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Is Inflation Persistence Over?

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We analyze inflation persistence in several industrial and emerging countries in the recent past by implementing unit root tests in the presence of unknown structural breaks and by estimating reduced-form models of inflation dynamics. We select a very representative group of 23 industrial and 17 emerging economies. Our sample period is comprised of quarterly data and differs for each country. Our results indicate that inflation persistence is decreasing over time for the great majority of industrial economies. Many emerging economies, however, show increasing persistence and even a few have highly persistent inflationary processes. We also observe structural breaks in all inflation processes we study with the exception of the inflation processes of Germany and Austria. Our results are robust to different reduced forms of the inflation processes and different econometric techniques.

Analisamos a persistência da inflação em vários países industriais e emergentes no passado recente, por meio da implementação de testes de raiz unitária na presença de quebras estruturais desconhecidas e por meio da estimação de modelos de forma reduzida da dinâmica da inflação. Selecionamos um grupo representativo de 23 economias industriais e 17 economias emergentes. Nosso período amostral é composto por dados trimestrais e varia entre os países de nossa amostra. Nossos resultados indicam que a persistência da inflação diminui ao longo do tempo para a grande maioria das economias industriais. Muitas economias emergentes, no entanto, mostram aumento da persistência e, até mesmo, algumas dessas economias têm processos inflacionários altamente persistentes. Observamos, também, quebras estruturais em todos os processos de inflação que estudamos com exceção dos processos de inflação da Alemanha e da Áustria. Nossos resultados são robustos a diferentes formas reduzidas de processos de inflação e diferentes técnicas econométricas.

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1. INTRODUCTION

One of the most important characteristics of the dynamics of inflation is its degree of persistence. It is related to how quickly inflation reverts to its initial level after a shock. As Mishkin (2007) points out, if inflation is persistent, it increases the costs of monetary policy (in terms of product or unemployment) to keep inflation under control.[1]

In the last years, both industrial and emerging economies have experienced important changes in the degree of their inflationary persistence. As Cechetti et al. (2007) show both the volatility and level of inflation has decreased in industrial economies. In these economies, the decades of 1960 and 1970 were considered periods of high and persistent inflation, while the more recent decades, 1990 and 2000, have low levels of inflation as well as low persistence.

Contrary to industrial countries, emerging economies have experienced high levels of inflations for a longer period. Some of these countries, such as Brazil, Argentina, Bolivia, Peru, Mexico, Israel, Poland and Turkey, have had periods of hyperinflation in the last thirty years.[2] Only recently, in the decade of 1990, the levels of inflation have started to decrease in these countries. This, in part, is due to the important changes in the conduct of their macroeconomic policies.[3] However, it is not clear if the decrease of the level of inflation has been accompanied by a reduction of their inflationary persistence.

Our objective in this paper is to analyze empirically the inflation persistence of several industrial and emerging countries in the recent past. We select a very representative group of 23 industrial and 17 emerging economies. We want to answer the following questions: has inflation persistence decreased and been stable for industrial economies? has it decreased and been stable for emerging economies that had and had not experienced hyperinflation in the recent past?[4,5,6,7]

Our results, in general terms, show that inflation persistence is decreasing over time for the great majority of industrial economies in our sample. Many emerging economies in our sample, however, show increasing persistence and even a few have very persistent inflationary processes over time. We also find that, with the exception of inflation in Germany and Austria, all others inflation processes present structural breaks, which indicates that they have not been stable through time.

[1] In a more formal way, we can define inflation persistence as the propensity of inflation to converge slowly towards its long run equilibrium following a shock that has taken inflation away from this equilibrium.

[2] To define a hyperinflation country, in the first place, we choose a sample of countries that had at least three consecutive quarters of 15% inflation. We also look at the recent monetary history of the country, search IMF country reports and anecdote facts about the country.

[3] As examples of some macroeconomic policies we can list: inflation targeting adoption, reduction of budget deficits, improvement of financial regulation, trade liberalization and flexible exchange rate policies among others. It is also important to add that for Latin American countries the renegotiation of the external debt was a pre-condition and basis for inflation stabilization, particularly in Brazil.

[4] Our sample of emerging economies is Argentina, Brazil, Bolivia, Chile, Colombia, Czech Republic, Hungary, Israel, Korea, Mexico, Peru, Philippines, Poland, South Africa, Slovak Republic, Thailand, and Turkey. Our sample of industrial countries is: Austria, Australia, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, Norway, New Zealand, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States.

[5] See Stock and Watson (2006) for a brief analysis of monetary policy in some industrial countries in the last years.

[6] Low persistence of inflation occurs when the parameter is significantly lower than 1. Stability means that the persistence parameter is stable in a statistical sense across different subsamples of our data.

[7] Various factors can explain persistence: it may be inherited from persistent fluctuations in the determinants of inflation, like marginal cost or output gap (this is called extrinsic persistence); the dependence of inflation on its own past, also called intrinsic persistence and persistence due to the formation of inflation expectations. Each one of this persistence can be associated with one of the three terms of a new Keynesian Phillips curve.

To obtain our results, in the first place we test for the presence of a unit root with Aumengted Dick Fueller (1979), ADF tests, and for the presence of structural breaks with Quandt-Andrews and Andrews and Ploberger (1994).[8]

In the second place, we use Kim and Perron (2009) and test for the presence of unit roots of all inflation series in our sample with the exception of Germany and Austria, taking in consideration possible unknown structural breaks in these series.[9]

In the third place, we estimate several reduced models of inflation.[10] The following types of models are estimated: models with lags of inflation with and without GDP gap; and new Keynesian Phillips curves.

We use quarterly data of inflation, GDP and unemployment for each of our countries. The sample period for each country differs, depending of the availability of these data. For most countries, we have very long span of inflation data. For some we have almost 50 years of quarterly data.[11]

For many of the countries we consider, substantial shifts in monetary policy have occurred over the past two decades. In the case of European countries, the introduction of the Euro is a very important milestone. In the case of emerging economies, we can cite more sound macroeconomic policies including, for many of them, the choice of inflation targeting as a framework for monetary policies.

Our results, in general, confirm the results of a vast literature that shows that inflation persistence has been decreasing for industrial economies, such as: Dossche and Everaert (2005), Taylor (1999), Altissimo et al. (2006), Benati (2008) and Batini (2002).

Our paper contributes to the literature by looking at a greater and more diversified group of countries, including several emerging ones, by considering a more recent period and by estimating various inflation dynamics specifications, considering possible unknown structural breaks in these dynamics.

Other papers look at how inflation persistence has evolved over time also estimating reduced form inflation processes.[12] For example, Mishkin (2007) studies inflation persistence in the United States in the last 40 years using auto regressive models and decomposing inflation in cycle and trend as in Stock and Watson (2006). Mishkin confirms the results of Stock and Watson (2006) showing that inflation persistence is decreasing worldwide since the 1990s, compared with persistence observed in the 1960 and 1970s.[13]

Nason (2006) describes the dynamics of inflation in the United States with several different models of inflation and confirms the results of Mishkin (2007) and Stock and Watson (2006) that inflation persistence is decreasing in the United States in the last years. Rudd and Whelan (2005) estimate a new Keynesian hybrid Phillips curve with lags in inflation and argue that argue that the data actually provide very little evidence of an important role for rational forward-looking behavior in the United States. Fuhrer (2005) also models inflation using a hybrid Keynesian Phillips curve. He separates

[8] In the case of the structural break tests, we use an autoregressive specification for each inflation process based on equation (2) in the text without the dummies that represent structural breaks.

[9] In the case of these two countries, we also have no evidence of the presence of unit root as well using traditional tests, such as ADF.

[10] We also look at the inflations correlograms, decompose all inflation series in trend and cycle and do some recursive least squares (recursive coefficient) analysis. All these analyses, in general terms, confirm the results we present in this paper.

[11] The following countries have inflation series starting at the second quarter of 1960: Australia, Canada, Finland, Greece, Luxembourg, France, Japan, New Zealand, Switzerland, United Kingdom and United States.

[12] For a very good discussion on the estimation of reduced form inflation processes as well as other techniques for estimating inflation persistence see Fuhrer (2009).

[13] Stock and Watson (2006) show the inflation dynamics in the United States is well described by several latent factors, such as cycle and trend, both with stochastic volatility. Cycle is a stationary process while trend in non-stationary. Inflation persistence is described as a trend. The authors show that persistence in inflation has decrease substantially in the United States in the last decade.

persistence in two types: one related to the dynamics of the output gap and the other to marginal cost and that depends on lags of inflation. Fuhrer shows that the more relevant part of inflation in the last years is due to intrinsic inflation and not to output gap.

The rest of the paper is the following. Section 2 describes the data. Section 3 presents the empirical analysis. Section 4 concludes.

