions of expectations to long-term expectations.

Evidence reveals there is pass-through from positive long-term inflation expectation shock to headline CPI inflation. The contemporaneous (impact) pass-through associated with the food inflation shock is large, relative to core inflation. The pass-through of core inflation shocks to long-term inflation expectations tends to be more persistent after six months. Long-term inflation expectations propagate the adverse inflation shocks into the real economy. This is due to inflation and long-term inflation expectations shocks affecting economic variables in the same direction, which indicate reinforcing tendencies on economic activity. Periods of heightened inflationary pressures result in elevated long-term inflation expectations. In policy terms, this suggests policymakers should adopt a policy stance that aims to break down such adverse reinforcing tendencies.

The findings show that monetary policy tightening in response to inflationary pressures manage to dampen long-term inflation expectations. Viewed from this light, financial markets believe that policymakers are committed to keeping inflation within the target band. Furthermore, this suggests that monetary policy is not highly accommodative of unanchored long-term inflation expectations. According to Leduc et al. (2002), policymakers who are willing to pay the costs of disinflation do not find themselves in a policy bind when confronted with an upward revision in inflation expectations.

The fact that long-term inflation expectations are persistently around 6 per cent may, to certain extent, signal "imperfect policy credibility". First, it is possible that financial market participants understand policymakers' communication of the "partial accommodation" of temporary target breaches on account of supply shocks.[9] Second, the period post-financial crisis was characterised by policy communication that emphasised the stabilisation of the output gap. So there might still be inertia as agents learn about the new regime. To overcome the adverse effects of imperfect policy credibility from arising due to unintended outcome of policy communication, then policymakers should (i) have clear views on the responses to supply shocks, and (ii) offer clarity on what

[9] This kind of communication is not very different to the previous "escape clause".

level of inflation within the target band they aspire towards or are comfortable with in the medium to long run.

Nonetheless, policy lessons from literature on multiple equilibria[10] point out that clarity, commitment and credibility is crucial in preventing high inflation episodes from recurring. The adoption of preceding policy stance would eliminate the existence of multiple equilibria which reflects problems of confidence and can have adverse effects on the behavior of economic agents (Honkapohja, 2015). Christiano and Gust (1999) indicate that there are potential economic benefits in eliminating multiple equilibria because under commitment, the equilibrium is unique and the inflation rate is low on average.

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[10] Also known as the expectations trap hypothesis.

30

Inflation Expectations, Adverse Aggregate Supply Shock and Long-Term Inflation Expectations

Learning Objectives

- Distinguish between the effects of a positive inflation expectations shock and an adverse aggregate supply shock
- Disentangle the exchange rate movements due to inflation expectations shock and adverse supply shock
- Show the reasonableness of the estimated inflation expectations shocks series

30.1 Introduction

This chapter assesses what an appropriate policy response to inflation expectation shocks means. We begin with an analytical framework that includes expectation shocks, aggregate supply and demand shocks. Fig. 30.1 depicts the framework adopted to identify the three shocks.

Literature provides ample evidence, showing that in cases where the inflation-targeting framework is well implemented, a severe supply shock that hits the economy need not strongly constrain the ability of the monetary authorities to respond if inflation expectations are "well" anchored. Under such instances, based on Fig. 30.1(a) the inflation

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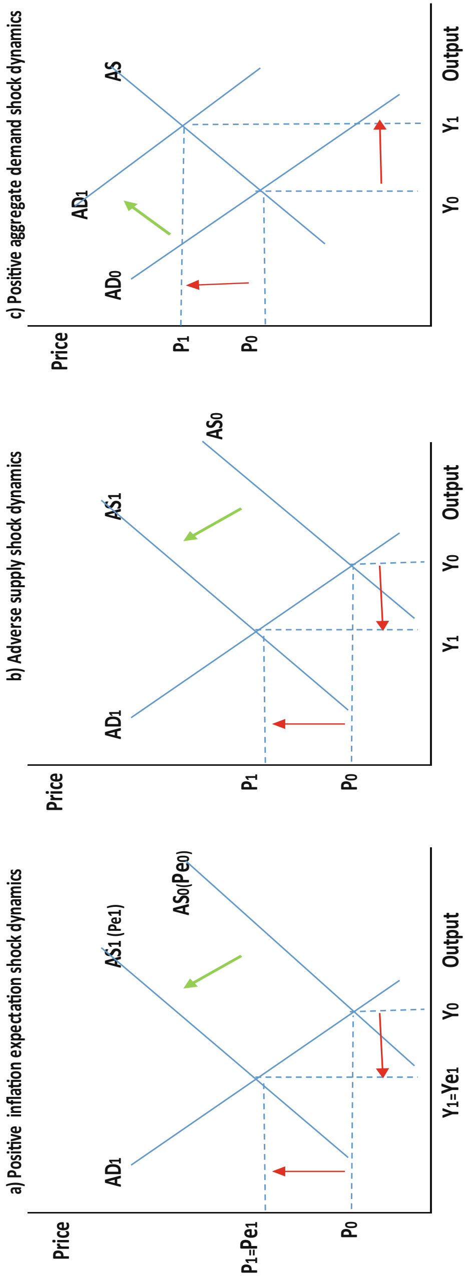

Fig. 30.1 Identifying different shocks. *Source*: Authors' drawing

expectations shock may fail to translate into realised price inflation if (i) inflation expectations are "well" anchored, and (ii) if "poorly" anchored, monetary policy authorities recognise this early on and embark on a policy stance that pre-empts this to spill over to realised inflation. In this case, price (P1) will not be the same as the expected price (Pe1) and output will not decline to an expected output (Ye1). This is the ideal theoretical outcome, which may not come to bear in reality, in part due to price rigidities.

To clearly distinguish the impact of shocks and derive appropriate policy implications, the chapter differentiates the effects of a positive inflation expectations shock from those of an adverse aggregate supply shock and positive aggregate demand shock. From Fig. 30.1 it seems that a positive inflation expectations shock resembles an adverse supply shock. If that is the case, is it possible to disentangle its effects on the economy? Yes, it is possible. This is achieved through relying on the theoretical predictions of the responses of prices and output to positive inflation expectations, positive aggregate demand and adverse aggregate supply shocks. First, a positive aggregate demand shock moves the price and output in the same direction. In contrast, the adverse aggregate supply shock moves price and output in different directions. As such, the analysis imposes the theoretical prescribed sign restrictions to identify the aggregate supply and demand shocks.

Last, the chapter considers a positive inflation expectations shock as a standalone shock. However, we do not have strong views about how well-anchored inflation expectations are and, therefore, whether the expected price increase and an expected decline in output become realised. Hence our methodology does not impose any signs on actual price and output variables, and leaves them unrestricted. However, the approach imposes a positive sign on the inflation expectation variable. This is a reasonable approach to separate a positive inflation expectation shock from the adverse aggregate supply shock.

Do the effects of a positive inflation expectations shock differ from those of an adverse aggregate supply shock? The debate about the response of monetary policy to inflationary pressures emanating from supply shocks in the absence of demand side pressures rages on in South Africa. This is despite evidence showing that the persistently negative output gap can be accompanied by inflationary pressures and poorly anchored inflation expectations. In this chapter we use the sign restriction approach described earlier to determine the contributions of demand pressures on inflation.

This will show that a positive aggregate demand shock based on the sign restricted VAR exerts downward pressures on inflation without including an output gap in the analysis. Furthermore, does the repo rate adjust in a similar manner to a positive inflation expectations shock, the adverse aggregate supply and positive aggregate demand shocks? Do they drive the rand/US dollar exchange rate movements?

These policy and research gaps have not been highlighted in policy deliberations. In literature we differ in both the objective of the study and methodology from both Barnett et al. (2010) and Gabriel (2010). The analysis extracts the estimated demand, supply and expectation shocks series from the model. In addition, the objective is to show the current influence of these shocks on impacting inflation expectations, the exchange rate and inflation dynamics. Thereafter, derive policy implications based on the findings.

Expected shock effects are always discounted in the decisions making by agents while the unexpected aspects induce revisions. So, how reasonable are the effects of the estimated unexpected components of inflation expectations shocks series on the dynamics of selected economic variables? Does the elevated unexpected inflation component lead to loosening or tightening of credit conditions? These aspects are explored in next sections.

30.2 To What Extent Do the Effects of a Positive Inflation Expectations Shock Differ from Those of an Adverse Aggregate Supply Shock?

A sign restricted VAR model is estimated using monthly (M) data spanning June 2001 to July 2015, which includes the annual changes in retail sales, headline inflation, eight-year break-even inflation expectations, the repo rate and annual changes in the rand/US dollar exchange rate. The VAR is estimated using six lags selected by Aikake Information Criteria (AIC) and keeps only 10,000 draws that satisfy the imposed restrictions. This chapter isolates the effects of a positive inflation expectations shock from those of positive demand and adverse supply shocks.

The findings in Fig. 30.2 show that the impact of a positive inflation expectations shock on the variables in the model is the same as the adverse supply shock. Fig. 30.2(a) shows that the decline in retail sales growth is not different as both responses are within the confidence bands depicted by the grey area. The responses of inflation in Fig. 30.2(b) and the repo rate in Fig. 30.2(d) increase. Nonetheless, the increase is significantly less than the responses to the adverse supply shock.

From a policy perspective, these findings reinforce the view that the concurrence of adverse supply shocks and positive inflation expectations shocks can have debilitating effects on economic activity. In view of their negative independent effects, their simultaneous occurrences may indeed require a different policy response and approach.

30.3 What Can Be Inferred from the Reaction of Monetary Policy to a Positive Inflation Expectations Shock, Adverse Supply Shock and a Positive Demand Shock?

Does the policy rate adjust in a similar manner to the effects of a positive inflation expectations shock relative to those associated with adverse supply and aggregate demand shocks? The magnitudes of the responses of the repo rate and inflation expectations are compared respectively to adverse aggregate supply and positive demand shocks. The repo rate rises more aggressively to a positive demand shock in Fig. 30.3(a) relative to other shocks.

