Credit Supply Shocks in a Changing World

Miguel C. Herculano *
University of Nottingham
This Version: January 22, 2021

Abstract

How did the transmission of credit supply shocks change in the past decades ? To study this question, I estimate a time-varying structural vector autoregression which allows parameters governing the relationship between credit and the macroeconomy to move smoothly over time. The analysis delivers new results on such relation which may help guide the nascent theoretical literature on the subject. The key empirical finding is that, the relevance of credit supply shocks in explaining leverage dynamics has risen over the past few decades.

Keywords: Credit supply; US Business Cycle ; Time-varying VAR.
JEL: C32, E32, E51.

1 Introduction

In recent years, a consensus has emerged that credit supply shocks, that represent exogenous, unanticipated changes to lenders willingness to lend, which are independent of borrowers net worth, are important in understanding business cycle fluctuations and key drivers of macroeconomic risk. Many papers seek to identify credit supply as orthogonal shocks in vector-autoregressive models (eg. Mumtaz et al. (2018), Eickmeier and Ng (2015), Lown and Morgan (2006)). This paper investigates the possibility that the parameters that govern the relationship between credit supply

*Correspondence: Sir Clive Granger Building, King's Meadow Campus, Lenton Lane, Nottingham NG72NR UK. E-mail: miguel.herculano@nottingham.ac.uk. Acknowledgements: I thank John Tsoukalas, Dimitris Korobilis, Gary Koop, Christian Ewald, Yannis Tsafos and Sisir Ramanan for their comments and advise.

and the macroeconomy, which are assumed constant in most papers, are subject to structural changes.

I begin by re-examining the empirical relation between credit supply and the macroeconomy. The results from this preliminary exercise motivate further study. Apart from being unclear in theory, the macroeconomic effect of a credit supply shock on inflation and leverage, in a time-invariant VAR is empirically ambiguous - impulse responses of a credit supply shock in a recursively identified reduced form SVAR lead to inconclusive results. According to Mian et al. (2017), the inflationary nature of credit supply shocks is important and a key identifying feature of potentially dangerous credit booms. The authors distinguish between credit supply shocks that work their way to the macroeconomy through the production capacity channel and through the local demand channel. Credit that relaxes borrowing constraints, allowing firms to invest more, results in an enhanced production capacity in the economy. It is deflationary in nature and is thought to increase productivity and employment in sectors which are financially constrained. On the contrary, credit supply shocks operating through local demand are inflationary, since agents borrow to consume, leverage in the economy increases and with it macroeconomic risk. Schmitt-Grohé and Uribe (2016) and Korinek and Simsek (2016) suggest that the local demand channel of credit supply expansions results in amplified business cycles, characterized by short term stimulus to the economy that eventually reverts.

Leverage has been found to be a key contributing factor to the Great Recession and the slow recovery in the US (see for example Mian and Sufi (2010)). However, the relationship between leverage and credit supply is also unclear because, the extent to which expansions in credit supply lead to greater leverage in the economy depends on specific transmission channels working in opposite directions. If an expansion in credit supply generates enough economic value added, then leverage may not increase. Whereas, if the marginal amount of credit is employed in activities that fail to generate value such as poor quality projects or low value-added activities, then leverage will increase. On one hand, easier credit ought to increase the amount of borrowing in the economy thereby building up overall leverage. On the other hand, the increased amount of funding in the economy results in greater real activity lowering leverage. Therefore, whether expansions in credit supply are inflationary or deflationary; leveraging or deleveraging is ultimately an empirical question and depends on which of the channels discussed dominates at each point in time.

The purpose of this paper is to examine potential structural changes in the relation between credit and the macroeconomy discussed. The main focus is in understanding how the macroeconomic consequences of credit supply shocks changed over time and whether these are time-dependent. Can credit supply shocks be characterized as inflationary ? Do they necessarily lead to more leverage and thereby more macroeconomic risk ? To study these questions, I follow Primiceri (2005) and Cogley (2005) and specify a time-varying vector autoregressive model with stochastic volatility (TVP-SV-VAR), which allows the parameters governing the relationship between credit supply and the macroeconomy to move smoothly over time. There are good reasons to believe that the transmission mechanism of credit supply may have changed over time. First, financial intermediation was subject to important institutional changes in the past decades, characterized by deregulation, financial innovation, and globalization which have contributed to expansions in credit supply. Second, borrowers balance sheets have changed to become more reliant on credit. Third, the transmission of credit supply shocks is contingent on the economic environment which has changed significantly.