2. DATA

Our data are quarterly and differs depending on the country. We select 40 countries: 23 industrial and 17 emerging. Our data source is the International Financial Statistics of the International Monetary Fund. Our measure of inflation is headline Consumer Price Index inflation, CPI. We use as exogenous the following variables: the GDP gap, which is the difference between nominal GDP and potential GDP obtained through Hodrick-Prescott filtering and the unemployment rate.

For the purpose of our analysis, we separate our sample of countries in three groups: one group is comprised of industrial countries (Austria, Australia, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, Norway, New Zealand, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States), emerging countries that did not experience "hyperinflation" in the recent past (Chile, Colombia, Czech Republic, Hungary, Korea, Philippines, South Africa, Slovak Republic and Thailand), and emerging economies that have had hyperinflation recently , such as Argentina, Brazil, Bolivia, Peru, Mexico, Turkey, Israel and Poland. We define as a hyperinflation country, one that had three consecutive quarters of inflation over 15% in our sample period.

Table 1 Panel A shows the sample periods for the inflation series of all countries we analyze. For several of them, the sample period starts at the second quarter of 1960. The countries in which the samples periods are lower are Czech Republic and Slovak Republic, in which the data starts at the second quarter of 1993.

Table 1 Panel B shows the sample periods for the GDP of all countries in our sample. For most countries, the series of GDP are much smaller than the series of inflation. In the case of unemployment, as Table 1 Panel C shows the sample are even much shorter than both the samples of inflation and GDP for almost all countries except for the United States, where the series starts in the first quarter of 1960.

In Table 2, we present descriptive statistics of the inflation processes. Table 2 Panel A shows that average quarterly inflation in industrial economies is 1.24% and that the average standard deviation is 1.30%. The country with the highest average inflation is Portugal, 2.42%, and with the highest standard deviation is Iceland with 2.89%.

Table 2 Panel B shows descriptive statistics of inflation for the group of emerging economies that did not have hyperinflation episode in the last thirty years. One can see that average inflation is 2.08% and average standard deviation is 2.07%. The economy with the highest average inflation is Colombia, 3.67%, and with the highest standard deviation is Hungary, 2.85%.

Table 2 Panel C shows descriptive statistics of inflation for the group of emerging economies that experienced a hyperinflation episode in the last thirty years. We can see that average inflation is 10.45% and average standard deviation is 20.72%. The economy with the highest average inflation and standard deviation is Brazil, 23.78%, and 35.88% respectively.

In the next section, we will present our empirical analysis of inflation persistence based on unit root tests in the presence of unknown structural breaks and the estimation of reduced form inflation dynamics for the groups of countries in our sample.

3. EMPIRICAL ANALYSIS

There is little agreement in the literature on how to measure inflation persistence. Therefore, we examine a set of econometric methods that attempt to capture the persistence in inflation. The results reported in this section are based on some of the methods that are most frequently used in the literature. They range from unit root tests in the presence of unknown structural breaks to the estimation of reduced-form models of inflation dynamics.

3.1. Unit root tests

As it is well known, a process that has a unit root is a highly persistent one. To verify if any of our inflation processes has a unit root and structural breaks, we follow two steps. In the first step, we test for the presence of a unit root with Aumengted Dick Fueller (1979), ADF, and for the presence of structural breaks with Quandt-Andrews and Andrews and Ploberger (1994).[14] Only in the case of the inflation processes of Germany and Austria, we reject the null of a unit root as well as the presence of structural breaks.[15]

In the second step, following Kim and Perron (2009) we test for the presence of a unit root in the presence of unknown structural breaks for all inflation processes with the exception of Germany and Austria. Kim and Perron allow for the possibility of an unknown structural break both for the Hypotheses of a unit root process, the null Hypotheses, as well as for the Hypotheses of stationary process, the alternative Hypotheses. In all our tests, we consider the possibility of an unknown structural break both at the intercept and at the trend.[16]

Table 3 presents the results. In the case of some emerging economies – Argentina, Peru, Bolivia, Hungary and Czech Republic – we accept the null hypothesis of a unit root in the presence of unknown structural breaks. Of these countries, three have experienced hyperinflation in the recent past. For all other inflation processes, we reject the null.

3.2. Autoregressive processes

After the unit root tests, we estimate reduced form specifications. We will explore several possibilities. They range from autoregressive dynamics to different specifications of new Keynesian Phillips curves.

One of the most obvious ways of measuring inflation persistence is to regress inflation on its first lag as in equation (1) below. The estimated coefficient of the first lag of inflation is the first order autocorrelation coefficient of the inflation series.

$$\pi_t = \beta_0 + \beta_1 \pi_{t-1} + \varepsilon_t, E[\varepsilon_t] = 0, Var(\varepsilon_t) = \sigma_\varepsilon^2 \tag{1}$$

Figure 1 to 3 presents rolling samples estimates with a ten year window of theses coefficients for industrial, emerging economies without hyperinflation and emerging economies with hyperinflation respectively.[17]

[14] We use the trimmings 10%, 15%, 25% and 35% for the Quandt-Andrews and Andrews-Ploberg tests and equation (2) in the text without the dummies representing structural breaks as our specifications .

[15] In the case of Austria, the p-value of the ADF test is 0.083 and in the case of Germany the p-value of the ADF is 0.00.

[16] The possibility of existence of more than one break was also considered for some countries, like Argentina for example. In this case, we used Kim and Perron (2009) with rolling samples. We continue to reject and not the unit root for the same countries as is shown in Table 3.

[17] We do not show the confidence intervals, but they are available with the authors upon request.

In Figure 1, we present the estimated coefficients for some industrial countries. As one can see, inflation persistence is decreasing overt time for these countries.[18] In the case of emerging economies, we see a mixed result from Figures 2 and 3. In the case of emerging without hyperinflation, Slovak Republic, for instance, presents increasing persistence. Some emerging with hyperinflation, such as Brazil and Peru for example, present decreasing persistence while others like Bolivia, Turkey and Mexico show increasing persistence.

Another form of measuring inflation persistence is by regressing inflation on several of its lags as in equation (2) and then calculating the sum of coefficients on lagged inflation. If the sum of coefficients is close to 1 in a statistical sense, then shocks to inflation have long lived effects on inflation. The higher the sum of the coefficients of inflation lags, the longer it takes for inflation to return back to its mean, or the more persistent is the inflationary process.

$$\pi_t = \beta_0 + \beta_1 \pi_{t-1} + \sum_{k=1}^{L} \phi_k \pi_{t-k} + \varepsilon_t, E[\varepsilon_t] = 0, Var(\varepsilon_t) = \sigma_\varepsilon^2 \tag{2}$$

where π_t is headline consumer inflation.

To the extent that lagged inflation captures true persistence in the price setting process the model implies that rapid reductions of inflation can only be produced at the cost of substantial increase in unemployment or decrease in product. Hence, the model points to a gradualist approach as providing the best way to effect a large reduction in inflation.

An equivalent approach for analyzing persistence (and the one we will follow in this paper) is to estimate ρ in equation (3) as Whelan and O'Reilly (2005) show.

$$\begin{aligned} \pi_t &= \beta_0 + \sum_{j=1}^{D} d_j + \rho \pi_{t-1} + \sum_{j=1}^{D} \rho_{d_j} \pi_{t-1} + \sum_{k=1}^{L} \triangle \pi_{t-k} + \varepsilon_t \\ E[\varepsilon_t] &= 0, Var(\varepsilon_t) = \sigma_\varepsilon^2 \end{aligned} \tag{3}$$

There are a number of good reasons for focusing on ρ as our main measure of inflation persistence. For example, in this model, ρ is a crucial determinant of the response to shocks over time. It can also be shown that $1/(1-\rho)$ gives the infinite-horizon cumulative impulse response to shocks.

In equation (3), we also use as regressors, so as to indicate structural breaks, dummies alone and dummies interacting with the first lag of the inflation process.[19] The dummies for most countries are related to structural breaks that we observe using Quandt-Andrews and Andrews and Ploberger (1994) with rolling samples.[20] For some, we obtain the same structural breakpoints as in Kim and Perron (2009) unit root tests. Table 4 presents the quarters in which we consider a structural break for all countries, with the exception of Germany and Austria, in our sample period.

We choose the number of lags of first difference of headline consumer inflation in (3) so as the residuals do not present serial correlation, using Breusch-Godfrey LM test to identify serial correlation.[21] We also check for heteroskedasticity with White (1980) and Breusch and Pagan (1979). If there is evidence of heteroskedasticity, we correct it with the Newey and West (1987) robust errors. We do a Wald test for the sum of persistence coefficients equal to one for all estimations.

Table 5 Panel A shows the estimated persistence coefficients for this specification for industrial economies including the dummies of structural breaks. The majority of industrial countries (78%) show

[18] This is what happens for most industrial economies. For the others industrial sthat are not in Figure 1, the estimated coefficients are available upon request to the authors.

[19] Dummies are represented by d and D is the total number of dummies.

[20] Andrews (1993) is an asymptotic theory for Quandt's (1960) test for a one-time parameter shift,

[21] Breusch (1979) and Godfrey (1978).

decreasing persistence over time, as one can see.[22] For all industrial countries, we reject the null hyphoteses of sum of the persistence coefficients equal to one.