Furthermore, the fact that the repo rate responses to the positive demand shock and an adverse supply shock are within the grey shaded area suggests that policy tightening adjustments to these shocks are not statistically different. However, it is noticeable that the repo rate does not

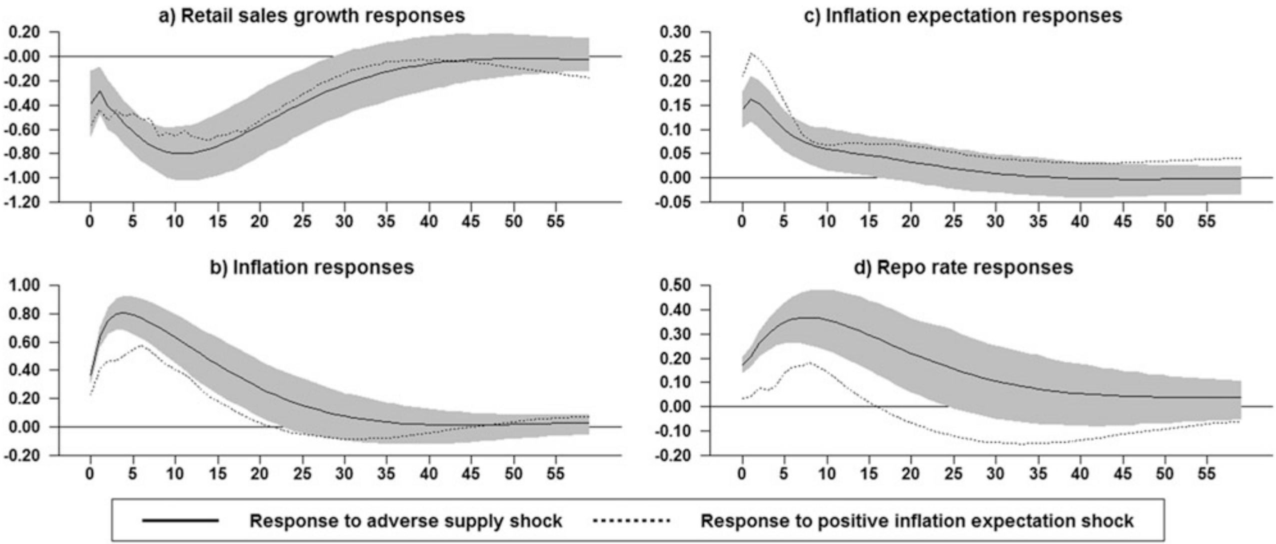

Fig. 30.2 Positive inflation expectations shocks and adverse supply shock. *Source*: Authors' calculations. *Note*: The grey shaded area denotes the16th and 84th percentile confidence bands

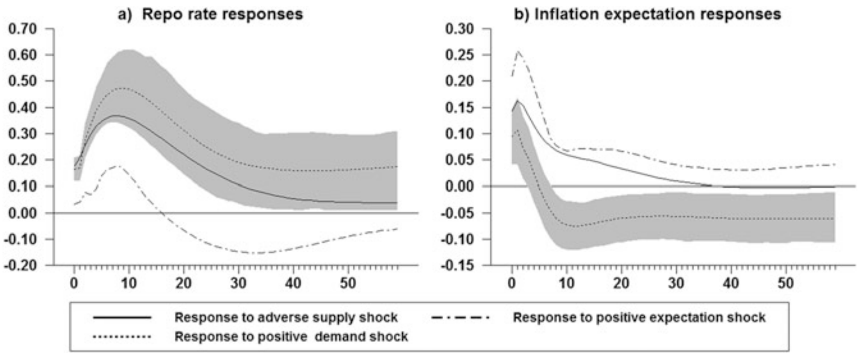

Fig. 30.3 The comparison of the responses on the repo rate and inflation expectations to various shocks. *Source*: Authors 'calculations. *Note*: The grey shaded area denotes the16th and 84th percentile confidence bands

rise very much in response to a positive inflation expectations shock. The results suggest that the policy rate is indeed tightened in response to these three shocks, although the magnitudes differ. The rate of tightening is intense in response to the effects of a positive demand shock.

In Fig. 30.3(b) all inflation expectations decline in a significantly different manner in response to different shocks. However, it is evident that the aggressive increase in the repo rate translates into a quick decline in the response of inflation expectations due to a positive demand shock. Thus positive inflation expectations shocks and adverse supply shocks lead to persistent and sluggish rise in inflation expectations.

This suggests that the public may believe that the monetary policy authority does accommodate temporary shocks which increase long-term inflation expectations to supply related shock. In a policy perspective, this suggests that the policy rate adjustments should not be as aggressive to a positive inflation expectation shock compared to response towards demand and supply shocks. The finding that positive demand shock leads to a highly transitory increase in inflation expectations suggests that monetary policy conduct may have earned credibility in dealing with positive demand shocks relative to positive inflation expectations and supply shocks.

30.4 What Is the Impact of Positive Demand, Adverse Aggregate Supply and Inflation Expectations Shocks on the Rand per US Dollar Dynamics?

The sections examines the responses of rand per US dollar exchange rate (R/US$) to the three shocks. Fig. 30.4(a–c) confirms that the exchange rate is responsive to these shocks and the magnitudes differ.

The R/US$ exchange rate depreciates for nearly 13 months due to a positive inflation expectations shock. This is longer than the 10 months exerted by the adverse supply shock. In contrast, the demand shock leads to a very short rand depreciation episode. Fig. 30.4(d) compares all the responses of the R/US$ exchange rate to the three shocks and finds that the rand depreciates by nearly 2.1–2.3 per cent at peak response due to an increase in inflation expectations and adverse supply shocks, respectively. The depreciation occurs in the first eight months and is large relative to that arising from a positive demand shock. Similarly, the magnitude of the exchange rate response to an adverse supply shock is large compared to that from positive inflation expectation shock.

It is interesting to find that the exchange rate depreciation due to the positive demand shock is followed by a significant correction which leads to a massive appreciation. How is this possible? This might be due to the aggressive response of the policy rate to a demand shock relative to the other two shocks. The rate and magnitude of the repo rate response may be partly responsible for attracting capital inflows as the interest rate differential favours an increase in the demand for domestic assets and in turn the currency appreciation. On the other hand, the exchange rate responses to supply and inflation expectations shocks may imply that market participants are of the view that policy is "partially accommodative" of aggregate supply shocks. This is in line with the use of "escape clauses" in the stabilisation of the output gap. Overall, these results suggest that adverse supply shocks, positive aggregate demand and inflation expectation shocks are among the drivers of the exchange rate.

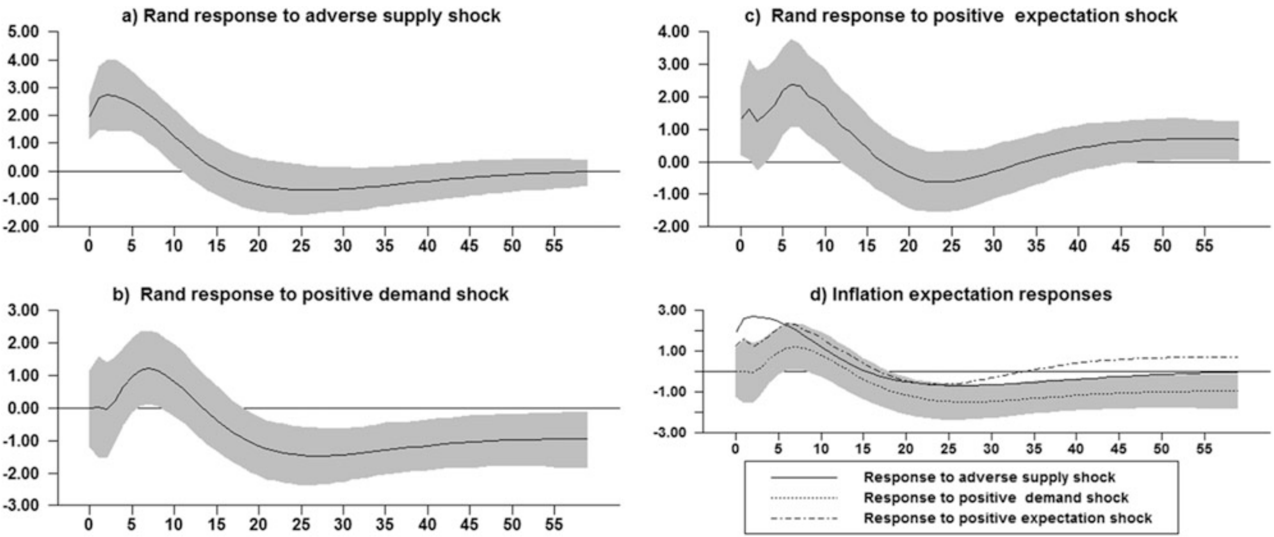

Fig. 30.4 The response of the rand/US dollar exchange rate to the three shocks. *Source*: Author's calculations. *Note*: The grey shaded area denotes the16th and 84th percentile confidence bands

Furthermore, they maybe instigators of upside risk factors to the inflation outlook via exchange rate depreciation.

30.5 Which Shock Is a Drag on Economic Recovery via Retail Sales?

The absence of demand pressures and the sluggish economic recovery has fuelled the debate on how policy should respond to mostly supply shock-driven inflationary pressures and breaches of the upper inflation target band. In this section, we determine the contributions of each of the three shocks to the evolution of retail sales growth as a proxy for consumption growth. Fig. 30.5 shows that since 2011 (also shown by circled portion) all shocks have been a drag on retail sales growth. Amongst the three shocks, the adverse supply shock leads to the least decline in retail sales growth. The negative contributions from the positive demand shocks indeed show weak demand pressures.

However, the significant part of the slowdown in growth in retail sales is due to the effects of a positive inflation expectations shock. Inflation expectations have become highly correlated to the R/US dollar exchange rate changes post-2010. The results further reinforce the view that financial market participants associate the R/US dollar depreciation with expected inflation or a worsening inflation outlook.

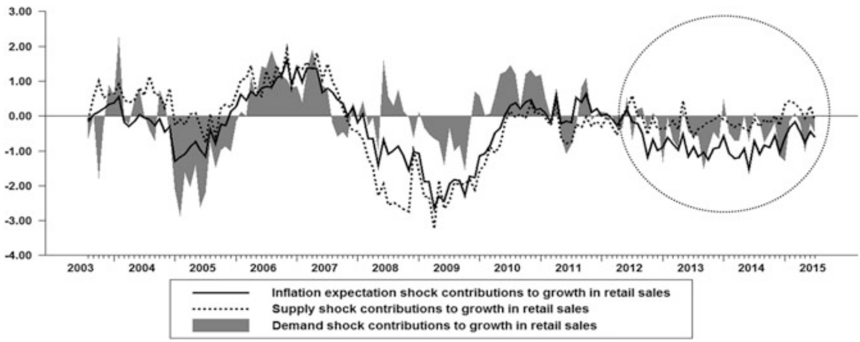

Fig. 30.5 Contributions of inflation expectations, demand and supply shocks to growth in retail sales growth. *Source*: Author's calculations

30.6 Inflation Expectations Shock and Adverse Supply Shock Effects on the Exchange Rate

Much of the policy talk and communication has emphasised the adverse risks posed to the R/US$ by the imminent Fed policy normalisation. Policymakers have also clearly stated that domestic factors do play a role in the R/US$ exchange rate movements. So, what does a positive inflation expectations shock do to the R/US$ changes? Evidence in Fig. 30.6 shows that since mid-2011 the inflation expectations shock contributed more to the depreciation of the R/US$ exchange rate relative to the supply and demand shocks.

The adverse supply shock has contributed to the rand depreciation since mid-2011, but the magnitudes are far less than those associated with the positive inflation expectations shock. In contrast, the demand shocks have contributed less to R/US$ depreciation, except in the latter part of 2014 onwards. These findings suggest that negative GDP growth and low growth expectations contributed to the depreciation of the R/US$ exchange rate. In fact, as at July 2014, all three shocks have been contributing to the depreciation of the R/US$ exchange rate.