The identification strategy adopted follows the literature and consists in including the component of credit spreads which is orthogonal to default risk - the Excess Bond Premia (EBP) in Gilchrist and Zakrajšek (2012) - as a measure of credit supply in the vector of endogenous variables of a Structural VAR (SVAR). Following Gilchrist and Zakrajšek (2012), a shock to the EBP is interpreted as a credit supply shock in a system identified through a classic recursive scheme. Similar strategies have been used by many other authors to study the importance of credit supply shocks, albeit in a time-invariant SVAR environment (eg. Bassett et al. (2014), Mumtaz et al. (2014) and Lown and Morgan (2006)). A popular alternative identification strategy consists in using DSGE founded sign restrictions in an effort to reduce the space of licit impulse responses (see for example Gambetti and Musso (2017), Eickmeier and Ng (2015), Hristov et al. (2012), Peersman (2011) and

De Nicolo and Lucchetta (2010)). We employ a sign restriction routine similar to Eickmeier and Ng (2015) to evaluate the robustness of our key results.

This paper contributes to the literature that studies the role of credit supply shocks in driving business cycle fluctuations. Three sets of results emerge from our empirical exercise. First, evidence suggests that the sensitivity of leverage to changes in the stance of credit supply in the economy has increased and is found to be occasionally high, in particular before recessions. This evidence points towards the importance of credit supply in driving financial imbalances in the economy that eventually have real economic costs. This result is consistent with the narrative in Peydro et al. (2015) that credit supply is key in driving financial imbalances in the economy, sowing the seeds of financial crisis. For instance, in the early 2000s an expansion of credit supply equivalent to 1 standard deviation of EBP, led to an unprecedented increase in leverage of about 5 standard deviations in the long-run (equivalent to a 21 % increase in the credit-to-gdp gap). Nevertheless, our results suggest that expansions in credit supply may not necessarily precede higher leverage. For instance, the posterior median of the impulse response function of leverage, with respect to a credit supply shock, is indistinguishable from zero in the long-run until the mid 1980s. Such a result implies that the marginal amount of credit in the economy was generating enough economic value such that its impact in terms of leverage was nill, stressing the idea that credit supply shocks are not necessarily associated with increasing financial imbalances in the economy.

Second, real economic activity appears to have become less sensitive to credit supply shocks in the past few decades. In particular, a credit supply shock characterized by a decrease in the EBP in 1 standard deviation (0.5 %), which leads to an increase of approximately 0.37 standard deviations in the Output gap (0.78 %) in the 1970s has more than halved over the course of 40 years. In 2016 this figure is estimated to have decreased to approximately 0.23 % in 2016. However, this result is not robust to different identification strategies and therefore should be read with caution. Third, in the early periods of the sample, credit supply shocks tended to have a deflationary impact on the economy in the short-run (one quarter) and an inflationary impact in the long-run (20 quarters). Whereas, in more recent periods the response of inflation is more muted. However, this results should be approached with caution because the posterior of impulse response functions of inflation is very wide. Nevertheless, the result that in the long-run, credit supply shocks are inflationary seems to hold across identification schemes.

The remainder of the paper proceeds as follows. Section 2 reviews the relevant literature on the link between Credit Supply and the Business Cycle; Section 3 outlines the Data used throughout this study; Sections 4 and 5 present the econometric approach and motivate the need for a time-varying parameter approach to think about credit supply shocks; Section 6 discuses the results and Section 7 concludes.

2 Literature Review

2.1 Early contributions

Early literature on the macroeconomic consequences of credit market developments typically view credit as a propagating device of business cycle fluctuations, rather than the a driver of real activity per se. This line of thought dubbed the *credit view* is associated with the transmission mechanisms of monetary policy. The focus is on how frictions in credit markets propagate monetary policy shocks to real activity through the balance sheet channel, via changes in borrowers net worth; and through bank-based channels operating via financial intermediaries balance sheets (see Boivin et al. (2010) for a review). Broadly consistent with this view, a number of more recent papers investigate the implications of diverse types of frictions within the framework of Dynamic Stochastic General Equilibrium models. Kiyotaki and Moore (1997) study the effects of collateral constraints on borrowing, Bernanke et al. (1999) emphasise the link between the external financial premium and borrowers networth which give rise to a financial accelerator mechanism, enhancing swings in borrowing and therefore in real activity. Numerous other studies taking a similar approach are surveyed by Brunnermeier et al. (2012).

Taking a different stance, a number of studies conjecture a more active role of credit in the economy. The hypothesis that credit markets may be the source of shocks and therefore drive the business cycle is investigated by a number of authors. Several papers introduce a banking system into an otherwise standard New Keynesian DSGE model. This allows the authors to study the relevance of various types of credit supply shocks - such as credit spread shocks by Curdia and Woodford (2010), bank valuation shocks by Gertler and Karadi (2011) and Gertler and Kiyotaki (2015) and ”risk shocks”, which refer to fluctuations in agency problems by Christiano et al. (2014). The main message from these studies is that developments in credit markets can potentially originate shocks which drive real activity. Christiano et al. (2014) argues that fluctuations in risk are the most important shock driving the business cycle.