Tabel 5 Panel B shows the estimation of equation (3) for emerging economies. As one can see, some countries like Chile, Israel, Mexico, Poland, Turkey and Slovak Republic show increasing persistence. Of these, Turkey and Poland are hyperinflation countries. The other hyperinflation countries show decreasing persistence. This is the case of Brazil for instance. Once more, we reject the null hypotheses of sum of the persistence coefficients equal to one.

We repeat the estimation above including in equation (2) the output gap calculated using Hodrick-Prescot filter. Again, we test for serial correlation, heteroskedasticity, and in their presence we correct using Newey-West.

The results for the industrial economies are very similar to the ones described above (see Table 6 Panel A). However for emerging economies, the results differ somewhat from the previous ones. No emerging economy presents increasing persistence.

We think that this result has may be related to two distinct explanations. The first is that inflation persistence for these countries could be associated with changes in its intrinsic driving process, rather than solely changes in its dynamics. Several of these emerging market economies in the recent years have implemented more aggressive monetary policy and this could have had an effect over GDP gap and thus in inflation persistence. The second explanation may be related to the fact that our series of GDP for each country is shorter than the series of inflation for most countries in our sample, particularly for emerging ones.

We will estimate in the following section new Keynesian models of inflation that incorporate inflation expectations. This will allow us to capture if monetary policy has anchored inflation expectations more solidly in the last years. This could have important implications to inflation persistence,

3.3. New Keynesian Phillips curves estimation

The most important implication of the pure new Keynesian model of inflation is that there is no intrinsic persistence in inflation in the sense that there is no structural dependence of inflation on its own lagged values. Instead, inflation is determined in a completely forward-looking manner. One implication of this model in contrast to traditional ones is that it is much easier to quickly reduce inflation in this model than in the traditional one. In fact, according to the new Keynesian model, inflation can be costless controlled by a credible commitment to keep output close to its potential.[23]

Due to the difficulty of fitting the data with new Keynesian pure forward-looking model, a vast literature that incorporates lags of inflation in the new Keynesian Phillips curve (NKPC) has emerged.[24] For many, this class of models represents a sort of common-sense middle ground that preserves the insights of standard rational expectations models while allowing for better empirical fit by dealing directly with a well known deficiency of the pure forward looking model of inflation. As a result this class of models has been widely used in applied monetary policy analysis.

The structural equation for inflation that we estimate is in the spirit of hybrid new Keynesian Phillips curve as in (3). These models add a dependence of inflation on its lagged values to otherwise

[22] This can be observed by the looking at the sum of the persistent coefficients alone and interacting with dummies of structural breaks.

[23] The most popular formulation of the new Keynesian framework is based on Calvo (1983) model of price random adjustment. The model assumes that in each period a random fraction of firms reset their price while all other firms keep their prices unchanged. Calvo assumes an imperfectly competitive market structure as well. These two hypotheses generate the basic new Keynesian model of inflation.

[24] See Fuhrer and Moore (1995), Gali and Gertler (1999) and L. et al. (2005) for some theoretical models that justify the inclusion of lags of inflation in the new Keynesian Phillips curves.

purely forward looking models. Such models are often considered as a compromise between the need for rigorous micro foundations of the sort underlying the pure new-Keynesian Phillips curve and the need to fit the data empirically.

$$\begin{aligned} \pi_t &= \sum_{j=1}^{D} d_j + \rho\pi_{t-1} + \sum_{j=1}^{D} \rho_{d_j}\pi_{t-1} + (1-\rho)E_t[\pi_{t+1}] \\ &+ \beta_2 h_{t-1} + \varepsilon_t, E[\varepsilon_t] = 0, var(\varepsilon_t) = \sigma_\varepsilon^2 \end{aligned} \tag{4}$$

where h_t is output gap.

The parameter that measures inflation persistence is ρ. Again, we interact this parameter with dummies indicating structural breaks (d are the dummies and D is the total number of dummies).

We use two different instruments for the expectation of inflation one period ahead. One instrument are lags of current inflation.[25] The other instrument are forecasts of inflation obtained from a VAR with inflation and GDP gap as dependent variables. In this case, the number of lags of the VAR is chosen using Akaike information criteria.

We also check for serial correlation with Breusch-Godfrey LM test and for heteroskedasticity with White (1980) test. In the presence of serial correlation, we include more lags of regressors, until there is no more evidence of serial correlation. In the presence of heteroskedasticity, we correct with Newey-West (1987) robust matrix.

Table 7 Panels A and B shows the estimated persistence with the lags of current inflation as instruments for industrial and emerging economies respectively. Table 7 Panels C and D shows the estimated persistence with the forecast of inflation of the inflation equation of the VAR as an instrument.

The results for estimations with both instruments are somewhat different from the ones we find before. Several industrial economies have the sum of the persistent coefficient not statistically significant. For those that are significant, we observe a decrease in persistence. In the case of emerging economies, the results are mixed. Some of these countries show significant and increasing persistence while others have decreasing persistence. Again, we think that these results may be associated with changes in its intrinsic driving process of inflation and with the fact that we have very different sample periods of GDP data for all countries, particularly for emerging ones.

3.4. Robustness tests

We include wage rigidity in the new Keynesian framework in line with Gali and Blanchard (2005). The objective is to see if there is a change in estimated persistence due to these rigidities.

Gali and Blanchard (2005) incorporate wage rigidities in the structural model of inflation. One implication of Gali and Blanchard (2005) model is the relation between inflation and unemployment as in equation (4). The ρ coefficient continues to measure inflation persistence. Gali and Blanchard show that this coefficient is an increasing function of wage rigidity.

$$\begin{aligned} \pi_t &= \sum_{j=1}^{D} d_j + \rho\pi_{t-1} + \sum_{j=1}^{D} \rho_{d_j}\pi_{t-1} + (1-\rho)E_t[\pi_{t+1}] + \beta_1 u_{t-1} + \varepsilon_t \\ E[\varepsilon_t] &= 0, var(\varepsilon_t) = \sigma_\varepsilon^2 \end{aligned} \tag{5}$$

[25] We are aware of the fact that this instrument leads to identification problems regarding backward vs. forward solutions and implied expected values of inflation persistence. Therefore, we look for other instruments such as the ones mentioned in the text.

As Mishkin (2007) points out, when researchers estimate this equation they typically find that the coefficient on the unemployment gap has declined in the absolute value since the 1980s often by a marked amount. In other words, the evidence suggests that the Phillips curve has flattened.

Table 8 Panels A and B shows the estimated ρ for this specification. Due to the limitations of unemployment data in our sample, we cannot use as regressors dummies of structural breaks for almost all countries. So it is not appropriate to say anything about increasing or decreasing persistence for this empirical analysis. However, one can observe that several industrial countries present negative and significant coefficients (very low persistence) while most emerging economies present significant and over 0.40 coefficient of persistence. The highest significant coefficient for industrial countries is 0.3983, while for emerging is 0.67652 (Mexico) that is a hyperinflation country.

We also perform several other robustness tests. We look at the inflation correlograms, decompose all inflation series in trend and cycle and do some recursive least squares (recursive coefficients) analyses for the whole sample and for subsamples of the data of each country. Due to space restrictions, we do not report the results.[26] All these analyses, in general terms, confirm the main empirical evidences we present above in this paper.

3.5. Discussion of the results

After gauging all the empirical evidence that we find- considering several unit root tests with unknown structural breaks, the estimation of reduced form inflation dynamics and various robustness tests- we ponder that, in general terms, our results indicate that most industrial economies experience decreasing inflation persistence over time, while in the case of emerging economies several show increasing and even some present highly persistent inflationary processes. Of the former group, some are countries that experienced hyperinflation in the recent past.

In interpreting our results, we must first recognize that all of them are based on reduced-form relationships. Thus, they are about correlations and not necessarily about true structural relationships. Explanatory variables in our inflation estimations are themselves influenced by changes in economic conditions. So, changes in the underlying monetary policy regime are likely to be a source changes in reduced-form inflation dynamics. This problem is especially acute for structural relationship involving expectations or other factors that are not directly observable and so cannot be included in reduced form regressions. In such cases, we cannot use the reduced form equations to disentangle the effects of such unobserved factors which themselves may be driven by changes in monetary policy from that of other influences.

In terms of macroeconomic policies, we think that these results are important for emerging economies. Despite some recent improvements in these policies in some of these countries, inflation persistence is still an important issue for them. Due to the fact that inflation persistence increases the cost of disinflation, emerging economies should focus on macroeconomic policies, particularly monetary policies, to decrease this persistence in the near future.

4. CONCLUSION

We analyze inflation persistence in several industrial and emerging countries in the recent past by implementing unit root tests in the presence of unknown structural breaks and by estimating reduced-form models of inflation dynamics. We select a very representative group of 23 industrial and 17 emerging economies.