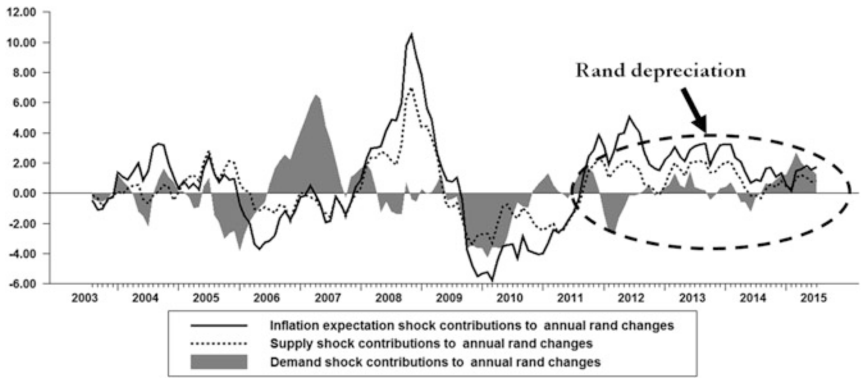

Fig. 30.6 The inflation expectations shock and adverse supply shock contributions to R/US$ exchange changes. *Source*: Author's calculations

30.7 Positive Demand Shocks vs. Positive Inflation Expectations Shocks on Inflation

The analysis shows the contributions of a positive inflation expectations shock and an adverse supply shock to inflation in Fig. 30.7. The results show that between 2008 and 2010 inflation expectations and supply shocks were the key drivers of inflation and may explain the delayed decline in inflation during recession in 2009. The same shocks are also responsible for elevated inflation between 2011 and 2014. They have been pulling down inflation since January 2015. As stated in the previous section, this might be wearing off. The results in Fig. 30.7 reinforce the absence of demand pressures in driving inflation since December 2012.

Overall, the evidence presented in this section reinforces the view that the absence of demand pressures plays a limited role in mitigating the pass-through of inflationary supply shocks and inflation expectations in South Africa. This is in stark contrast to the experience in advanced economies. For instance, Sussman and Zohar (2015) find that the five-year inflation expectations in the US, euro area and Israel have become highly correlated with global demand and supply conditions as reflected in oil prices. Furthermore, they establish that post-financial crisis global demand explains a significant part of developments in global inflation expectations.

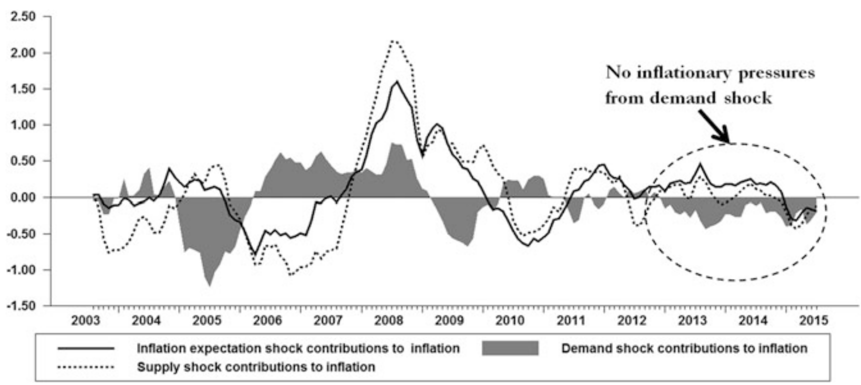

Fig. 30.7 Inflation expectations and adverse supply contributions to inflation. *Source*: Author's calculations

Moreover, we assess the reasonableness of the estimated inflation expectations shocks series using the 12-month centred moving average as in Fig. 30.8. We determine the relationships between the estimated inflation expectations shock series and selected economic indicators to see if it is consistent with expected economic outcomes. The business and consumer confidence indices Fig. 30.8(a) and (b) decline due to an increase in the unexpected component of inflation expectations. This means that animal spirits are weakened during periods of heightened unexpected inflation expectations, which in turn depress economic activity. In addition in Fig. 30.8(c) and (d), the positive relationship between the unexpected inflation expectations component with wage inflation overwhelmingly suggests that the elevated component of unexpected inflation expectations increases private and public sector wage inflation. The responses of the private and public sectors wage growth are different. The private sector has a slightly steeper slope than the public sector, suggesting that it is more responsive to the estimated unexpected inflation expectations shock series.

Fig. 30.8(e) an unexpected inflation expectations series affects employment and there is a negative relationship, which means that employment declines as the unexpected inflation expectation component increases. Similarly Fig. 30.8(f) and (g), unit labour costs increase due to unexpected inflation expectations shock. In Fig 30.8(h) and (i) consumption expenditure and GDP growth are sensitive to the estimated inflation expectations and exhibit a negative relationship. The steeper slope of the bilateral relationship for consumption suggests that consumption expenditure is more sensitive than GDP growth to an increase in the unexpected component of the estimated inflation expectations shock series. But non-durable consumption is less sensitive compared to other components of expenditure.

Finally, evidence in Fig. 30.9(a) shows that there are linkages between the unexpected component of inflation expectations and the credit conditions index. There is negative relationship between the credit conditions index and inflation expectations. This relationship is much steeper compared to that between the credit condition index and the unexpected component of the adverse supply shock. The negative sign implies that elevated inflation expectation and adverse supply shock lead to tighter

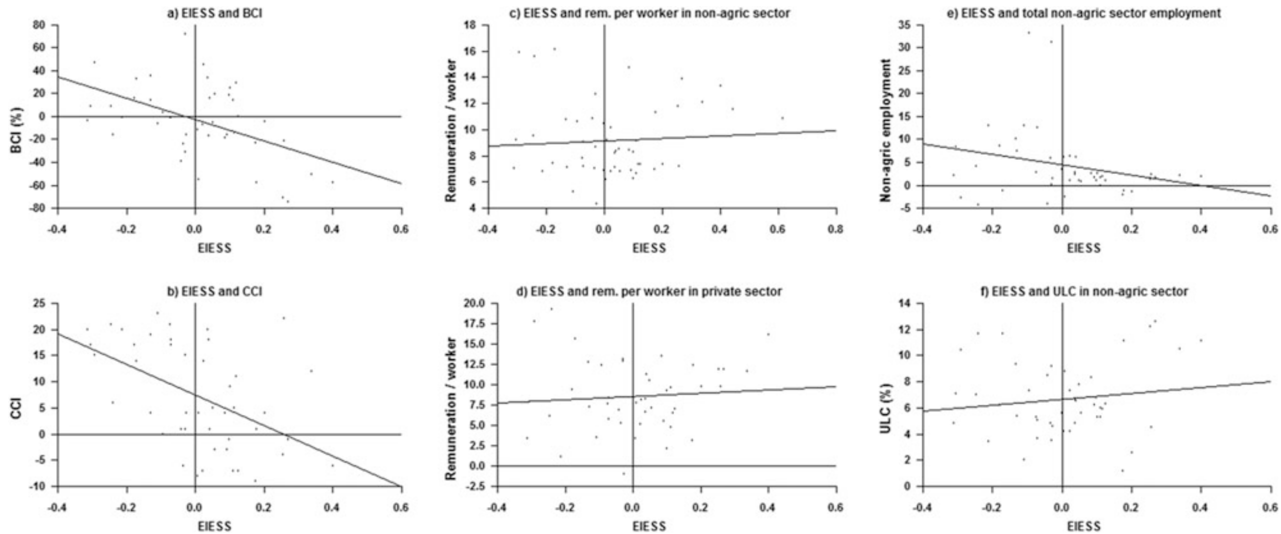

Fig. 30.8 Relationship between estimated inflation shock expectation series and other variables. *Note*: EIESS refers to estimated inflation expectation shock series. BCI refers to business confidence indicator changes, CCI refers to consumer confidence indicator, rem. per worker refers to remuneration per worker, non-agric. refers to non-agricultural, and ULC refers to unit labour costs

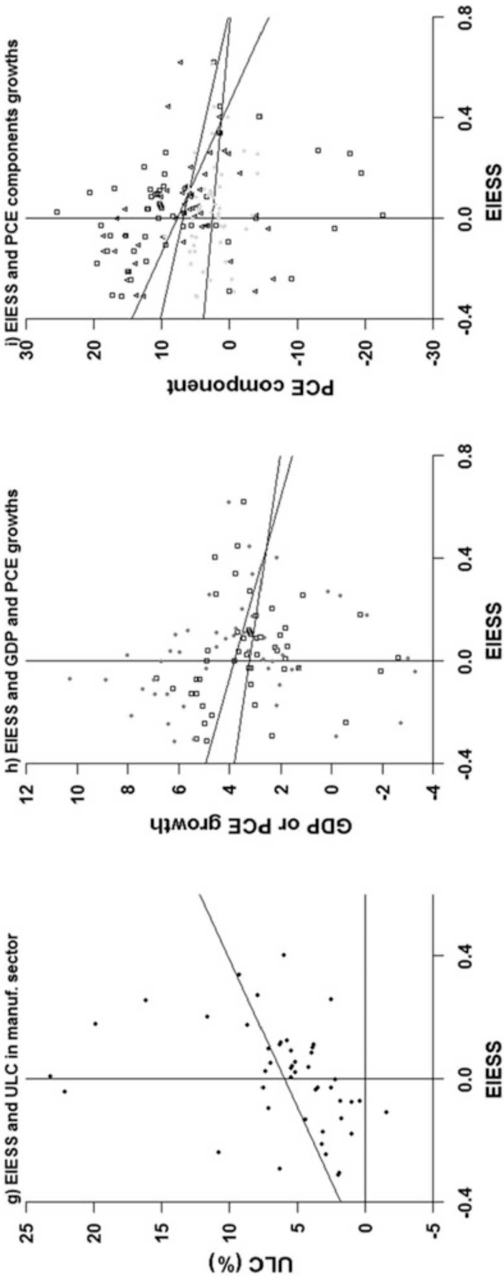

Fig. 30.8 (continued)