2.2 Theoretical foundations of credit supply shocks

Credit supply shocks refer to unanticipated changes to lenders willingness to lend and more generally to their risk appetite profile. The essence of why expansions of credit supply may foster financial instability and cause disruptions to the macroeconomy is related to excessive risk taking by financial intermediaries and the build-up of financial imbalances in the economy. Stein (2013) discusses two root causes leading to overheating credit markets that have been labelled by Peydró (2014) *the preference channel* and *the agency channel*.

The preference channel is related with what is referred to in the literature as *credit market sentiment* and refers to fluctuations in the price of risk over time, reflecting beliefs of the end investor that may or may not be fully rational. Therefore, lax credit standards in mature stages of the business cycle may occur because investors neglect low-probability risks and extrapolate current good economic conditions (see Gennaioli et al. (2015)). Alternatively, there are also rational motives for swings in credit market sentiment. Habit formation models (eg. Campbell and Cochrane (1999)) capture the reality of pro-cyclical movements in risk appetite which may drive cycles in credit. Pro-cyclical movements are justified by the need for compensation for holding risky assets in recessions.

The second explanation for why credit markets may overheat is related to excessive risk taking of financial intermediaries arising from limited liability and high leverage - *the agency channel*.

According to Stein (2013) and Peydró (2014) financial innovation, regulation and changes in economic environment are key risk factors driving credit supply that may be above optimal levels due to financial frictions under which financial intermediaries operate.

2.2.1 How do Credit Supply Shocks affect the Real Economy ?

Much of the theoretical research regards expansions in credit supply as an exogenous shock related to financial intermediaries balance sheet (eg. relaxation of lending constraints), which affects the real economy through an amplifying mechanism that propagates the shock.

In Justiniano et al. (2015) a credit supply expansion works by relaxing the total amount that can be borrowed, which is exogenously limited. Schmitt-Grohé and Uribe (2016) model credit supply as an unexpected decline in borrowing costs in a small open economy, which leads to an increase in consumption of imported goods and an increase in external debt. The international dimension of credit supply shocks is also explored by Justiniano et al. (2015) where an increase in efficiency of the financial sector or the rise in international capital flow are the key elements behind an exogenous expansion of credit supply. Other authors model credit supply as changes in loan-to-value ratios or payment-to-income constraints (see for example Greenwald (2016), Favilukis et al. (2017)).

Alternatively, credit supply shocks may be viewed as endogenous. This is the main idea of "sentiment" models, featuring endogenous credit supply shocks, where positive credit market sentiment shocks lead to predictable reversals, causing swings in the business cycle. This stylized fact is documented by Krishnamurthy and Muir (2015) and López-Salido et al. (2017) which show that an environment of low credit spreads proceeds sudden rises of credit spreads and such episodes coincide with financial crisis. Mian et al. (2018) highlight that household debt tends to mean-revert - a rise predicts a reversal three to seven years after the initial shock.

Credit supply expansions have also been associated to long term distortions to the economy. Gopinath et al. (2017) argue that credit supply is associated to lower productivity growth in the Spanish manufacturing sector between 1999 and 2012. During this period they show that funding was being diverted to higher networth firms that were less productive. More generally, Borio et al.

(2015) finds that credit booms undermine productivity growth due to labour reallocation towards lower productivity sectors.

2.2.2 Credit Supply or Credit Demand ?

A key initial question to ask is whether the growing amount of debt outstanding in modern economies has been driven by credit demand or credit supply shocks. Credit demand shocks are unexpected changes to borrower's net worth that change their credit balance. In theory, credit supply shocks are independent of borrower's balance sheet condition. However, in practice credit demand and supply shocks are not mutually exclusive and it is plausible that they reinforce each other. As noted by Mian et al. (2018) a credit supply shock may shift credit demand outwards.

Disentangling credit demand and supply shocks is difficult when working with aggregate data because through the lens of small-scale SVAR methods credit demand shocks are observationally equivalent to more general aggregate demand shocks and therefore obtaining orthogonalized impulse responses is challenging. Nevertheless, understanding which force dominates is important since they have different macroeconomic implications.

The main strategy to analyse this question has been to focus on credit supply shocks which are easier to identify in aggregate data. Moreover, it has been argued that credit supply ought to be the dominant force behind the dynamics of credit market developments in past decades. Most models featuring credit demand shocks prescribe that an expansion in credit demand should lead to higher interest rates and greater future growth. However, as Justiniano et al. (2015) and Mian et al. (2018) note, this prescription is at odds with what can be observed in the data. Mian et al. (2017) in particular find that a rise in household debt associated to a credit demand shock, characterized by an increase in permanent income does not result in future growth. On the contrary, the authors find that episodes of rising household debt are associated with low spreads between mortgage credit and sovereign debt, which lends support to the credit supply view. Similar results are reported by Muir (2017). In a sample covering 19 countries they find that spreads between bonds with high credit risk tend to narrow before financial crisis. Taken together, the evidence overwhelmingly favours the view that credit supply is the dominant force and the key ingredient of credit growth which poses macroeconomic risks.