Our results show that inflation persistence is mostly decreasing over time for the industrial economies. Many emerging economies, however, show increasing persistence over time and even some have very persistent inflationary processes. We also find that the great majority of inflationary

[26] They are available with the authors upon request.

processes present structural breaks in their sample periods, which indicate that they have not been stable.

Mishkin (2007) makes it clear that inflation expectations must be a key driving force behind inflation. This dependence has long been implicit in traditional Phillips curve analysis but now expectations are explicit and are also a central feature of new Keynesian Phillips curves in which current period inflation is a function of expectations next period and output gap.

Anchoring of inflation expectations must be related to monetary policy. During the past years several central banks have increased their commitment to price stability in both words and action. The Federal Reserve, the European Central Bank and other central banks of industrial and some of emerging economies have been committed to keep inflation under control.

For many emerging economies, however, our empirical evidence indicates that anchoring inflation expectations is problematic still because of high inflation persistence that we observe. The increase of monetary policy effectiveness in these countries thus is related to the capacity their central banks will have to decrease inflation persistence in the next years.

BIBLIOGRAPHY

Altissimo, F., Ehrmann, M., & Smets, F. (2006). Inflation persistence and price-setting behavior in the Euro area. A summary of the IPN evidence. Occasional Paper Series 46, European Central Bank.

Andrews, D. W. K. (1993). Tests for parameter instability and structural change with unknown change point. *Econometrica*, 62:1383–1414.

Andrews, D. W. K. & Ploberger, W. (1994). Optimal tests when a nuisance parameter is present only under the alternative. *Econometrica*, 62:1383–1414.

Batini, N. (2002). Euro area inflation persistence. Working Paper 201, ECB.

Benati, L. (2008). Investigating inflation persistence across monetary regimes. *Quarterly Journal of Economics*, 123:1005–1060.

Breusch, T. S. (1979). Testing for autocorrelation in dynamic linear models. *Australian Economic Papers*, 17:334–355.

Breusch, T. S. & Pagan, A. R. (1979). Simple test for heteroscedasticity and random coefficient variation. *Econometrica*, 47:1287–1294.

Calvo, G. (1983). Staggered prices in a utility maximizing framework. *Journal of Monetary Economics*, 12:383–398.

Cechetti, G. S., Hooper, P., Kasman, C. B., Schoenholtz, L. K., & Watson, W. M. (2007). Understanding the evolving inflation process. In University, B., editor, *U.S. Monetary Policy Forum*.

Dickey, D. A. & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, 74:427–431.

Dossche, M. & Everaert, G. (2005). Measuring inflation persistence. A structural time series approach. Working Paper 495, ECB.

Fuhrer, C. J. (2005). Intrinsic and inherited inflation persistence. Working Paper Series 05, Federal Reserve Bank of Boston.

Fuhrer, C. J. (2009). Inflation persistence. Working paper, Federal Reserve Bank of Boston.

Fuhrer, C. J. & Moore, G. (1995). Inflation persistence. *Quartely Journal of Economics*, 110:127–159.

Gali, J. & Blanchard, O. (2005). Real wage rigidities and the new keynesian model. In *Conference on Quantitative Evidence of Price Determination*, pages 29–30, Washington D.C.

Gali, J. & Gertler, M. (1999). A structural econometric analysis. *Journal of Monetary Economics*, 44:195–222.

Godfrey, L. G. (1978). Testing against general autoregressive and moving average error models when the regressors include lagged dependent variables. *Econometrica*, 46:1293–1302.

Kim, D. & Perron, P. (2009). Unit root tests allowing for a break in the trend function at an unknown time under both the null and alternative hypotheses. *Journal of Econometrics*, 148:1–13.

L., C., Einchenbaum, M., & Charles, E. (2005). Nominal rigidities and the dynamics effects of shocks to monetary policy. *Journal of Political Economy*, 113:1–45.

Mishkin, S. F. (2007). Inflation dynamics. Working Paper Series National Bureau of Economic Research 13147, NBER.

Nason, M. J. (2006). Instability in U.S. inflation:1967-2005. Working paper, Federal Reserve Bank of Atlanta.

Newey, W. K. & West, K. D. (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica*, 55:703–708.

Quandt, R. (1960). Tests of the hypothesis that a linear regression obeys two separate regimes. *Journal of the American Statistical Association*, 55:324–330.

Rudd, J. & Whelan, K. (2005). Modelling inflation dynamics: A critical review of recent research. working paper series, Federal Reserve Board.

Stock, H. J. & Watson, W. M. (2006). Why has U.S. inflation become harder to forecast? Working Paper Series National Bureau of Economic Research 12324, NBER.

Taylor, J. (1999). Staggered price and wage setting in macroeconomic. In Taylor & Woodford, editors, *Handbook of Macroeconomics*, volume 1b. North-Holland.

Whelan, K. & O'Reilly, G. (2005). Has Euro-area inflation persistence changed over time? *The Review of Economics and Statistics*, 87:709–720.

White, H. (1980). A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica*, 48:817–838.

Table 1: Sample Periods

Our data are quarterly and differs depending on the country. We select 40 countries: 23 industrial and 17 emerging. Our data source is the International Financial Statistics of the International Monetary Fund. Our measure of inflation is headline Consumer Price Index inflation, CPI. We use as exogenous the following variables: the GDP gap, which is the difference between nominal GDP and potential GDP obtained through Hodrick-Prescott filtering and the unemployment rate. Panel A presents the sample periods for inflation. Panel B presents the sample periods for GDP and Panel C shows the sample periods for unemployment.

Panel A: Inflation Sample Periods			
Emerging Economies		Industrial Economies	
Argentina	1987Q2-2011Q2	Austria	1962Q3-2011Q2
Bolivia	1983Q3-2011Q1	Australia	1960Q2-2011Q1
Brazil	1980Q1-2011Q1	Belgium	1968Q4-2011Q2
Chile	1976Q3-2011Q1	Canada	1960Q2-2011Q1
Colombia	1960Q2-2011Q2	Denmark	1967Q2-2011Q2
Czech Republic	1993Q2-2011Q2	Finland	1960Q2-2011Q2
Hungary	1976Q2-2011Q2	France	1960Q2-2011Q2
Israel	1977Q2-2011Q2	Germany	1991Q2-2011Q2
Mexico	1960Q2-2011Q2	Greece	1960Q2-2011Q2
Peru	1988Q3-2011Q2	Iceland	1983Q2-2011Q2
Phillipines	1960Q2-2011Q2	Ireland	1998Q4-2011Q2
Poland	1988Q2-2011Q2	Italy	1970Q1-2011Q2
South Africa	1960Q2-2011Q2	Japan	1960Q2-2011Q1
South Korea	1970Q2-2011Q1	Luxembourg	1960Q2-2011Q2
Slovak Republic	1993Q2-2011Q2	Netherlands	1972Q3-2011Q2
Thailand	1965Q2-2011Q2	Norway	1960Q2-2011Q1
Turkey	1983Q3-2011Q2	New Zealand	1960Q2-2011Q1
		Portugal	1970Q1-2011Q2
		Spain	1975Q1-2011Q2
		Sweden	1960Q2-2011Q2
		Switzerland	1960Q2-2011Q2
		United Kingdom	1960Q2-2011Q2
		United States	1960Q2-2011Q2

Table 1 – Sample Periods

Panel B: Sample Period for GDP			
Emerging Economies		Industrial Economies	
Argentina	1993Q1-2010Q4	Austria	1964Q1-2010Q4
Bolivia	1995Q1-2009Q3	Australia	1960Q1-2010Q4
Brazil	1993Q3-2010Q4	Belgium	1980Q1-2010Q4
Chile	1996Q1-2010Q4	Canada	1960Q1-2010Q4
Colombia	1990Q1-2010Q4	Denmark	1977Q1-2010Q4
Czech Republic	1990Q1-2010Q4	Finland	1970Q1-2010Q4
Hungary	1995Q1-2010Q4	France	1965Q1-2010Q4
Israel	1971Q1-2010Q4	Germany	1960Q1-2010Q4
Mexico	1981Q1-2010Q4	Greece	2000Q1-2010Q4
Peru	1979Q1-2010Q4	Iceland	1997Q1-2010Q4
Phillipines	1980Q4-2010Q4	Ireland	1997Q1-2010Q4
Poland	1995Q1-2010Q4	Italy	1960Q1-2010Q4
South Africa	1960Q1-2010Q4	Japan	1960Q1-2010Q4
South Korea	1960Q1-2010Q4	Luxembourg	1995Q1-2010Q4
Slovak Republic	1993Q1-2010Q4	Netherlands	1977Q1-2010Q4
Thailand	1993Q1-2010Q4	Norway	1961Q1-2010Q4
		New Zealand	1987Q2-2010Q4
		Portugal	1977Q1-2010Q4
		Spain	1970Q1-2010Q4
		Sweden	1980Q1-2010Q4
		Switzerland	1970Q1-2010Q4
		United Kingdom	1960Q1-2010Q4
		United States	1960Q1-2011Q1