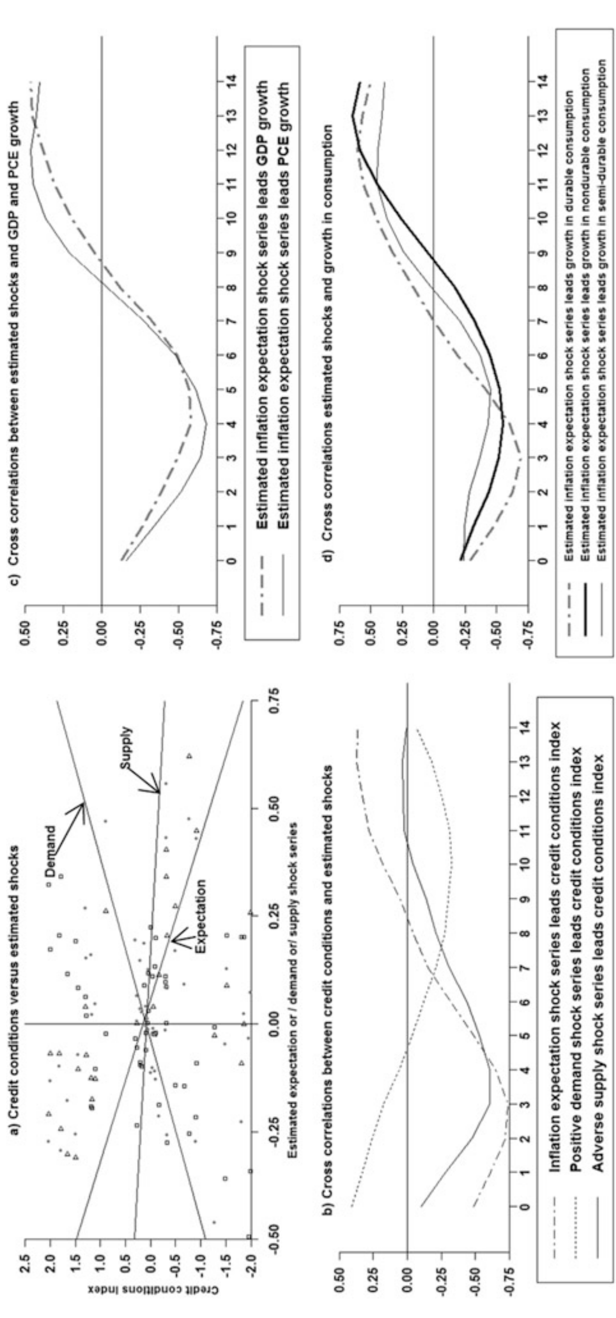

Fig. 30.9 Credit conditions and estimated shock series and cross correlations

credit conditions (Fig. 30.9). The cross correlation in Fig. 30.9(b) to (d) indicate a negative relationship. This suggests that GDP growth, consumption and its components will decline when preceded by the elevated estimated inflation expectations shock series. We conclude that evidence based on the scatter plots and cross correlations adheres to the expected theoretical relationships.

30.8 Conclusion and Policy Implications

This chapter examined whether the effects of a positive inflation expectations shock differ from those of an adverse aggregate supply shock. This includes assessing the role of positive aggregate demand shock and comparing it to those of the positive inflation expectations shock and an adverse aggregate supply shock. Evidence indicates that the concurrence of the adverse supply shocks and positive inflation expectations shocks can have devastating effects on economic activity. These shocks exert similar negative and pronounced responses on retail sales as a proxy for demand. Furthermore, the findings indicate that the adverse supply shock did contribute to the rand depreciation since mid-2011 but the magnitudes are far less than those associated with the positive inflation expectations shock.

On the other hand, the repo rate is adjusted aggressively to a positive aggregate demand shock. This aggressive increase in the repo rate to a demand shock translates into a quick decline in the response of inflation expectations. The policy implication is that financial market participants do indeed believe that the monetary policy authority deals decisively with positive aggregate demand shocks. Hence, monetary policy conduct may have earned credibility in dealing with demand-driven inflationary shocks. But the absence of demand pressures plays a limited role in mitigating the inflationary effects of supply shocks and inflation expectations.

The results differ in relation to the policy responses due to supply shocks and positive inflation shocks. Irrespective of the fact that positive inflation expectations shocks and the adverse supply shocks lead to a persistent rise in inflation expectations and the depreciation in the exchange rate, agents have learned that policy is "partially accommodative" to these shocks. From a policy perspective, the findings reinforce the view that the concurrence of adverse supply shocks and positive inflation expectations shocks that tend to move economic variables in the same direction can have debilitating effects on economic activity. This means that policymakers should take appropriate action when necessary to mitigate that expected prices do not become realised prices.

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31

Wage Increases in Excess of 6 Per cent, Inflationary Dynamics and Expectations

Learning Objectives

- The impact of excess wage inflation shocks on one- and two-year-ahead inflation expectations
- Feedback effects between excess wage increases and inflation
- The extent to which the agents update inflation expectations and the propagation due to upside risk factors to inflation
- The role of labour market adjustment via wage changes

31.1 Introduction

The previous chapter examined the effects of inflation expectation shocks and adverse supply shock. However, in practice the policymakers look at a variety of measures of inflation expectations, including the Bureau of Economic Research (BER) survey inflation expectations. Of particular importance is reference made to inflation expectations of businesses and labour, which are considered as price setters in the economy. Policymakers constantly cite wage and salary increases in excess of 6 per cent as an upside risk factor to the inflation outlook. This is underpinned by the

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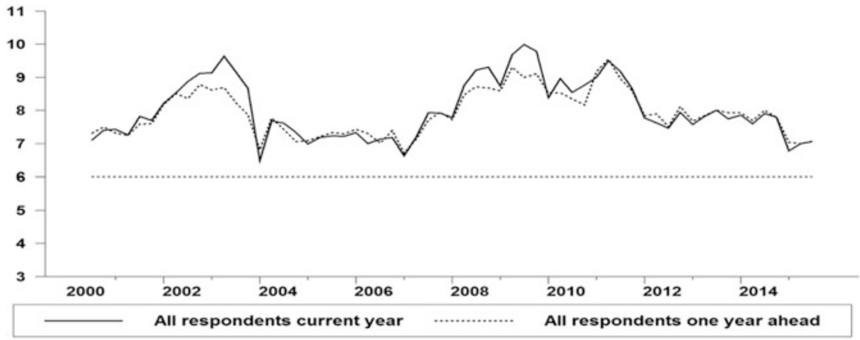

Fig. 31.1 Expectations of salary and wage increases. *Source*: BER

importance of the interaction of wage growth and the price formation process. How do wage increases in excess of 6 per cent impact inflationary dynamics and expectations? How should monetary policy respond?

The analysis starts the discussion by showing that current and one-year-ahead BER expectations of nominal wage and salary increases have been in excess of 6 per cent and have increased in the last two quarters of 2015, as shown in Fig. 31.1. The trends suggest that economic agents have undertaken a view that future inflation will be persistently around (and even slightly above) 6 per cent. Viewed from this lens, it is possible that the policymaker's concerns that "poorly" anchored inflation expectations can accentuate prolonged deviations of the inflation from the target. In turn, they can trigger wage and price-setting behaviour that can make inflation deviations more persistent and costly to reverse.

This chapter examines the role of inflation expectations adjustment process via a number of channels. Do the one- and two-year-ahead inflation expectations become less anchored due to excess wage inflation shocks? Is there evidence of feedback effects between excess wage increases and inflation? Furthermore, does this link depend on the source of excess wage increases? Is there a difference between the impact of food and headline CPI shocks on excess wage increases?

If the formation of inflation expectations is affected by the constant learning process and updated beliefs as economic agents adjust to new regimes as suggested in literature, to what extent are inflation expectations updated, based on unexpected positive shocks to current inflation expectations? How robust is the evidence that inflation expectations are updated? Once unhinged, how long do they take to return to pre-shock levels and what is the half-life of the shock? The much newer analysis is an application of a counterfactual analysis to determine the consumer price inflation and inflation expectations in amplifying shocks. This is the basis of why maintaining price stability and anchoring of inflation expectation remains of considerable importance.

Furthermore, the analysis looks at the role of labour markets, using the counterfactual analysis of the role that excess wage growth above 6 per cent plays in cushioning GDP growth to external shocks. In addition, the analysis shows the role of inflation and inflation expectation using counterfactual on the wage adjustment following the US QE 1 shock. These gaps have not been quantified from the South African perspective before. Economic theory suggests that labour markets should adjust during recessions or to severe financial shocks via the downward revision of wages and price expectations to facilitate a return to pre-crisis output. To illustrate the role of labour markets in facilitating an adjustment following adverse financial and economic shocks we ask: Did wages and excess wages respond to the first round of the US Fed quantitative easing shock? Did the inflation expectation adjust as theory predicts? According to theory, labour has a role in the adjustment process.

For instance, labour markets have a role in the transmission of a financial shock on domestic aggregate demand as in Appleyard, Field and Cobb (2008).[1] The real effective exchange rate (REER) appreciation in turn makes domestic goods expensive to rest of the world. Similarly, in Fig. 31.2(a) the aggregate demand curve shifts downwards leading to price and output declines. Both the REER appreciation and reduced aggregate demand leads to a price reduction from P_0 to P_1 in Fig. 31.2(a) and (b).

[1] Note: P_e and W_e refers to expected prices and wages respectively. AD refers to aggregate demand curve. AD_0 and AD_1 refer to initial and final aggregate demand curve respectively. AS refer to aggregate supply curve. $Assr_0$ to $Assr_1$ refer to initial and final short-run aggregate supply curve. ASlr refer to long run aggregate supply. AD_0 and AD_1 refer to initial and final aggregate demand curve respectively. Y_0 and Y_1 are initial and final outputs respectively. W_0 and W_1 are initial and final repo rate levels respectively. C_0 and C_1 are the initial and final credit levels, respectively.

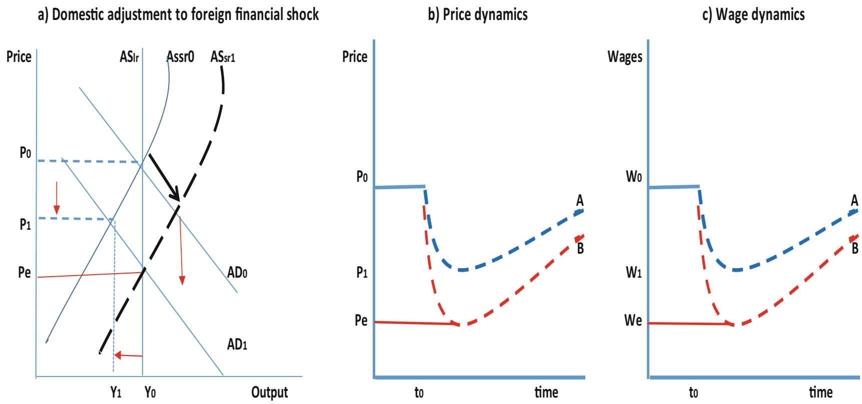

Fig. 31.2 The theoretical role of the labour market in economic adjustment to foreign financial shock. Fig. 25.3 shows the interaction between aggregate demand (AD) and aggregate supply (AS) and distinguishes between the short-run (ASsr) and the long-run (ASlr) aggregate supply. We also differentiate between instantaneous and sluggish (slow) macroeconomic adjustments. The global financial shock, through the portfolio rebalancing channel, leads to a surge in capital inflows or "search for yield". This appreciates the recipient country's exchange rate as foreigners exchange their currency for domestic currency to buy domestic assets. *Source*: Authors' drawing and adapted from Appleyard et al (2008)

The policy rate in response to the decline in prices and output also adjusts downwards.

What is the role for labour markets? Their adjustment is needed to return to the initial output. This happens via a reduction in nominal wages from W_0 to W_1 in Fig. 25.3(c), when labour markets realise that actual prices fall to expected prices from P_1 to P_e in Fig. 31.2(b). This shifts the short-run aggregate supply from $Assr_0$ to $Assr_1$ such that the initial output equilibrium is restored and wages have to decline to W_e in Fig. 31.2(c).