2.3 Progress on the empirical front

2.3.1 Large historical and cross-country studies

Episodes of rapid credit growth and soaring leverage are the most powerful predictors of impending financial crisis. These facts have been well documented in a series of papers by Dell'Ariccia et al. (2012) Reinhart and Rogoff (2009) and Schularick and Taylor (2012), Taylor et al. (2016) amongst others.

Reinhart and Rogoff (2009) find that episodes of soaring external debt are associated with banking crisis and generally lead sovereign debt crisis. Based on a sample of 200 recessions across 14 advanced countries over 140 years, Jorda et al. (2012) finds that when accompanied by financial crisis, recessions are more costly on average and large ex-ante credit booms are preceded by more severe recessions and more costly recoveries. In another paper, Jordà et al. (2011) also documents an association between credit growth and external imbalances. The authors note that strong credit booms usually go hand-to-hand with an influx of foreign liquidity, an expansionary monetary policy stance and financial innovation, since the increase in local deposits and wealth is limited. These and other authors document the rapid financialization and increasing leverage experienced by developed economies in the last forty years to which Taylor et al. (2016) call "the financial hockey stick". Similar findings are reported by Gourinchas and Obstfeld (2012) using a sample of 79 emerging and developing countries. The authors find that rising leverage, credit expansion and real currency appreciation are the most robust predictors of financial crisis. This finding holds for emerging and developed economies.

Using US data from 1929 to 2013, López-Salido et al. (2017) find a predictable cycle in credit spreads. The leading property of credit spreads in predicting episodes of financial distress is also studied by Muir (2017), Gilchrist and Zakrajšek (2012) which report results that are consistent with these findings. The real economic consequences of exuberant credit market sentiment is explored by Baron and Xiong (2017). While analysing 20 developed economies over 1920–2012, the authors find that an expansion in private credit predict a crash in bank equity prices.

2.4 Why the Transmission mechanism of Credit Supply Shocks may have changed

2.4.1 Institutional changes in credit markets

Structural changes in the functioning of credit markets have the potential to alter the macroeconomic relevance of credit supply shocks. One of the major changes in credit markets in recent decades is due to the progressive liberalization of the financial system which allowed an increase in competition at a national and international level and facilitated financial globalization. While it is unclear whether competition and financial globalization increase or decrease systemic risk (see Peydró (2014) for a review of the literature) these phenomena are clearly associated with key risk factors associated to excessive risk taking and expansions in credit supply. As noted by Boivin et al. (2010), the result of financial liberalization is that an increase in interest rates no longer constraints bank's access to funding. Therefore, credit supply ought to be less sensitive to interest rates.

In addition, the growth of securitization and more generally financial innovation during the last decades is often related to the build up of financial imbalances and expansion of credit supply (Mian and Sufi, 2009). Securitization increased the attractiveness of credit loans as an asset class by allowing the transformation of otherwise illiquid financial products into marketable securities, therefore expanding credit supply. On the other hand, it led to an enormous expansion in the shadow banking system (see Adrian and Shin (2009) for more details) in which traditional financial intermediation is replaced by lending via financial markets. Two major impacts of the growth of shadow banking as a result of securitization are highlighted by Boivin et al. (2010). First, it allows borrowers to access finance directly bypassing financial intermediaries. Second, it has lead to a much easier access to credit. Up until the Great Recession, down-payments requirements and refinancing costs had been falling.

Taken together, evidence suggests that not only credit supply has expanded but that the price elasticity of credit supply may have changed as a result of increasing competition in the financial sector, a proliferation of alternative financial products, financial globalization and liberalization of the financial system.

2.4.2 Changes to Borrowers Balance Sheets

The bank lending view posits that changes in credit supply influence the economy because many borrowers depend on bank loans to finance their activities. Therefore, an increase in the availability of loans lead to rising consumer spending and investment (Boivin et al., 2010). However, this mechanism is reliant on the assumptions of i) no perfect substitutability between bank loans and other sources of funds and ii) borrowers want to borrow more if given the opportunity to do so. There are good reasons to believe that neither assumption holds true in all states of the world. First, the evidence previously discussed shows that funding in the economy is shifting towards a non-bank based system. Second, borrowing constraints of the non-financial sector may not always bind. Atif Mian and Sufi (2014) make a strong case against the bank lending view, arguing that the credit-crunch during the Great Recession was not driven by the bank lending channel. Instead, it was borrowers balance sheets that explained the sharp pull-back in spending. In their recent article, Mian and Sufi (2018) propose that expansions in credit supply, operating through household demand are an important driver of business cycles. The mechanism works as follows. First, an expansion of credit supply works its way to the real economy by boosting local demand as opposed to building up productive capacity. This leads to rising credit and a short term stimulus to aggregate demand which reverts since it is not accompanied of enhanced economic fundamentals and results in rising leverage.