Table 1 – Sample Periods

Panel C: Sample Period for Unemployment			
Emerging Economies		Industrial Economies	
Brazil	2001Q4-2011Q1	Austria	1998Q1-2011Q1
Chile	2007Q1-2011Q1	Australia	1982Q2-2011Q1
Colombia	2001Q1-2011Q1	Belgium	1993Q1-2011Q1
Czech Republic	1995Q1-2011Q1	Canada	1993Q1-2011Q1
Hungary	1998Q1-2011Q1	Denmark	1993Q1-2011Q1
Peru	2007Q1-2011Q1	Finland	1993Q1-2011Q1
Poland	1993Q1-2011Q1	Germany	1993Q1-2011Q2
South Korea	1993Q1-2011Q1	Iceland	1991Q1-2011Q1
Slovak Republic	1997Q1-2010Q4	Italy	2007Q1-2011Q1
Thailand	2001Q1-2011Q1	Japan	1993Q1-2011Q1
Turkey	2005Q1-2011Q1	Luxembourg	1993Q1-2011Q1
		Netherlands	1992Q1-2011Q1
		Norway	1997Q1-2011Q1
		Sweden	1991Q1-2011Q1
		Switzerland	1993Q1-2011Q1
		United Kingdom	1992Q2-2011Q1
		United States	1960Q1-2011Q1

Table 2: Descriptive Statistics of Inflation

Our data are quarterly and differs depending on the country. We select 40 countries: 23 industrial and 17 emerging. Our data source is the International Financial Statistics of the International Monetary Fund. Our measure of inflation is headline Consumer Price Index inflation, CPI. Panel A presents the descriptive statistics of inflation for industrial economies. Panel B presents the descriptive statistics for emerging economies that did not have hyperinflation. Panel C presents the descriptive statistics of inflation of countries that experienced hyperinflation in the recent past according to our criteria.

Panel A: Industrial Economies				
	Average	Max	Stand. Dev.	No. Obs
Austria	0,84%	8,50%	1,14%	196
Australia	1,26%	5,82%	1,09%	204
Belgium	0,97%	4,29%	0,88%	171
Canada	1,00%	3,67%	0,91%	204
Denmark	1,23%	5,72%	1,18%	177
Finland	1,26%	5,86%	1,27%	205
France	1,12%	4,14%	0,99%	205
Germany	0,49%	2,72%	0,50%	81
Greece	2,12%	13,24%	2,66%	205
Iceland	2,31%	20,25%	2,89%	113
Ireland	0,65%	2,10%	0,93%	51
Italy	1,73%	6,94%	1,51%	166
Japan	0,83%	8,09%	1,27%	204
Luxembourg	0,88%	3,47%	0,80%	205
Netherlands	0,81%	3,11%	0,95%	156
Norway	1,18%	6,81%	1,17%	205
New Zealand	1,48%	8,54%	1,38%	204
Portugal	2,42%	11,85%	2,51%	166
Spain	1,72%	7,84%	1,56%	146
Sweden	1,18%	6,33%	1,21%	205
Switzerland	0,70%	5,62%	0,83%	205
UK	1,43%	9,96%	1,44%	205
USA	0,99%	4,22%	0,91%	205
AVERAGE	1,24%		1,30%	

Table 2 – Descriptive Statistics of Inflation

Panel B: Emerging Economies without Hyperinflation				
	Average	Max	Stand. Dev.	No. Obs
Chile	2,57%	10,37%	0,0237	120
Colombia	3,67%	14,39%	0,0282	205
Czech Republic	1,10%	4,72%	0,0118	73
Hungary	2,62%	15,82%	0,0285	141
Phillipines	2,21%	14,85%	0,0261	205
South Africa	2,01%	6,35%	0,014	205
South Korea	1,82%	13,03%	0,0217	164
Slovak Republic	1,53%	6,66%	0,0162	73
Thailand	1,20%	10,64%	0,0163	185
AVERAGE	2,08%		2,07%	

Table 2 – Descriptive Statistics of Inflation

Panel C: Emerging Economies with Hyperinflation				
	Average	Max	Stand. Dev.	No. Obs
Argentina	11,45%	173,35%	0,2947	105
Bolivia	10,27%	178,75%	0,2863	116
Brazil	23,78%	225,67%	0,3588	126
Israel	5,69%	69,31%	0,1077	205
Mexico	4,42%	29,41%	0,0566	205
Peru	12,69%	222,29%	0,3238	92
Poland	6,39%	80,76%	0,1388	93
Turkey	8,88%	69,31%	0,0909	135
AVERAGE	10,45%		20,72%	

Table 3: Unit Root Tests with Structural Breaks

Our data are quarterly and differs depending on the country. We select 40 countries: 23 industrial and 17 emerging. Our data source is the International Financial Statistics of the International Monetary Fund. Our measure of inflation is headline Consumer Price Index inflation, CPI. The unit root test with unknown breaks both at the null at the alternative hyphoteses is based on Kim and Perron (2009).

	Unit Root Test Statistic	λ	Estimate Sample Break
Argentina	−1,3579	0,1	1990Q1
Australia	−4.1977**	0,3	1972Q4
Belgium	−3.7064*	0,2	1975Q4
Bolivia	−1,0092	0,1	1985Q3
Brazil	−5.6011***	0,2	1994Q2
Canada	−4.9123***	0,4	1982Q2
Chile	−14.1664***	0,9	2005Q1
Colombia	−3.7844*	0,6	1992Q2
Czech Republic	−2,5427	0,2	1998Q1
Denmark	−14.2674***	0,4	1982Q2
Finland	−4.0855*	0,3	1977Q3
France	−5.7291***	0,5	1983Q3
Greece	−5.2086***	0,2	1972Q3
Hungary	−3,2278	0,3	1989Q4
Iceland	−6.2535***	0,3	1991Q4
Ireland	−6.1440***	0,8	2008Q3
Israel	−5.4682***	0,2	1985Q3
Italy	−4.0838*	0,4	1983Q1
Japan	−4.8615***	0,3	1977Q2
Luxembourg	−4.7265**	0,5	1983Q4
Mexico	−4.81**	0,5	1988Q1
Netherlands	−5.1548***	0,4	1989Q1
Norway	−4.3167**	0,4	1983Q1
New Zealand	−8.837***	0,5	1987Q2
Peru	−0,6586	0,1	1990Q3
Phillipines	−6.3021***	0,5	1985Q1
Poland	−0,1322	0,1	1990Q1
Portugal	−5.2810***	0,4	1985Q1
South Africa	−4.5585*	0,6	1991Q4
South Korea	−5.3819***	0,3	1981Q3
Slovak Republic	−3.8941*	0,3	1998Q1
Spain	−4.9406***	0,3	1986Q3
Sweden	−4.5572**	0,4	1981Q1
Switzerland	−4.2955**	0,3	1974Q4
Thailand	−4.896***	0,4	1981Q2
Turkey	−10.0721***	0,4	1993Q3
United Kingdom	−4.9217***	0,4	1980Q2
United States	−6.279***	0,4	1981Q3

*** Rejects unit root hypothesis with 1%.
** Rejects unit root hypothesis with 5%.
* Rejects unit root hypothesis with 10%.

Figure 1: Estimated Autocorrelation Coefficients: Industrial Economies

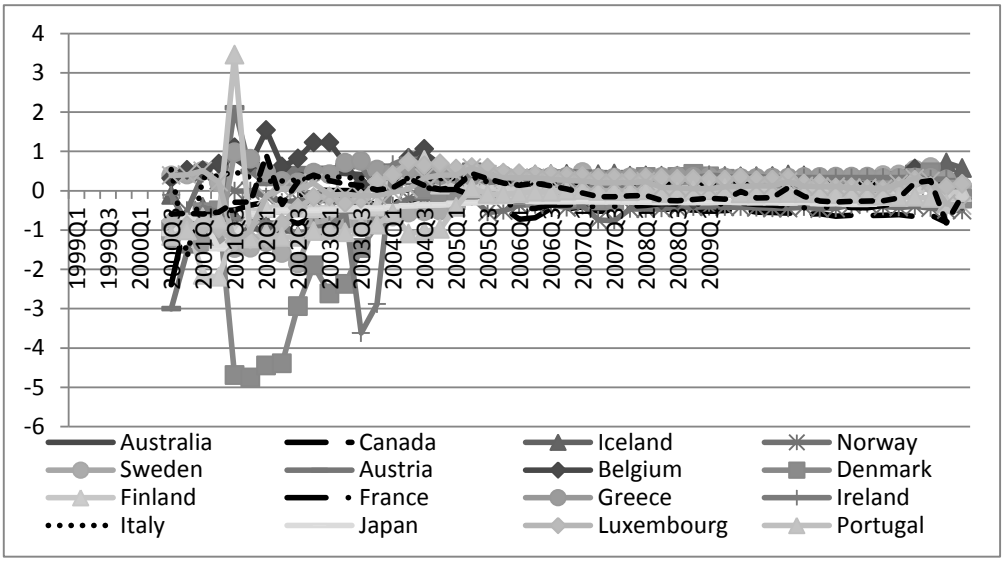

Figure 2: Estimated Autocorrelation Coefficients: Emerging Economies without Hyperinflation