31.2 How Do the Inflation Expectations Become Poorly Anchored?

When are inflation expectations "well" anchored? The analysis does not engage in an exhaustive review of literature arguments. But briefly states that when faced with temporary deviations of inflation, it is generally accepted that inflation expectations are "well" anchored, if the public has a reasonable degree of confidence that inflation will return to the target in the medium term and remain there.[2] In such instances the public believes that policymakers are capable of doing whatever it takes to prevent high inflation episodes from recurring. The public does not doubt the determination of policymakers to return inflation to the target. This argument is underpinned by literature asserting that the absence of commitment and credibility in monetary policy conduct is a key factor in recurring inflationary episodes (Leduc et al. 2002). Therefore, monetary policy conduct can be a source of instability in inflation expectations and inflation regimes.

Furthermore, evidence of "poorly" anchored inflation expectations becomes evident if temporary shocks that increase expected inflation lead to permanent increases in actual inflation. We refrain from an extensive review of the literature on whether the formation of inflation expectations is characterised by an extrapolative, or backward or forward-looking, or a rational process. But simply state that vast literature shows that inflation expectations fail to adhere to the rational expectations hypothesis. Literature establishes that inflation expectations are better explained by the learning and adaptive process; hence, they are largely backward-looking. In addition, Vargas et al. (2009) argue that the presence of wage and price indexation also contributes to inflation, behaving as if inflation expectations are backward-looking.[3]

[2] The idea and definition of "well" anchored inflation expectations is captured by a state in which the public is fairly confident in its forecast of long-run inflation, such that new information has a limited impact (Bernanke 2003).

[3] This aspect is particularly important in South Africa as there are instances of wage agreements indexed to the prevailing consumer price inflation for multiyear periods.

Of importance in the discourse is the degree of inflation persistence and the disinflation costs. As such, to the degree that inflation expectations affect inflation persistence as suggested by the New Keynesian open economy theory, policymakers that can successfully anchor inflation expectations can reduce inflation persistence. In turn, low inflation persistence implies that the related output costs due to a disinflationary monetary policy stance will be small. Furthermore, “well” anchored inflation expectations can lower the fraction of backward-looking agents caused by wage and price indexation and the persistence of inflation.

31.3 Does Wage Growth in Excess of 6 Per cent Impact Inflation Expectations?

This section briefly looks at selected relationships between inflation expectations and wage growth in excess of 6 per cent, using quarterly (Q) data that spans 2002Q3 to 2015Q1. This includes determining whether one-year-ahead inflation expectations change in response to economic developments. Maule and Pugh (2013) suggest that when individuals believe that short-term economic developments will affect long-term inflation, this will increase the correlation between short and long-term inflation expectations. As such in Fig. 25.4(c) and (d) there is evidence that the one- and two-year(s)-ahead inflation expectations are responsive and rise when current inflation expectations increase.

This preliminary evidence indicates that individual inflation expectations or perceptions at longer horizons may become more responsive to current perceptions about inflation outturns or news. This happens when the expected deviations of inflation from the target are perceived to be more persistent. In addition, perceptions may reveal that monetary policy attaches less weight in returning inflation to the target in the medium to long-run (Maule and Pugh 2013).

What happens to inflation expectations when they are preceded by excess wage growth? An *excess wage growth* is given by the difference between growth in wages and 6 per cent and negative values are replaced by zero. Thus only wage growth rates that exceed 6 per cent are used in

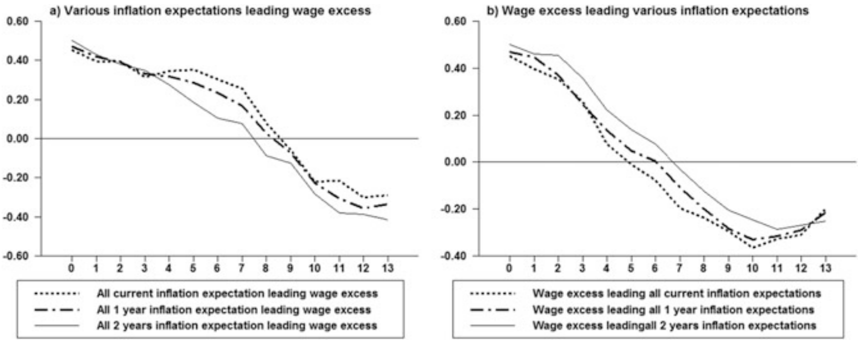

Fig. 31.3 Lead-lag relationship between of excess wage growth and inflation expectations shocks. *Source*: Authors' calculations

the analysis. This analysis distinguishes between the private and public sector wage growth, respectively. This is a preliminary approach to test whether inflation expectations remain anchored when preceded by excess wage growth. Fig. 31.3(a) and (b) show that inflation expectations rise when preceded by excess wage growth. There is also evidence of feedback effect between excess wage growth and inflation expectations.

31.4 Are Inflation Expectations "Well" Anchored?

This section adopts a hypothesis testing approach to assess the extent to which inflation expectations are "well" anchored? We test two hypotheses, namely:[4]

Hypothesis 1: *If inflation expectations are "well" anchored, then inflation expectations are unlikely to move in response to economic shocks that are projected to push inflation away from the target temporarily.*

[4] See Anderson and Maule (2014).

Hypothesis 2: *If inflation expectations are "well" anchored, they should not be affected further ahead because at that point the price rise will have fallen out of the annual calculations.*

The analysis begins by investigating the role of two-years-ahead inflation expectations in the transmission of private sector excess wage growth effects to consumer price inflation (Infl) using Eq. (31.1). The $Priv\_wagexcess\_dummy_{t-i}$ denotes the private sector excess wage growth. The $2yrs\_\exp_{t-i}$ denotes the two-years-ahead inflation expectations. The equation enables the determination of actual inflation responses and counterfactual impulse responses. The counterfactual impulse responses refer to responses derived after shutting off the two years inflation expectation or setting the estimated coefficients for this variable to zero.

$$Inf_t = constant + \sum_{i=1}^{4} \beta_i Inf_{t-i} + \sum_{i=0}^{4} P_i 2yrs\_exp_{t-i} + \sum_{i=0}^{4} T_i Priv\_wagexcess\_dummy_{t-i} + \varepsilon_t \quad (31.1)$$

The cumulative inflation responses to the private sector excess wages are shown in Fig. 31.4(a). Inflation rises considerably in the presence of two-year-ahead inflation expectation as shown in Fig. 31.4(a), rather than when inflation expectation is shut off the model. The amplification effects induced by two-year-ahead inflation expectation are shown in Fig. 31.4 (b). This shows that inflation expectations are propagators of private sector excess wage shock to inflation; hence, it is important to anchor them.

Does the exchange rate channel propagate wage shocks to inflation expectation? The analysis is extended to show the role of exchange rate in the responses of two-year-ahead inflation expectation based on Eq. (31.2). The *Exch* denotes the annual rand/US dollar exchange rate and this variable captures the transmission of private sector excess wage shocks to two-year-ahead inflation expectation shock. Similar to the explanations provided in the preceding section, we calculate the counterfactual impulse by shutting off the effect of the exchange rate and compare the responses

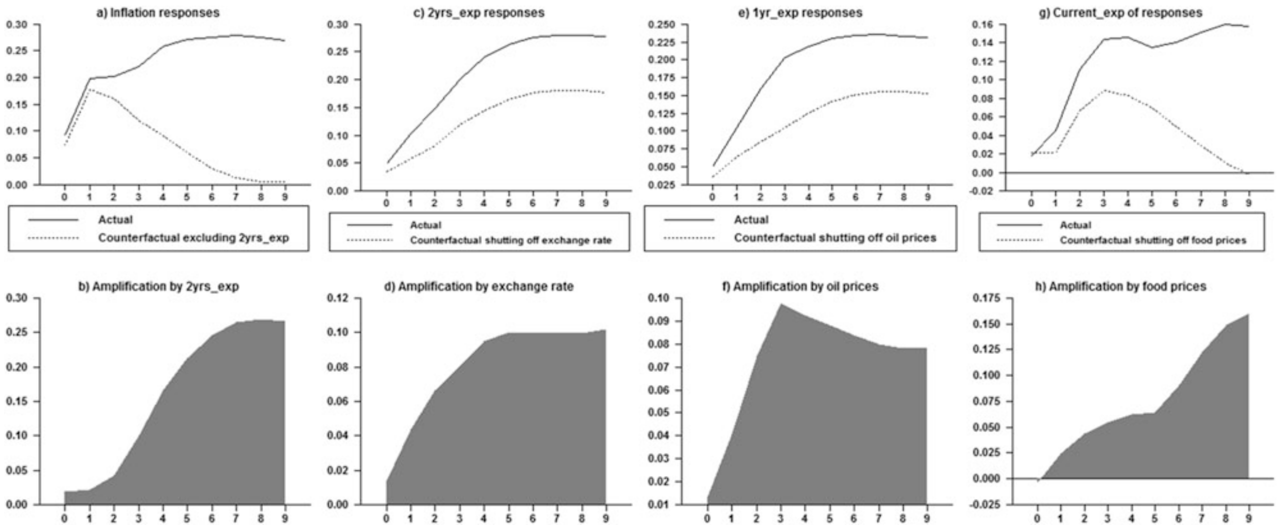

Fig. 31.4 Inflation responses to private sector excess wage growth and amplification by two year ahead inflation expectation. *Source*: Authors' calculations. *Note*: 2yrs_exp and 1yr_exp refers to two years ahead and one year ahead inflation expectation. Current_exp refers to current inflation expectation

when this channel is not shut off in the model. The gap between the actual and counterfactual shows the amplifying effect of the exchange rate.

$$2yrs\_exp_t = constant + \sum_{i=1}^{4} \beta_i 2yrs\_exp_{t-i} + \sum_{i=0}^{4} P_i Exch_{t-i} + \sum_{i=0}^{4} T_i Priv\_wagexcess\_dummy_{t-i} + \varepsilon_t \tag{31.2}$$

Evidence shows that positive private sector excess wage growth shocks lead to a significant increase in the two-year inflation expectations Fig. 31.4(c). This happens when the exchange rate channel is shut off and when it is included in the model. Inflation expectations increase further due to positive excess wage shock in the presence of exchange rate depreciation and the amplification effects shown in Fig. 31.4(d). This means that exchange rate depreciation makes expectations become less anchored. The next estimations replace two year ahead inflation expectations with one year ahead and current inflation expectations. In addition, the exchange rate is replaced with oil price changes and food price inflation.

Oil price shocks also amplify the responses of one-year-ahead inflation expectation to private sector excess wage growth. One-year-ahead inflation expectation increases more in the presence of oil price change than when this is shut off in the model in Fig. 31.4(e) and (f). Similarly, food price inflation propagates wage shock to current inflation expectations. Current inflation expectations increase significantly when the food price inflation is not shut off in the model in Fig. 31.4(g) and (h). All this evidence shows that inflation expectations are not well-anchored and may remain unanchored for a long period of time, perpetuated by the prevalence of short-term risks to inflation outlook.