Overall, the balance sheet of the non-financial sector changed significantly over the last decades. Leverage, as measured by the credit-to-GDP ratio has increased from roughly 70 % in 1960 to just over 179 % in 2016, after having peaked at 195 % in 2008 [1]. In addition, the debt service ratio of

[1] Series DDDI12USA156NWDB retrieved from FRED, Federal Reserve Bank of St. Louis.

households followed an upward trend from 1980, where it stood at 10 % to 13 % in 2008, having fallen to just under 10 % at present. A different balance sheet of the non-financial sector may have lead to changes in the slope of the credit demand curve which ought to change the macroeconomic outcome of a credit supply shocks.

2.4.3 Changes in the Economic Environment

Changes in the economic environment alter macroeconomic risk-premia and therefore influence credit decisions. The current prolonged period of low interest rates driven by lower global economic growth and an increase in the convenience yield for safety and liquidity (Del Negro et al., 2019) creates incentives to take on greater credit risk, operate with greater levels of leverage and engage in yield seeking behavior (Allen and Rogoff, 2010; Stein, 2013). Moreover, the last forty years have witnessed several economic eras, ranging from the beginning and end of the Great Moderation, the Great Recession and consequent recovery. It is plausible that the relationship between credit and the macroeconomy might have changed as a result of changes in economic behavior and policy rules.

3 Data

This study draws on US data collected from 1973 to 2016 retrived from FRED - Federal Reserve Bank of St. Louis, the Bank for International Settlements (BIS) and the website of Simon Gilchrist. The variables used are the following.

- **GDPg -** a measure of the Gross Domestic Product gap which is calculated as the difference between the Real Gross Domestic Product (GDPC1) and Real Potential Gross Domestic Product (GDPPOT) as a percentage of the later. The potential GDP is a measure of economic fundamentals. Purging this component of GDP allows for a clear picture of the impact of credit supply shocks on the short term cyclical component of real activity.
- **Inflation -** The consumer price index (CPIAUCSL) is included and transformed to logarith-

mic differences so as to measure inflation.

- **FFR -** The Effective Federal Funds rate (FEDFUNDS) is differenced to ensure stationarity.
- **EBP -** The Excess Bond Premium (EBP) is considered at a monthly frequency and aggregated to a quarterly frequency so as to match the other macroeconomic variables in the model. The indicator is available on Simon Gilchrist's website.
- **Leverage -** Measured as the the cycle of the Credit-to-GDP ratio (Q:US:P:A:A), which according to the BIS *"captures the build-up of excessive credit in a reduced form fashion"*. The cyclical component of the ratio of Credit-to-GDP is found by applying a filter as recently proposed by Hamilton (2017) which offers advantages over the HP filter.

The VAR is estimated at a quarterly frequency and the variables are ordered as above.

4 Empirical Approach

4.1 The Model

Consider the following structural time-varying VAR with stochastic volatility (Primiceri, 2005) identified recursively (Gilchrist and Zakrajšek, 2012) written as follows

$$Y_t = B_{0t} + \sum_{j=1}^{p} B_{jt} Y_{t-p} + A_t^{-1} \Sigma_t \varepsilon_t, \quad \varepsilon_t \sim N(0, I_n). \tag{1}$$

where Y_t is a vector of endogenous variables that include the percentage deviations of GDP from potential GDP, as a measure of real activity; CPI inflation; the first difference of the federal funds rate; the EBP and leverage, as measured by the credit-to-GDP gap. The structural shocks ε_t are related to the VAR residuals u_t via the mapping $\varepsilon_t = A^{-1} u_t$. Identification is achieved in this setting through a recursive scheme where the orthogonal innovations of the EBP are interpreted as credit supply shocks. The drifting coefficients are meant to capture possible nonlinearities in the way the variables interact in the system. B_{0t} is an $n \times 1$ vector of time-varying intercepts; B_{jt}, $j = 1, ..., k$ are $n \times n$ matrices of coefficients that smoothly change over time, together forming

$B_t = [B_{0t}, ..., B_{pt}]$. The model allows for stochastic volatility which offers flexibility regarding potential heteroskedasticity of the shocks and nonlinearities in the covariance structure of the innovations. We consider a triangular reduction of the matrix of heteroscedastic unobservable shocks such that $A_{0t}\Omega_t A'_{0t} = \Sigma_t\Sigma_t$ where Ω_t is the structural variance covariance matrix, A_{0t} is upper diagonal and Σ_t is a diagonal matrix.

The extent to which time-variation in the relationship between the variables leads to shocks of varying magnitudes through time or a change in the transmission mechanism is entirely driven by data. The time-varying dynamics of the parameters are governed by the following specifications

$$\beta_t = \beta_{t-1} + \nu_t, \tag{2}$$

$$\alpha_t = \alpha_{t-1} + \zeta_t, \tag{3}$$

$$log\sigma_t = log\sigma_{t-1} + \eta_t. \tag{4}$$

where $\beta_t = vec(B_{0,t}, ..., B_{pt})$, $\alpha_t = vec(A_{0t}^{-1})$ [2] and σ_t is a vector of the diagonal elements of the matrix Σ_t. The parameter set $\theta = \{\nu_t, \zeta_t, \eta_t\}$ is jointly normally distributed such that $\theta \sim N(0, V)$, where V is a block diagonal matrix that collects idiosyncratic volatility of the innovations of the state equations (2 - 3), $V = diag(Q, S, W)$. It is worth noting that, although the specification allows the data to determine the degree of time-variation, the equations above impose the assumption that relationships amongst variables in the model change smoothly. This hypothesis is quite reasonable in a macroeconomic environment and widely adopted in the literature.