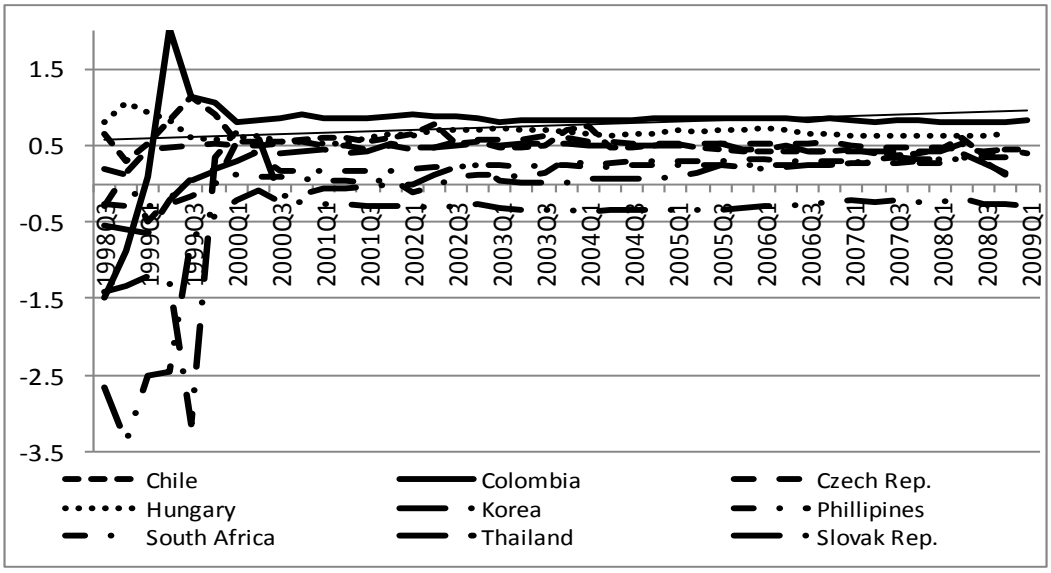

Figure 3: Estimated Autocorrelation Coefficients: Emerging Economies with Hyperinflation

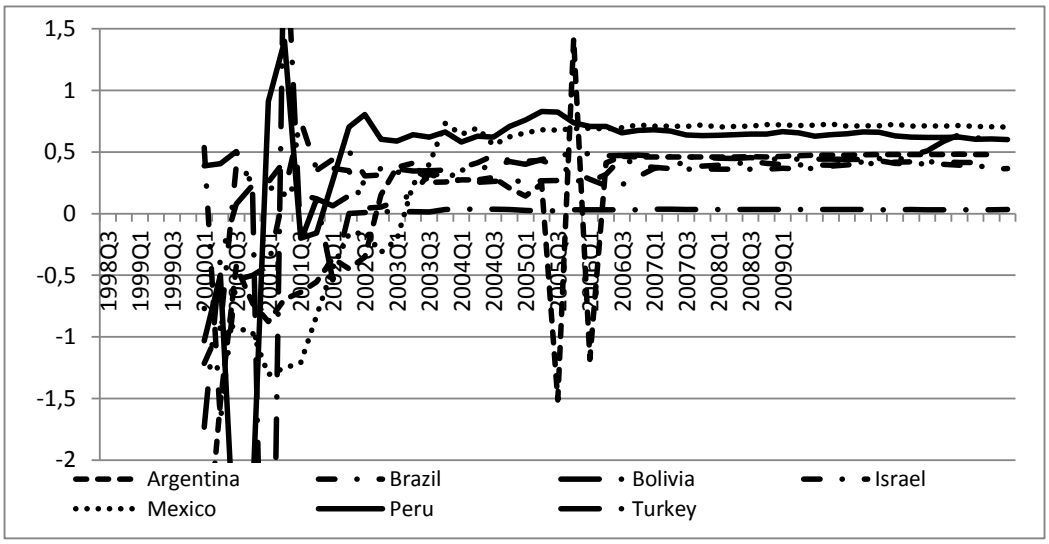

Table 4: Structural Breaks of Inflation for Reduced-Form Estimations

Our data are quarterly and differs depending on the country. We select 40 countries: 23 industrial and 17 emerging. Our data source is the International Financial Statistics of the International Monetary Fund. Our measure of inflation is headline Consumer Price Index inflation, CPI.

Argentina	1990Q1		Luxembourg	1983Q4	
Australia	1972Q4	1990Q3	Mexico	1973Q4	1988Q1
Belgium	1975Q4	1984Q4	Netherlands	1982Q2	1989Q1
Bolivia	1986Q2		New Zealand	1987Q2	1990Q2
Brazil	1994Q2		Norway	1983Q1	
Canada	1982Q2	1991Q1	Peru	1993Q2	
Chile*	1992Q4	2005Q1	Phillipines	1985Q1	
Colombia	1998Q1		Poland	1990Q1	
Czech Republic	1998Q1		Portugal	1985Q1	1992Q1
Denmark	1982Q2		South Africa	1991Q4	
Finland	1977Q3	1992Q4	South Korea	1981Q3	
France *	1982Q2		Spain	1986Q3	
Greece	1972Q3		Sweden	1990Q3	1978Q3
Hungary	1989Q4		Switzerland	1974Q4	
Iceland	1991Q4		Thailand	1981Q2	
Ireland	2008Q3		Turkey	2002Q4	
Israel	1977Q3		United Kingdom	1980Q2	
Italy	1983Q1		United States	1981Q3	
Japan	1977Q2				

Table 5: Autoregressive Processes of Inflation without Output Gap

Our data are quarterly and differs depending on the country. We select 40 countries: 23 industrial and 17 emerging. Our data source is the International Financial Statistics of the International Monetary Fund. Our measure of inflation is headline Consumer Price Index inflation, CPI. Panel A presents the results of the estimation of equation (2) in the text for industrial economies. Panel B presents the results of the estimation of equation (2) in the text for emerging economies. Below the estimated persistent coefficients in columns 1 to 3 of both panels A and B, we have a t statistic. In the last 2 columns of both Panels A and B, we have p-values.

Panel A: Industrial Countries					
	ρ	ρ_1	ρ_2	Wald test $\sum \rho = 0$	Wald test $\sum \rho = 1$
Austria	0,6651 ***			–	0,0208
	4,63				
Australia	0,7146 ***	−0,2096	−0,1029	0,012	0,0002
	5,6093	−1,2801	−0,5608		
Belgica	0,8247 ***	−0,7564 ***	0,0877	0,2155	0
	8,2414	−3,0952	0,4162		
Canada	0,8537 ***	−0,3062 **	−0,1213	0,0086	0,0005
	13,6644	−2,2137	−0,6373		
Denmark	0,3383 **	0,1234		0,0009	0,0001
	1,9784	0,6673			
Finland	0,744 ***	−0,0237	−0,0716	0	0,0249
	7,9196	−0,1393	−0,4678		
France	0,8828 ***	−0,2008 **		0	0,0001
	11,6432	−1,9542			
Germany	0,3101 *			–	0,0001
	1,9214				
Greece	0,4348 ***	0,3111 ***		0	0,0056
	2,6666	2,9853			
Iceland	0,5856 ***	−0,1981		0,0095	0,0001
	3,4938	−1,0824			
Ireland	0,0905	0,4018 **		0	0
	0,4993	2,4878			
Italy	0,6762 ***	0,0778		0	0
	6,1904	0,6855			
Japan	0,6259 ***	0,0288		0	0,0064
	3,3478	0,1571			
Luxembourg	0,7404 ***	−0,186 **		0	0
	10,2034	−2,0264			
Netherlands	0,6537 ***	−0,0038	−0,2662 *	0,0033	0
	5,1597	−0,0215	−1,6354		
Norway	0,5614 ***	−0,0102		0	0,0001
	4,3645	−0,0918			
New Zealand	0,7746 ***	−0,6319 ***	0,3176 **	0,001	0,0001
	11,2113	−4,7159	1,9812		
Portugal	0,5234 ***	−0,2596 *	0,1686	0,0109	0,0009
	3,434	−1,6813	1,1233		
Spain	0,7769 ***	−0,2469		0,0008	0,0027
	4,8577	−1,5815			
Sweden	0,6139 ***	−0,0104		0	0,0004
	6,0519	−0,1044			
Switzerland	0,6054 ***	−0,0476	0,1769	0	0,0191
	5,0058	−0,253	1,119		
United Kingdom	0,8344 ***	−0,1572		0	0,0004
	6,911	−1,4462			
United States	0,8915 ***	−0,5987 ***		0,0125	0
	11,3765	−4,727			