31.5 Evidence from the VAR Model

The preceding evidence is based on a single equation, which did not consider the feedback effects amongst variables. Consequently, we now apply a three-variable VAR approach, using private or public sector excess wage growth, current or one- or two-year-ahead inflation expectations and headline inflation. To isolate sectorial effects, the analysis distinguishes between private and public sector excess wage growth to assess the differential effects. The lag length of one lag was selected by the HQ criteria and the impulse responses are based on 10,000 draws. Fig. 31.5(a) and (b) shows the responses of all categories of inflation expectations to public and private sector excess wage growth shocks.

Evidence shows that all categories of inflation expectations rise for nearly 11 quarters (almost three years) in response to a positive excess wage growth shock in Fig. 31.5(c) and (d). This is a prolonged period. In addition, the responses are not transitory and do not quickly return to pre-shock levels. This suggests that inflation expectations are not "well" anchored. Furthermore, this evidence suggests that inflation expectations are highly responsive to an unexpected excess wage growth shock. Given the inflation expectations being persistently close to the upper part of the target band, their sensitivity heightens the upside risks they pose to the inflation outlook should they deviate from the target band for a prolonged period. The impulse responses also show significant differential responses. The current inflation expectations are highly responsive relative to the two-year-ahead. In light of this evidence, both Hypotheses 1 and 2 are rejected.

Furthermore, evidence shows that there are feedback effects. An unexpected 1 per cent positive inflation expectations shock increases excess wage growth in Fig. 31.5(c) and (d). The peak effects occur in the first quarter and decline thereafter. Inflation expectation shocks induce cyclicality in the wage setting process. The cyclicality of wage excesses implies that wages are set at a higher level in the first year followed by lower increases in the second and third years. This is likely due to the prevalence of multiyear wage indexation in the public and private sectors.

Consumer price inflation amplifies the responses of inflation expectations to positive public sector excess wage growth shock in Fig. 31.5(e). Evidence shows that actual inflation expectations responses exceed the counterfactual responses, meaning that inflation amplifies the transmission of wage excess growth shocks to inflation expectations. Similarly, in Fig. 31.5(f) consumer price inflation amplifies the inflation expectation responses to positive private sector excess wage growth shock. This means that price stability matters because in the absence of high consumer price

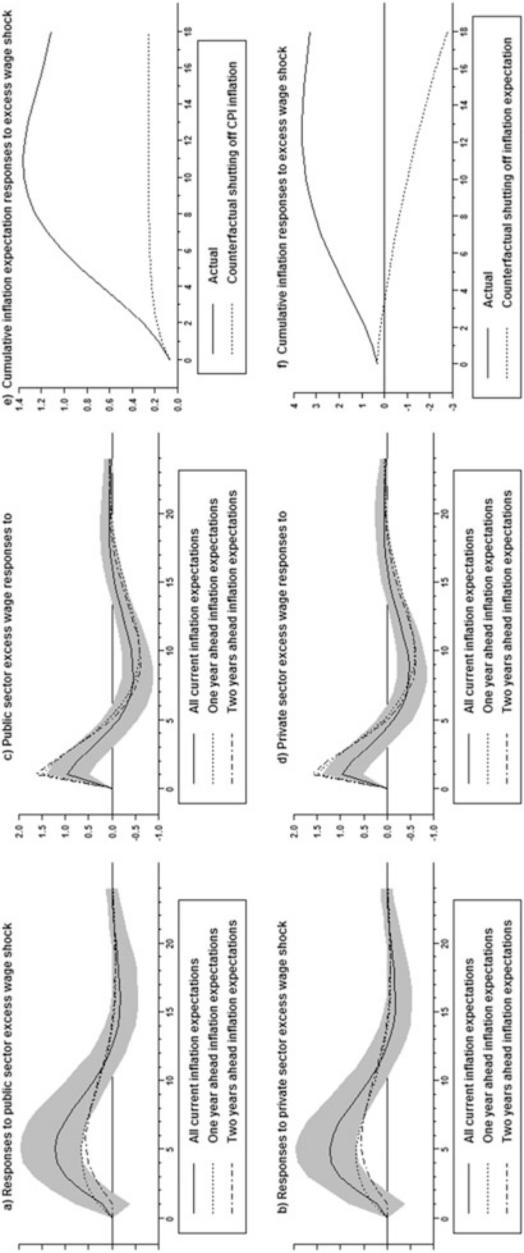

Fig. 31.5 Inflation expectations response to a positive excess wage growth shock. *Source*: Authors' calculations. *Note*: Responses are in percentage points

inflation, the positive wage excess growth shock would not have a substantial impact on inflation expectations.

31.6 To What Extent Do Agents Update Their Inflation Expectations?

Literature unambiguously points out that inflation expectations may react to news about inflation outturns but the duration of return of inflation expectations to pre-shock level matters for policy responses. This section assesses the implication of shocks to current inflation expectations on the one- and two-year-ahead inflation expectations. This is examined in number of ways using a VAR approach with public or private sector excess wage growth, current and one- or two-year-ahead inflation expectations. The excess wage growth variables and the one-and two-year-ahead inflation expectations are used interchangeably in the estimations. The model uses one lag selected by HQ criteria and 10,000 draws for impulse responses.

Fig. 31.6 shows the responses of one- and two-year-ahead inflation expectations to a 1 per cent unexpected increase in current inflation expectations. Fig. 31.6(a) shows that current inflation expectations shock raises the two-year-ahead inflation expectations more than the one-year-ahead inflation expectations. It is evident in Fig. 31.6(b) that the current inflation expectations shock is persistent when the two-year-ahead inflation expectations are used. If that is the case, how long does it take for half of the initial shock to die out? The half-life takes nearly seven quarters when considering the influence of two-year-ahead inflation expectations, which is three times the half-life when one-year-ahead inflation expectations are considered.

Thus evidence suggests that updating of the two-year-ahead inflation expectations is likely to remain persistently high due to a positive current inflation expectation shock. A high degree of persistence in the two-year-ahead inflation expectations may lead to persistent inflation. This implies that the return to the inflation target may be reached very slowly.

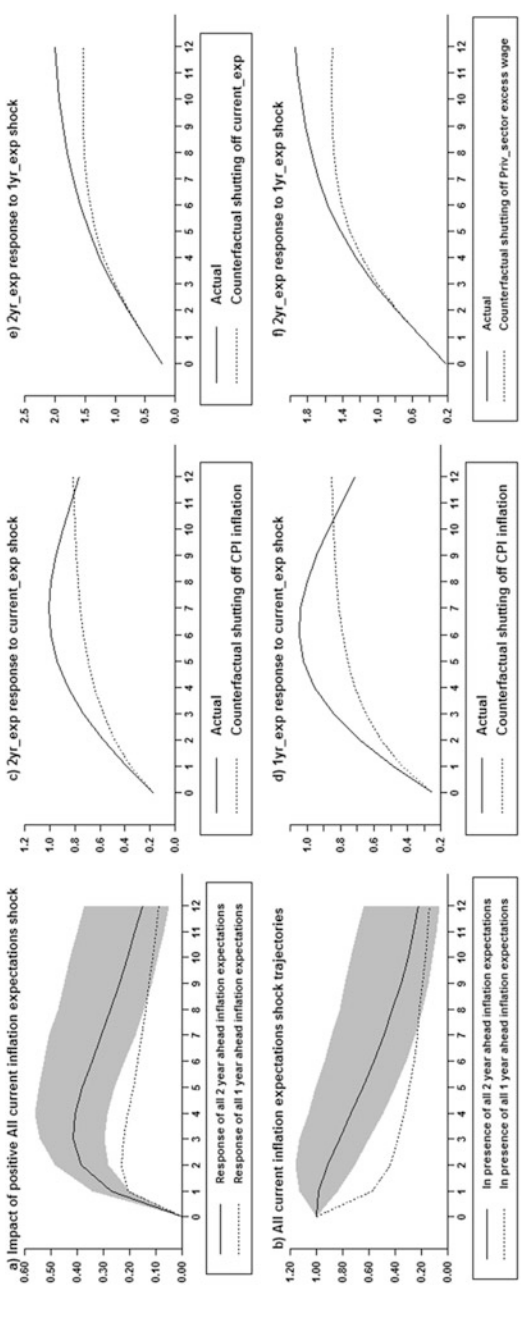

Fig. 31.6 Inflation expectations response to and inflation expectations shocks. *Source*: Authors' calculations. *Note*: Responses are in percentage points. 1yr_exp and 2yr_exp denote one and two years ahead inflation expectations, respectively. Current_exp denotes current inflation expectations

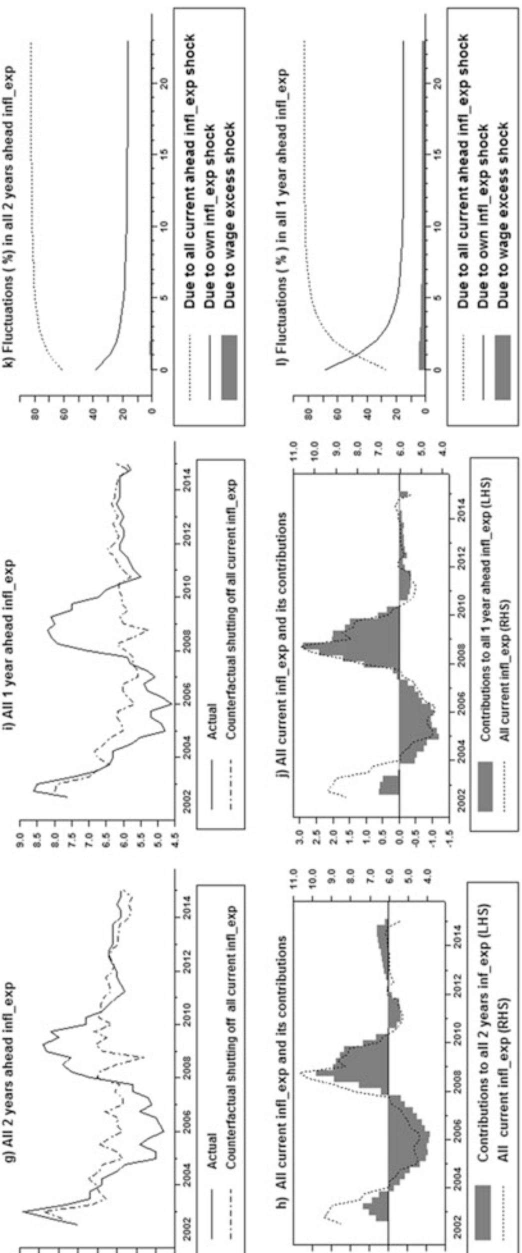

Fig. 31.6 (continued)

Furthermore, the sectorial distribution of the responses and agents' behaviour in Fig. 31.7(a) suggests that a positive one percentage point shock in current business inflation expectations raises one and two year ahead business expectations by less than one for one over all horizons. Despite evidence indicating that business respondents are slightly sensitive to developments in current inflation expectations, this updating may induce price instability in nominal debt contracts. Fig. 31.7(c) show that business inflation expectations changes are more persistent in the presence of two year ahead inflation expectations. Updating of inflation expectations makes future prices variable and unpredictable. So these results suggest that updating is undesirable if wages are in excess of 6 per cent.