4.2 Identification

Intuitively, a credit supply shock generally refers to an unanticipated change to lenders' willingness to lend and overall risk appetite, which can happen for multiple reasons surveyed in section 2. We employ two main identification strategies that have been used in prior studies to pin-down the macroeconomic consequences of credit supply shocks.

[2] The vec(.) operator stacks all VAR coefficients into a column vector.

First, credit supply shocks have been identified recursively as orthogonal innovations to a credit supply equation. The VAR analysis in Bassett et al. (2014), Lown and Morgan (2006) and Gilchrist and Zakrajšek (2012) consists in interpreting credit supply shocks as the innovations to variables that accurately measure credit supply. Similar to Ciccarelli et al. (2015), Lown and Morgan (2006) that use the net percentage tightening of US credit standards from senior loan officers' opinion surveys, Bassett et al. (2014) isolates the credit supply content of this measure by removing the component related to loan demand. Gilchrist and Zakrajšek (2012) use a firm level dataset to build an aggregate bond spread index. The authors decompose the spread into a component that reflects bond characteristics and expected defaults; from another component - the Excess Bond Premium (EBP) - which they interpret as a proxy of credit supply. Reassuringly, Mumtaz et al. (2014) finds that these and other alternative measures of credit supply tend to evolve very closely.

Such an identification scheme offers some advantages but also caveats. By imposing contemporaneous restrictions on the response of GDP and inflation to credit supply shocks, a recursive identification strategy disentangles credit supply shocks from "macro" aggregate supply and demand shocks by assuming that the macroeconomy reacts with a delay to credit supply shocks, thereby excluding financial accelerator effects that occur in response to real shocks. Moreover, in our exercise this identification scheme delivers results which are consistent with the theoretical construct of a credit supply shocks. On the other hand, the use of proxies to describe credit supply introduces a certain degree of measurement error in the VAR. A solution for this issue has been recently proposed by Mertens and Ravn (2014) albeit only for time-invariant parameter VARs. The application of such methods in a time-varying parameter environment is ongoing research and therefore we refrain from adopting such an approach in our TVP-SV-VAR. Nonetheless, this potential problem is expected to be ameliorated by the fact that different measures of credit supply seem to behave similarly (Mumtaz et al., 2014).

Second, an influential strategy adopted in the literature to recover credit supply shocks consists in using sign restriction routines (eg. Gambetti and Musso (2017), Eickmeier and Ng (2015), Hristov et al. (2012), Peersman (2011) and De Nicolo and Lucchetta (2010)). Theory offers ambiguous predictions on the impact of credit supply shocks in terms of inflation, interest rates and leverage. Nevertheless, a large number of authors agree that credit supply shocks result in a change of GDP and credit volumes of the same sign (see Table 2 in Hristov et al. (2012) and Tables I-II in Gambetti and Musso (2017) for a summary).

A sign restriction routine offers the advantage that the results are invariant to the ordering of the variables in the VAR. It consists in rotating the initial recursive impact matrix until the resulting impulse responses satisfies what theory prescribes (see Rubio-Ramírez et al. (2010)). This approach has clear limitations when the theoretical relationship between the variables in the model is not clear-cut or exhibits time dependence, which is the case of the relationship between credit supply, inflation and leverage. Although it is possible to remain agnostic about such relations, doing so defeats the main objective of a sign restriction routine of narrowing down the wide range of licit matrices that map the reduced form innovations into the structural shocks, resulting in imprecise inference on the impulse response functions. Nonetheless, we adopt a sign restriction routine as a robustness check, whereby a credit supply shock, leading to a decrease in credit spreads is restricted on impact to cause a positive increase in the output gap.

To further check the sensitivity of our results to the specific choice of order of the variables in the VAR we examine generalized impulse responses calculated in our TVP-SV-VAR in accordance to Pesaran (1997). However, it should be noted that generalized impulse responses do not deliver orthogonal shocks and any structural interpretation of the results is invalid.