Table 5 – Autoregressive Processes of Inflation without Output Gap

Panel B: Emerging Economies					
	ρ	ρ_1	ρ_2	Wald test $\sum \rho = 0$	Wald test $\sum \rho = 1$
Argentina	1,0806 ***	−0,7689 *		0,0332	0,0000
	3,0575	−1,6467			
Bolivia	0,1872	0,3675		0,4289	0,5251
	0,9093	0,4165			
Brazil	0,9341 ***	−0,3997 **		0,0050	0,0139
	6,9822	−2,1925			
Chile	0,2553 *	0,1962	−0,1212	0,0103	0,0000
	1,7617	1,2358	−0,7874		
Colombia	0,6088 ***	−0,026		0,0000	0,0000
	4,4359	−0,2221			
Czech Republic	0,0462	0,3109 **		0,0733	0,0017
	0,2185	2,0067			
Hungary	0,7207 ***	0,1815 *		0,0000	0,3261
	5,2758	1,8061			
Israel	0,0093	0,8217 ***	−0,2759 **	0,0000	0,0000
	0,0886	7,5122	−2,2549		
Mexico	−0,3749 *	1,3488 ***	−0,3454 ***	0,0000	0,0000
	−1,7617	5,862	−3,2484		
Peru	0,5656 **	0,1445		0,0000	0,0000
	2,1653	0,5513			
Phillipines	0,5716 ***	−0,1572		0,0009	0,0000
	5,2584	−1,0167			
Poland	0,1118	0,5466 ***		0,0000	0,0000
	1,4007	5,5514			
South Africa	0,8238 ***	−0,0569		0,0000	0,0373
	13,897	−0,4721			
South Korea	0,2635 *	−0,1381		0,2475	0,0000
	1,7911	−0,9387			
Slovak Republic	0,4791 **	0,026		0,0142	0,0162
	2,3529	0,2561			
Thailand	0,6502 ***	−0,3132 ***		0,0260	0,0000
	4,5205	−2,6134			
Turkey	0,1759	0,2728		0,0465	0,0149
	0,9977	1,2168			

*** Rejects with 1%.

** Rejects with 5%.

* Rejects with 10%.

Table 6: Autoregressive Processes Estimation with Output Gap

Our data are quarterly and differs depending on the country. We select 40 countries: 23 industrial and 17 emerging. Our data source is the International Financial Statistics of the International Monetary Fund. Our measure of inflation is headline Consumer Price Index inflation, CPI. We use as exogenous the following variables: the GDP gap, which is the difference between nominal GDP and potential GDP obtained through Hodrick-Prescott filtering and the unemployment rate. Panel A presents the results of the estimation of equation (3) in the text for industrial economies with the inclusion of output gap. Panel B presents the results of the estimation of equation (3) in the text for emerging economies with the inclusion of output gap. Below the estimated persistent coefficients in columns 1 to 3 of both panels A and B, we have a t statistic. In the last 2 columns of both Panels A and B, we have p-values.

Panel A: Industrial Economies					
	ρ	ρ_1	ρ_2	Wald test $\sum \rho = 0$	Wald test $\sum \rho = 1$
Austria	0,6273			—	—
	5,2325				
Australia	0,7152	−0,2097	−0,1027	0,013	0
	3,6671	−1,0385	−0,6589		
Belgium	−0,4184		0,4828	0,656	0
	−1,856		2,291		
Canada	0,8641	−0,2993	−0,1119	0,005	0,028
	11,12721	−1,455	−1,455		
Denmark	0,4555	−0,0006		0,001	0
	2,1673	−0,0033			
Finland	0,5292	0,3147	0,0101	0	0,461
	4,6721	2,1178	0,0501		
France	0,8677	−0,1512		0	0
	12,5946	−1,4931			
Germany	−0,1817			—	—
	−1,1145				
Greece	−0,2128			—	—
	−1,0395				
Iceland	0,5504			—	—
	3,1813				
Ireland	0,0578	0,4807		0,006	0,018
	0,2299	1,6817			
Italy	0,6979	0,1234		0	0,054
	9,3732	1,0724			
Japan	0,6425	0,0339		0	0,012
	6,1977	0,251			
Luxembourg	−0,1121			—	—
	−0,5839				
Netherlands	0,4482	0,1924	−0,3448	0,07	0
	2,1914	0,8404	−1,8425		
Norway	0,5626	−0,009		0	0,001
	4,6979	−0,0654			
New Zealand	0,3598			—	—
	3,4195				
Portugal	0,2616	−0,285	0,2645	0,246	0
	1,5215	−1,4687	1,0766		
Spain	0,8001	−0,1872		0	0,01
	7,0035	−1,274			
Sweden	0,4444	0,1713		0	0,019
	2,6728	1,1216			
Switzerland	0,2082	0,3167	0,1265	0	0,009
	1,0414	1,1405	0,5113		
United Kingdom	0,7962	−0,043		0	0,017
	10,3402	−0,3745			
United States	0,8689	−0,6176		0,052	0
	10,4447	−4,6432			

Table 6 – Autoregressive Processes Estimation with Output Gap

Panel B: Emerging Economies					
	ρ	ρ_1	ρ_2	Wald test $\sum \rho = 0$	Wald test $\sum \rho = 1$
Argentina	0,4069				
	4,6427				
Bolivia	0,5894				
	3,9389				
Brazil	0,2615				
	3,9715				
Chile	−0,2814		0,3313	0,7770	0,0000
	−1,1696		1,3477		
Colombia	0,8663				
	11,6388				
Czech Republic	0,0720	0,3390		0,0930	0,0180
	0,2005	1,0319			
Hungary	0,8040				
	10,1117				
Israel	0,7243		−0,1471	0,0000	0,0000
	7,1765		−1,1697		
Mexico	0,9996		−0,3453	0,0000	0,0000
	7,7764		−2,5331		
Peru	−0,0867	0,8090		0,0000	0,0000
	−0,3882	3,6291			
Phillipines	0,7553	−0,3612		0,0020	0,0000
	6,9186	−2,3982			
Poland	0,6753				
	10,0075				
South Africa	0,8204	−0,0582		0,0000	0,0570
	11,2390	−0,4601			
South Korea	0,2658	−0,1290		0,4000	0,0000
	2,3163	−0,7722			
Slovak Republic	0,5080				
	2,6988				
Thailand	−0,1628				
	−0,9366				

Table 7: New Keynesian Phillips Curves Estimations

Our data are quarterly and differs depending on the country. We select 40 countries: 23 industrial and 17 emerging. Our data source is the International Financial Statistics of the International Monetary Fund. Our measure of inflation is headline Consumer Price Index inflation, CPI. We use as exogenous the following variables: the GDP gap, which is the difference between nominal GDP and potential GDP obtained through Hodrick-Prescott filtering and the unemployment rate. Panel A presents the results of the estimation of equation (4) in the text for industrial economies using the first lag of inflation as an instrument. Panel B presents the results of the estimation of equation (3) in the text for emerging economies using the first lag of inflation as an instrument. Panel C presents the results of the estimation of equation (3) in the text for industrial economies using as instrument the forecast of inflation from a VAR that has an inflation and GDP equation. Panel D presents the results of the estimation of equation (3) in the text for emerging economies using as instrument the forecast of inflation from a VAR that has an inflation and GDP equation. Below the estimated persistent coefficients in columns 1 to 3 of A, B, C and D we have a t statistic. In the last 2 columns of Panels A, B, C and D we have p-values.

Panel A: Lag Inflation as Instrument: Industrial Economies					
	ρ	ρ_1	ρ_2	Wald test $\sum \rho = 0$	Wald test $\sum \rho = 1$
Austria	−0,4339			—	—
	−4,6312				
Australia	−0,1235	0,064	0,0341	0,858	0
	−0,4122	0,2872	0,2069		
Belgium	−0,573		0,5019	0,514	0
	−2,9873		2,4292		
Canada	0,4773	−0,0308	−0,2964	0,222	0
	2,2775	−0,1006	−1,2554		
Denmark	−0,0442	0,131		0,398	0
	−0,2957	0,7686			
Finland	−1,0941	1,2501	0,1843	0,086	0,001
	−5,0522	5,5031	0,7865		
France	0,1404	0,0293		0,093	0
	1,0302	0,271			
Germany	0,1523			—	—
	1,5338				
Greece	0,239			—	—
	2,04				
Iceland	−0,2396			—	—
	−0,9535				
Ireland	0,0044	0,4623		0,015	0,006
	0,0178	1,6863			
Italy	0,2516	0,0722		0,004	0
	2,3286	0,6957			
Japan	−0,1211	0,3261		0,073	0
	−1,0094	2,1389			
Luxembourg	0,1678			—	—
	1,3849				
Netherlands	1,1656	−0,7432	−1,0346	0	0
	4,9648	−2,6644	−4,051		
Norway	−0,2722	0,1755		0,415	0
	−2,3894	1,1846			
New Zealand	0,2645			—	—
	2,4981				
Portugal	0,0606	0,2743	−0,6772	0,08	0
	0,5638	1,2152	−2,524		
Spain	−0,4302	−0,8421		0	0
	−2,3088	−6,4839			
Sweden	−0,9553	0,3054		0	0
	−4,9944	1,7656			
Switzerland	−0,1635	0,2136	−0,1859	0,159	0
	−1,1488	0,8173	−0,7157		
United Kingdom	−0,2333	0,4009		0,123	0
	−1,5691	2,549			
United States	0,4798	−0,3917		0,41	0
	1,6014	−1,044			