In Fig. 31.7(d) the responses of trade unions inflation expectations to positive one- and two-year-ahead inflation expectations respond shock in a similar manner and there is no significant difference. If excess wage growth is driven by the expected inflation outlook, inferred from the persistence of inflation expectations and the prevalence of inflation, multiyear indexed labour wage and salary contracts worsen the labour cost outcomes. This implies that a sequence of independent transitory shocks may have considerable effects on labour costs; hence, it is important for policymakers to bring inflation outcomes and inflation expectations into the target band. If wage-push inflation constitutes a greater proportion of production costs, this can be significantly passed on to underlying inflation and raise various measures of core inflation. Fig. 31.7(b) shows that financial analysts also update their one and two year ahead inflation expectations following a positive shock to one year ahead inflation expectations.

Overall, these findings suggest that economic agents by and large form their inflation expectations based on current observed inflation expectations. However, it is possible that economic agents do use other available information about the future price movements as inputs to their inflation expectations.

Furthermore, Fig. 31.6 shows a historical decomposition approach that decomposes movements in the one-year and two-year-ahead inflation expectations from the model into those (i) caused by trend, (ii) attributed to shocks to inflation expectations, and (iii) caused by shocks to other variables within the system.[5] Fig. 31.6(h) and (i) show

[5] Ibid.

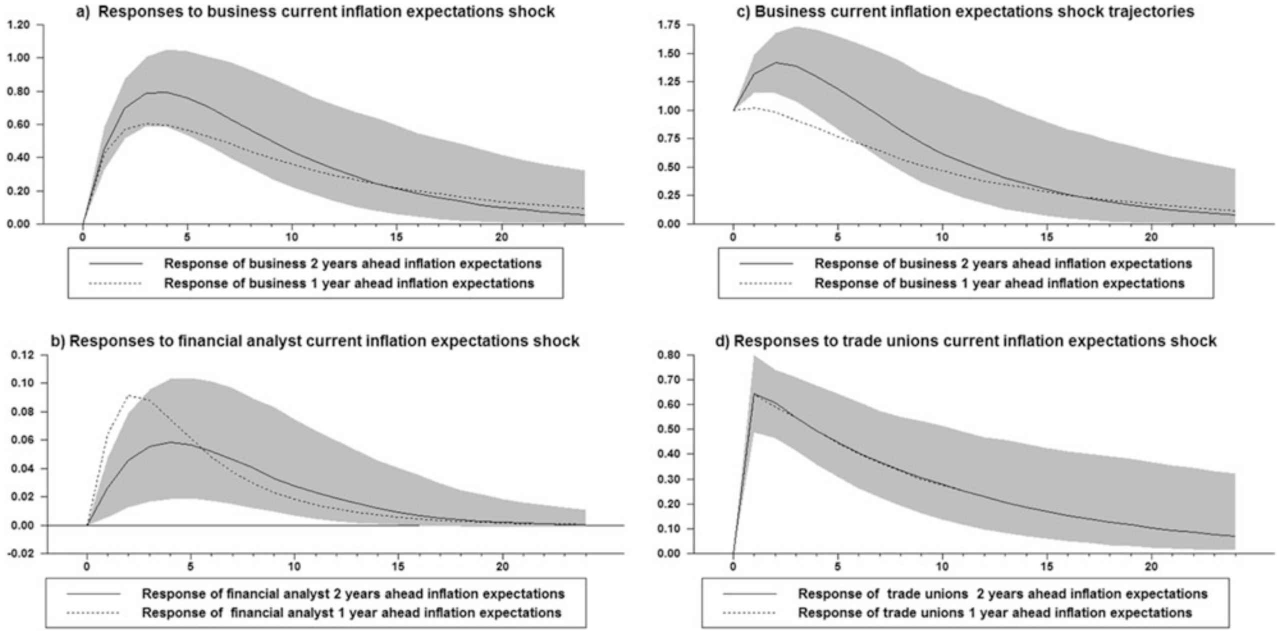

Fig. 31.7 Inflation expectations response to current inflation expectation shocks. *Source*: Authors' calculations. *Note*: Responses are in percentage points

that when current inflation expectations are declining (increasing) they also drag (increase) other inflation expectations, although the magnitudes differ. This suggests that the updating of the one- and two-year-ahead inflation expectations happens on both the downward and upward cycles of all current inflation expectations.

All current inflation expectations in Fig. 31.6(k) and (l) induce more variability in the movements of all one- and two-year-ahead inflation expectations. This is evidence that the proportion of movements in the one- and two-year-ahead inflation expectations is driven by current inflation expectations shock. So what policy implications can be inferred from all three approaches used in this section? Before offering any policy advice, evidence confirms that changes in current inflation expectations impact the one- and two-year-ahead inflation expectations. This suggests that policymakers should pay attention to these developments and remain committed to forward-looking policy conduct. In policy terms, because of the lag involved in the transmission of monetary policy to inflation, this may very well mean that to keep inflation under control, policymakers may at certain times anticipate and move in advance of inflationary developments. In some instances, it may be necessary to engage in "pre-emptive strikes" to neutralise inflationary shocks and pressures.

31.7 Did Excess Wage Growth and Inflation Expectations Adjust as Expected to Cushion the South African Economy to Financial Shocks Such as QE?

Did the labour market adjust as predict by theoretical models? To assess for the inverse transmission of foreign global financial shocks, we include the US Fed QE1 dummy variable (which equals one for duration of first round of quantitative easing (QE) and zero otherwise) as an exogenous variable in the VAR approach. The variables included are private or public excess wage growth or private or public wage growth, one- and two-year-ahead inflation expectations. The public and private sectors wage excesses

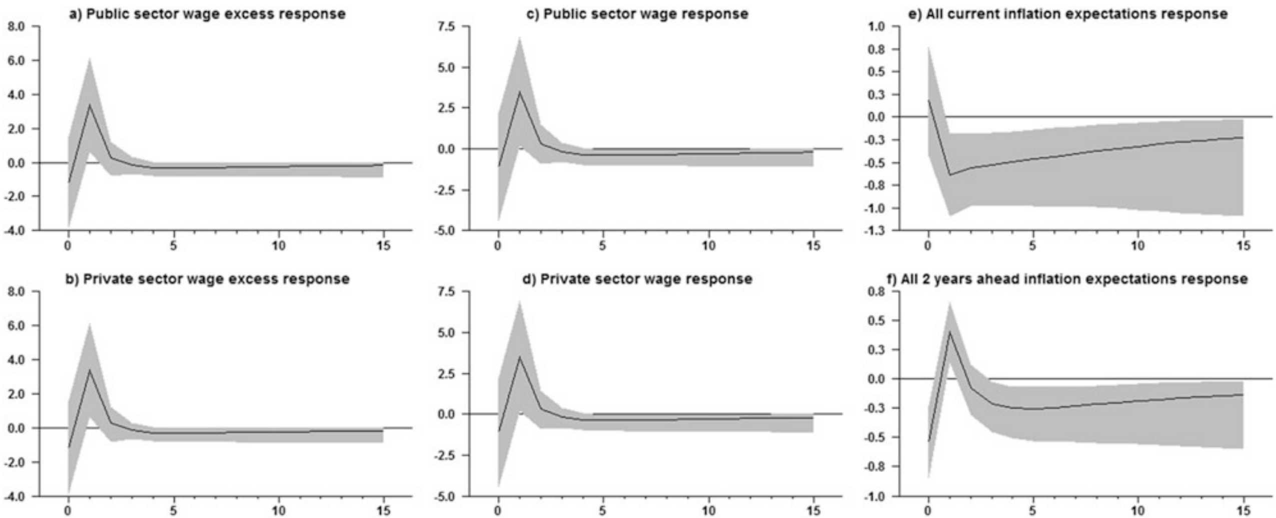

Fig. 31.8 Adjustments in labour market to US QE1 shock. *Source*: Authors' calculations. *Note*: Responses are in percentage points

are used interchangeably in the model. The analysis uses one lag as chosen by the HQ criteria and the impulse responses are based on 10,000 draws.

Fig. 31.8 reveals that an unexpected QE1 shock did impact both expected inflation for current and two years ahead by a small margin after two quarters. However, the public and private sector excess wage growth exhibit a marginal decline, suggesting that the presence of downward rigidities in the labour market limited the adjustment via the aggregate supply.

31.8 Evidence of the Counterfactual Role of Excess Wages in Transmitting Shock into GDP Growth

Did the wage excess cushion economic growth when the economy was hit by global shocks? In this context, the analysis is extended to examine further the role of excess wage growth in the transmission of adverse global GDP growth effects since 2008Q1 and in the subsequent periods. The excess wage growth is assessed for both the public and private sector using Eq. (31.3). The $Excess\_wageg_{t-i}$, denotes the public sector or private sector excess wage growth. The *Dummy*_2008, denotes the dummy which equals one beginning in 2008Q1 to end of sample and zero otherwise.

$$GDP_t = constant + \sum_{i=1}^{4} \beta_i GDP_{t-i} + \sum_{i=0}^{4} Q_i Excess\_wageg_{t-i} + \sum_{i=0}^{4} K_i Dummy\_2008_{t-i} + \varepsilon_t \tag{31.3}$$

This equation allows the determination of both the actual (counterfactual) GDP growth responses to adverse global GDP growth shock captured by $Dummy\_2008_{t-i}$. The counterfactual (actual) GDP growth arises when the excess wage growth channel is shut off (included) in the model. The estimation uses four lags. The propagating (magnifying) or

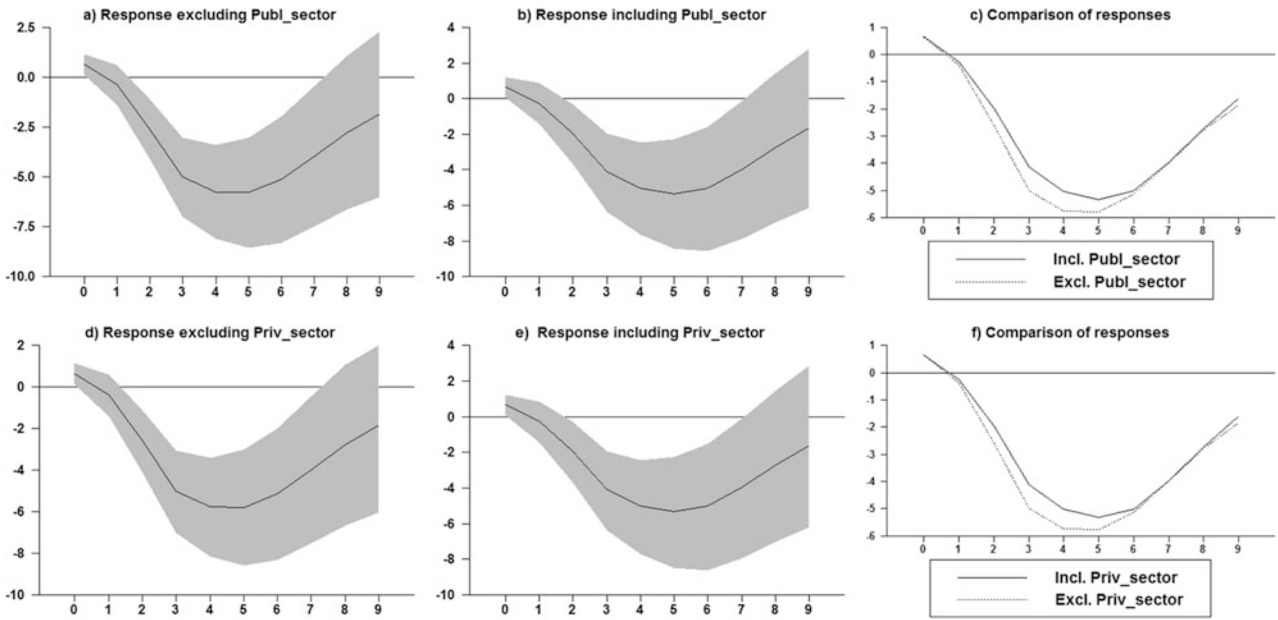

Fig. 31.9 GDP growth responses to adverse global GDP growth shock and role of excess wage growth. *Source*: Authors' calculations

restraining (stifling) ability of the excess wage channel is determined by the gap between actual and counterfactual responses.