4.3 Specification and Estimation

Estimation is standard and follows closely Primiceri (2005) regarding prior choices, number of lags considered and the estimation strategy. However, unlike the author we opt to specify uninformative priors and do not use a training sample to estimate the hyperpriors. This allows the model more flexibility and reflects the fact that we do not wish to impose any kind of prior information on the parameters. A description of the prior density choices is discussed below.

$$B_0 \sim N(0, 4 * I_n), \tag{5}$$

$$A_0 \sim N(0, 4 * I_k), \tag{6}$$

$$log\sigma_0 \sim N(0, I_n), \tag{7}$$

$$Q \sim IW(k_Q^2, s_k), \tag{8}$$

$$W \sim IW(k_W^2, s_w), \tag{9}$$

$$S \sim IW(k_S^2, s_s). \tag{10}$$

The hyperpriors are set to the values $s_k = 40$ $s_w = 2$ $k_Q = 0.01$ $k_S = 0.1$ $k_W = 1$. IW(.) denotes the inverse-wishart pdf. A Gibbs Sampler that does not differ from that proposed by Primiceri (2005) is used to estimate the model and the VAR is estimated with 2 lags following the author.

5 Motivation

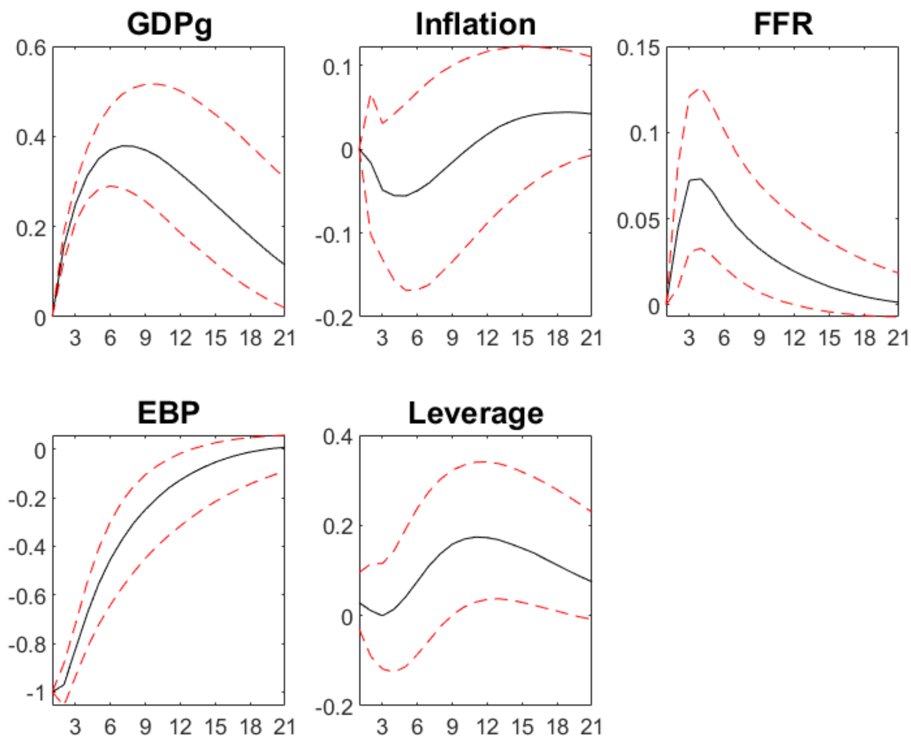
To motivate the discussion about the time-varying dynamics of credit supply shocks, let us start by examining the macroeconomic consequences of a credit supply shock in a time-invariant environment. This is commonly done by jointly estimating the following system

$$Y_t = B_0 + \sum_{j=1}^{p} B_j Y_{t-p} + A^{-1} u_t, \tag{11}$$

Which is similar to (1) except that no parameter depends on time t. The time-invariant counterpart of (1) is obtained by simply setting the variances of the state equations (2 - 4) to zero. Estimation yields the following impulse response function estimates

Figure 1 is consistent with the theoretical construct of a credit supply shock. An unexpected

Figure 1: Time-invariant impulse responses to a one standard deviation credit supply shock.



Note: Impulse response functions result from the estimation of a Bayesian VAR at quarterly frequency, following the specification detailed in section 4.1, where time-variation in the parameters is suppressed by setting the variance of the innovations to the coefficients state equation to zero. The credit supply shock is identified recursively on the EBP equation.Time series are standardized.

relaxation of borrowing constraints stimulates economic activity, which expands in the following 20 quarters. The response of inflation is unclear, which agrees with the idea that credit supply shocks exert both inflationary and deflationary pressures to the economy. Through the local demand channel, inflation is driven upwards, since credit is stimulating demand. Whereas, if it leads to a build-up of productive capacity in the economy, a credit supply shock can be deflationary. Overall, in reaction to a credit supply shock, inflation decreases in the short-run (approximately during the first 12 quarters) and increases thereafter. However, this finding may be a result of neglecting potential structural changes in the economy that may imply that credit supply shocks are inflationary in certain periods and deflationary in other periods. Moreover, the posterior of the impulse response is very wide and therefore, results are unclear. A richer time-varying parameter model is necessary to examine this question further.