Table 7 – New Keynesian Phillips Curves Estimations

Panel B: Lag Inflation as Instrument: Emerging Economies					
	ρ	ρ_1	ρ_2	Wald test $\sum \rho = 0$	Wald test $\sum \rho = 1$
Argentina	0,5103				
	6,0301				
Bolivia	−0,0297				
	−0,1533				
Brazil	0,3573				
	6,2320				
Chile	0,1992		0,2894	0,0030	0,0002
	1,2707		1,1668		
Colombia	0,4556				
	3,9511				
Czech Republic	−0,6092	0,8990		0,0570	0,0000
	−1,4706	1,8519			
Hungary	0,5128				
	4,8017				
Israel	0,6072		−0,1161	0,0000	0,0000
	6,0488		−1,1051		
Mexico	1,0311		−0,4072	0,0000	0,0000
	6,8668		−3,1165		
Peru	0,2638	0,0349		0,0003	0,0000
	1,9529	0,4796			
Phillipines	0,3751	0,1750		0,1030	0,0000
	1,8733	−0,9015			
Poland	0,5530				
	4,8120				
South Africa	−0,2424	0,1837		0,5960	0,0000
	−1,5805	1,1693			
South Korea	−0,2230	−0,1205		0,0210	0,0000
	−1,7879	−0,6821			
Slovak Republic	−0,1651				
	−1,1079				
Thailand	0,2357				
	2,3221				

Table 7 – New Keynesian Phillips Curves Estimations

Panel C: Forecast of Inflation as Instrument: Industrial Economies					
	ρ	ρ_1	ρ_2	Wald test $\sum \rho = 0$	Wald test $\sum \rho = 1$
Austria	0,1829			0,0620	0,0000
	1,8785				
Australia	−0,0236	−0,0038	0,0280	0,9960	0,0000
	−0,1938	−0,0337	0,1965		
Belgium	0,1225	−0,1568		0,7510	0,0000
	0,7326	−0,8402			
Canada	0,2605	0,2050	−0,2445	0,0250	0,0000
	2,6973	0,9707	−1,1834		
Denmark	−0,0111	0,1169		0,2790	0,0000
	−0,0878	0,7762			
Finland	0,2527	0,0544	−0,1556	0,5070	0,0000
	2,0468	0,3083	−0,5844		
France	−0,1710	0,2049		0,5540	0,0000
	−2,5696	3,3570			
Germany	0,1655			0,0940	0,0000
	1,6954				
Greece	0,4628			0,0000	0,0000
	4,4685				
Iceland	−0,7178			0,0000	0,0000
	−4,0471				
Ireland	−0,1489	0,7137		0,0000	0,0000
	−1,5899	5,1259			
Italy	0,1481	0,1136		0,0030	0,0000
	2,1255	1,3993			
Japan	−0,0985	0,3034		0,0380	0,0000
	−1,1898	2,5273			
Luxembourg	−0,0916			0,4320	0,0000
	−0,7909				
Netherlands	1,3362	−0,8545	−0,9791	0,0000	0,0000
	10,5396	−3,5587	−4,0437		
Norway	0,1807	−0,1731		0,9530	0,0000
	1,9646	−1,1714			
New Zealand	0,0515			0,4630	0,0000
	0,7379				
Portugal	0,3446	−0,1238	−0,4643	0,2080	0,0000
	2,7320	−0,5179	−1,7304		
Spain	0,3125	−1,0829		0,0000	0,0000
	1,9714	−8,0579			
Sweden	0,2120	−0,4882		0,0740	0,0000
	1,4413	−2,8604			
Switzerland	0,3774	−0,1216	−0,2556	0,9980	0,0000
	3,2650	−0,4223	−0,8752		
United Kingdom	0,1440	0,0967		0,0150	0,0000
	1,7883	0,8372			
United States	0,5177	−0,4295		0,2860	0,0000
	5,3433	−3,0074			

Table 7 – New Keynesian Phillips Curves Estimations

Panel D: Forecast of Inflation as Instrument: Emerging Economies					
	ρ	ρ_1	ρ_2	Wald test $\sum \rho = 0$	Wald test $\sum \rho = 1$
Argentina	0,3915			0,0000	0,0000
	7,0969				
Bolivia	0,0153			0,8710	0,0000
	0,1626				
Brazil	0,3763			0,0000	0,0000
	5,9203				
Chile	−0,0823	0,6751		0,0010	0,0016
	−0,3927	2,1863			
Colombia	0,4422			0,0000	0,0000
	5,1762				
Czech Republic	−0,3430	0,5940		0,0690	0,0000
	−1,4077	1,9632			
Hungary	0,4562			0,0000	0,0000
	4,9798				
Israel	−0,0313	0,4272		0,0000	0,0000
	−0,3041	4,3904			
Mexico	0,1588	0,2811		0,0000	0,0000
	1,8271	3,5751			
Peru	0,3118			0,0040	0,0000
	2,9953				
Phillipines	0,3207	−0,1447		0,0099	0,0000
	3,1165	−1,1794			
Poland	0,3736			0,0000	0,0000
	4,6882				
South Africa	0,0328	−0,0211		0,9090	0,0000
	0,3517	−0,1728			
South Korea	−0,2532	−0,0877		0,0160	0,0000
	−2,2912	−0,5362			
Slovak Republic	0,1290			0,4240	0,0000
	0,8044				
Thailand	−0,0680			0,5400	0,0000
	−0,6166				

Table 8: New Keynesian Phillips Curve with Wage Rigidities

Our data are quarterly and differs depending on the country. We select 40 countries: 23 industrial and 17 emerging. Our data source is the International Financial Statistics of the International Monetary Fund. Our measure of inflation is headline Consumer Price Index inflation, CPI. We use as exogenous the following variables: the GDP gap, which is the difference between nominal GDP and potential GDP obtained through Hodrick-Prescott filtering and the unemployment rate. Panel A presents the results of the estimation of equation (5) in the text for industrial economies using the first lag of inflation as an instrument. Panel B presents the results of the estimation of equation (4) in the text for emerging economies using the first lag of inflation as an instrument. Below the estimated persistent coefficients in columns 1 we have a t statistic. In the last columns of Panels A and B we have p-values.

Panel A: Industrial Economies		
	ρ	Wald test $\rho = 1$
Austria	−0,4439	0,0000
	−4,7101	
Australia	−0,0386	0,0000
	−0,3399	
Belgium	−0,1420	0,0000
	−1,1263	
Canada	0,2653	0,0000
	2,3950	
Denmark	0,0576	0,0000
	0,4874	
Finland	−0,3080	0,0000
	−2,3242	
France	0,1333	0,0000
	1,1797	
Germany	0,1507	0,0000
	1,4873	
Greece	0,2346	0,0000
	1,9177	
Iceland	−0,2253	0,0000
	−0,8308	
Ireland	0,3040	0,0050
	1,2763	
Italy	0,3083	0,0000
	2,4350	
Japan	0,0025	0,0000
	0,0241	
Luxembourg	0,1659	0,0000
	1,3741	
Netherlands	−1,5145	0,0000
	−5,3637	
Norway	−0,2227	0,0000
	−2,2477	
New Zealand	0,3217	0,0000
	3,0090	
Portugal	−0,2742	0,0000
	−1,6322	
Spain	−1,7114	0,0000
	−8,2761	
Sweden	−0,7491	0,0000
	−4,5780	
Switzerland	−0,1333	0,0000
	−1,2411	
United Kingdom	−0,0129	0,0000
	−0,1220	
United States	0,2210	0,0000
	2,4866	

Table 8 – New Keynesian Phillips Curve with Wage Rigidities

Panel B: Emerging Economies		
	ρ	Wald test $\rho = 1$
Brazil	0,4812	0,0410
	1,9441	
Chile	0,3685	0,0110
	1,8154	
Colombia	0,4401	0,0000
	4,1531	
Czech Republic	0,0207	0,0000
	0,1599	
Hungary	0,3283	0,0000
	3,2650	
Peru	0,4074	0,0840
	1,2869	
Poland	0,4502	0,0000
	3,4526	
South Korea	−0,6792	0,0000
	−3,7349	
Slovak Republic	−0,1864	0,0000
	−1,1395	
Thailand	0,2718	0,0000
	2,3351	
Turkey	0,0877	0,0000
	0,5246	