What are the implications for GDP growth dynamics via the excess wage growth channel? Fig. 31.9 shows that GDP growth declines whether both public sector (*Publ_sector*) and private sector (*Priv_sector*) wage excesses are included or not. Fig. 31.9(c) and (f) show the amplifying abilities. In both cases the actual responses declines (*incl. Publ_sector or incl. Priv_sector*) are less than the counterfactual (*excl. Publ_sector or excl. Priv_sector*). This shows that labour market adjustment did cushion the decline in GDP growth to adverse global GDP growth shock. However, the cushioning based on gaps between impulse responses shown in Fig. 31.9(c) and (f) is quite small.

31.9 Is There Evidence of a Feedback Link Between Excess Wage Growth and Inflation? Does It Depend on Sectors' Source of Wage Excess?

Fig. 31.10 shows the response of excess wage growth to a positive inflation shock in (c) and (d). Excess wage growth rises and there is no difference based on the inflation expectations variable used in Fig. 31.10(a) to (d). This evidence shows that there is strong interdependency between inflation and excess wage growth. However, excess wage growth rises by as much as 0.4 percentage points at the peak in response to a 1 per cent increase in the inflation rate. This peak is nearly four times the response of inflation to excess wage growth at the peak. Therefore, evidence indicates prevalence of interdependence between wage growth and inflation.

Indeed, wages tend to try to catch up with current or immediate past inflation as economic agents try to maintain or increase real wages. Private sector excess wage growth would be much higher than counterfactual following a positive inflation shock in Fig 31.10(e). This private sector excess wage growth is amplified by two-year-ahead inflation expectations.

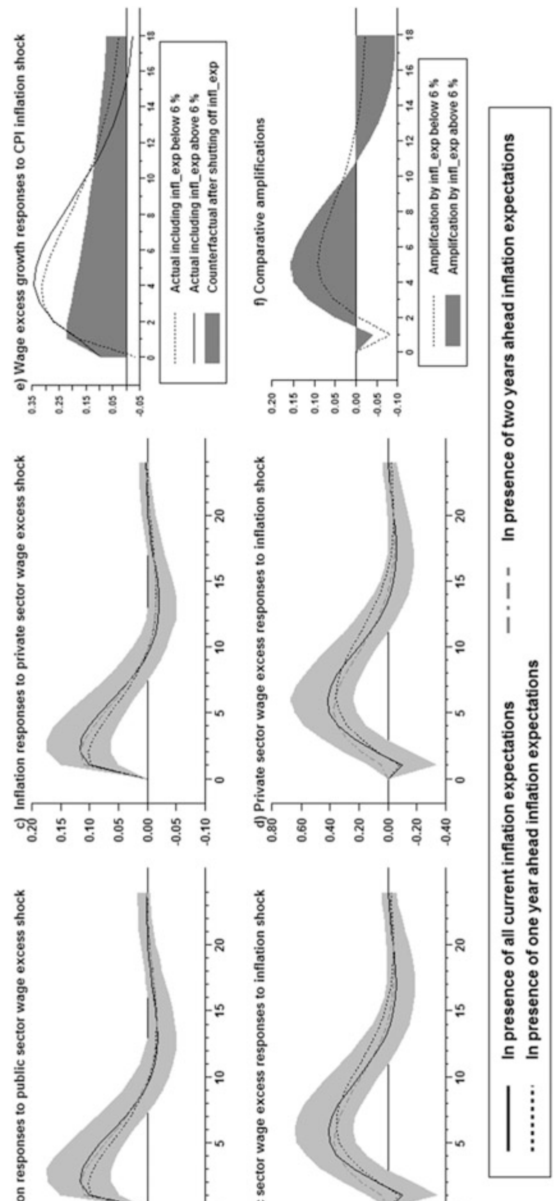

Fig. 31.10 Inflation and wage spiral effects. *Source*: Authors' calculations. *Note*: Responses are in percentage points

This suggests that elevated medium-term inflation expectation exacerbate the private sector wage increases following a positive inflation shock.

31.10 What Should Monetary Policy Do in Response to a Positive Excess Wage Growth Shock?

Then what should monetary policy do? Bernanke (2003) suggests that constrained discretion at its foundation recognises the critical importance of maintaining price stability, both in the short and long run. In addition, the desirability of maintaining price stability in the long run is by now hardly a matter for dispute. All parties involved are in full agreement that in the long run low inflation confers many benefits on the economy and raises welfare. Fig. 31.11(a) shows the cumulative responses of the repo rate to positive excess wage growth shocks. Evidence reveals that the policy rate is tightened as the excess wage growth shock raises inflation expectations in Fig. 31.11(c). In Fig. 31.11(d) the repo rate significantly increase due to a positive inflation expectations shock. This is consistent with a forward-looking monetary policy conduct.

This evidence concurs with Bernanke's (2003) critical proviso that, in conducting stabilisation policy, monetary policy authority must also maintain a strong commitment to keeping inflation as well as public expectations of inflation firmly under control.

However, the preceding analysis did not explain the role of counterfactual analysis regarding how the repo rate should react to positive excess wage shocks. Fig. 31.11(a) and (b) shows that the responses would be different considering the roles of consumer price inflation and wage excess, respectively.

The actual repo rate rises more than the counterfactual suggests. This suggests that repo rate tightening is amplified by elevated CPI inflation and inflation expectations in Fig. 31.11(a) and (d). Otherwise, if inflation is very low, the repo rate would be tightened very marginally as depicted by the counterfactual impulse responses. Fig. 31.11(c) shows that elevated wage excess amplifies inflation responses to positive inflation expectations

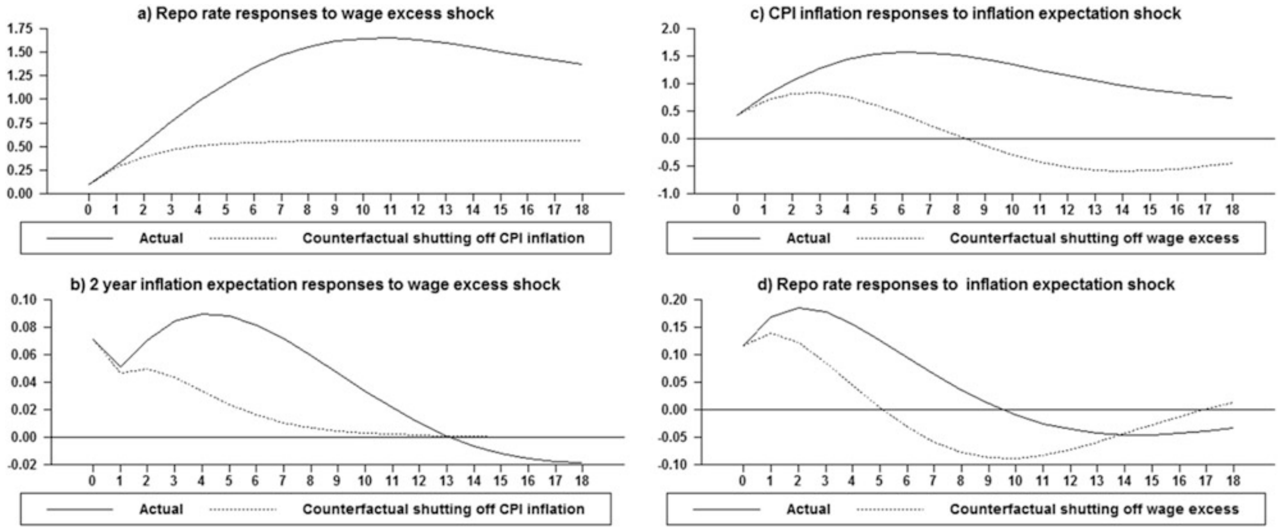

Fig. 31.11 Cumulative repo rate responses to excess wage growth shocks. *Source*: Authors' calculations. *Note*: Responses are in percentage points and shaded area denoted 16th and 84th percentiles

shocks. On the other hand, inflation amplifies the responses of inflation expectations to positive wage excess in Fig. 31.11(b).

31.11 Conclusion and Policy Implications

This chapter assessed the role played by wage growth in excess of 6 per cent and attempted to establish the effect of excesses of wage growth on inflationary dynamics and expectations. Evidence establishes that all categories of inflation expectations rise for nearly 11 quarters (almost three years) in response to a positive excess wage growth shock. The half-life of the inflation expectations shock takes nearly takes seven quarters when considering the influence of two-year-ahead inflation expectations. This is three times the half-life when one-year-ahead inflation expectations are considered.

Moreover, an unexpected positive inflation expectations shock raises excess wage growth. There is a strong feedback link between inflation outcomes, inflation expectations and excess wage growth. In addition, evidence establishes that inflation expectation shocks induce cyclicality in the wage setting process. Despite inflation expectation declining marginally, both the public and private sector excess wage growth did not decline, suggesting that downward rigidities in the labour market limited the adjustment via the aggregate supply to US QE1 shock. This may point to the prevalence of inflation indexed labour contracts which last for multiyear periods, which is normally three years in the case of the public sector. Based on evidence, such cyclicality aspects are pronounced due to the feedback of transitory inflation shocks on wage indexation.

In policy terms, allowing inflation expectation to remain high has the unintended consequences that policy initiatives may not be able to anchor wage growth within the inflation target band. This does not mean it is impossible to achieve sustainable desirable inflation outcomes and well-anchored inflation expectations. It requires policymakers to engage on a persistent drive of "moral suasion" with price setters to discourage the perpetual behaviour of wage indexation outside the inflation target band.

Changes in current inflation expectations impact the one- and two-year-ahead inflation expectations. Based on constrained discretion and considering the lag length involved in the policy transmission, it may indeed be necessary for monetary policy to anticipate and move in advance of inflationary developments. If the policy objective is to trigger unexpected revision of agents' decisions regarding future inflation outlook, it is not unusual that certain times necessitate pre-emptive strikes to neutralise inflationary shocks and pressures.

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