The response of leverage to a credit supply shock is also intriguing. While overall leverage seems to increase in reaction to an expansion in credit supply, there is a significant region of the posterior of the impulse responses below zero for the first 12 quarters after the shock hit the system. One possible explanation is that, again there are two opposing forces at work. The expansion in credit supply increases borrowing and therefore aggregate credit in the economy. If credit generates enough economic value added, then leverage need not increase. If the demand channel is dominant, leverage ought to increase. It is plausible that the extent to which credit is supporting value generating sectors and enhancing capital or being used in ends that do not generate future growth is varying over time. To have a clear picture of the changing nature of credit supply shocks, it is necessary to look at this question in an environment that takes into account time-variation.

The evidence discussed thus far motivates a different framework to think about credit supply shocks. In the rest of the paper we re-examine the questions discussed in a time-varying environment that allows us to have a better picture of how expansions in credit supply have changed in the past decades and how their macroeconomic consequences vary over time.

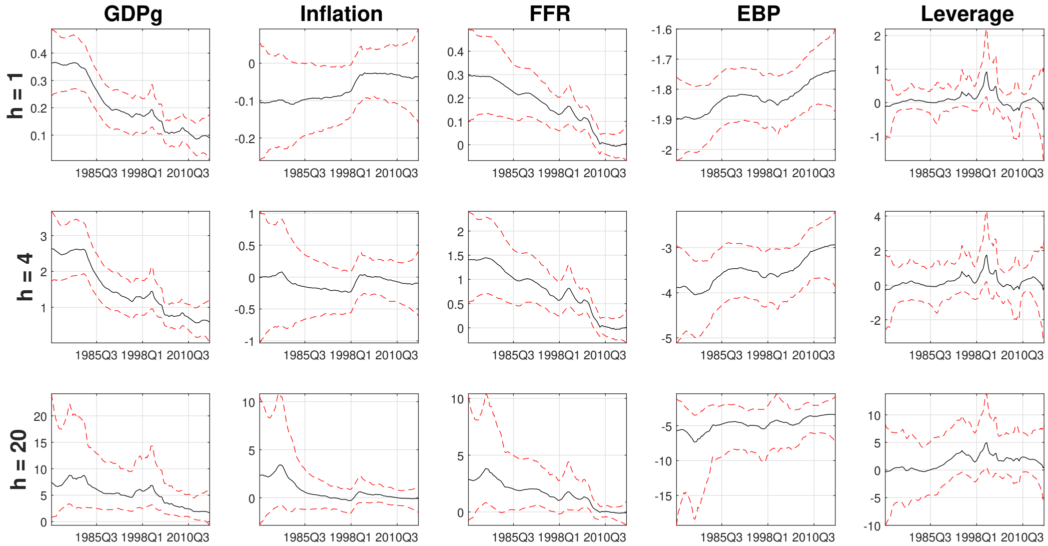
6 Discussion of the results

6.1 Evolution of the effect of Credit Supply shocks over time

One suspicion from the preliminary exercise carried out in section 5 of this paper is that the macroeconomic impact of credit supply shocks might have changed. To examine closer the potential structural changes, we take our time-varying parameter VAR to data and calculate dynamic impulse response functions. Results follow below.

Figure 2 characterizes the full dynamics of the impulse response functions of credit supply shocks in the economy from 1974Q1-2016Q1. Each row indicates the cumulative response of each variable in the system to a credit supply shock at a given horizon h. It can be seen that a credit supply shock characterized by a decrease in EBP of 1 standard deviation (0.5 %) leads to an increase of approximately 0.37 standard deviations in the output gap (0.78 %) in the 1970s, in the

Figure 2: Time-varying cumulative impulse response to a one standard deviation credit supply shock.



Note: Cumulative impulse responses show the sum of the impulse response functions of all variables over the horizons $h = \{1, 4, 20\}$ (in quarters) to a credit supply shock in the time-varying parameter VAR. The credit supply shock is identified recursively. The bands delimit the space between the 16th and the 84th percentiles of posterior densities. Time series are standardized.

short-run (h=1). Whereas, the exact same credit supply shock induces a stimulus to GDP resulting in an increase in the output gap of about 0.23 % in 2016. This result may suggest that credit supply shocks have become less significant as drivers of real economic activity. However, this result varies across identification schemes and therefore should be read with caution.

Results regarding the relationship between credit supply and inflation are less definitive. In the early periods of the sample, credit supply shocks tended to have a deflationary impact on the economy in the short-run (h=1), an inflationary impact in the long-run (h=20) and to be innocuous in the medium-run (h=4). Whereas, in more recent periods the response of inflation is more muted. However, these results should be approached with caution because the posterior of the impulse response functions of inflation is very wide and one cannot exclude the hypothesis of no effect of credit supply on inflation (ie, zero is included in the posterior density region). Figure 6 in the Appendix allow a more detailed look on this pattern. It confirms that, indeed in the short-run credit supply shocks tends to be deflationary, before reverting and generating inflation in the medium/long-term. However, this is only observed during the first half of the sample considers (roughly before 1998).

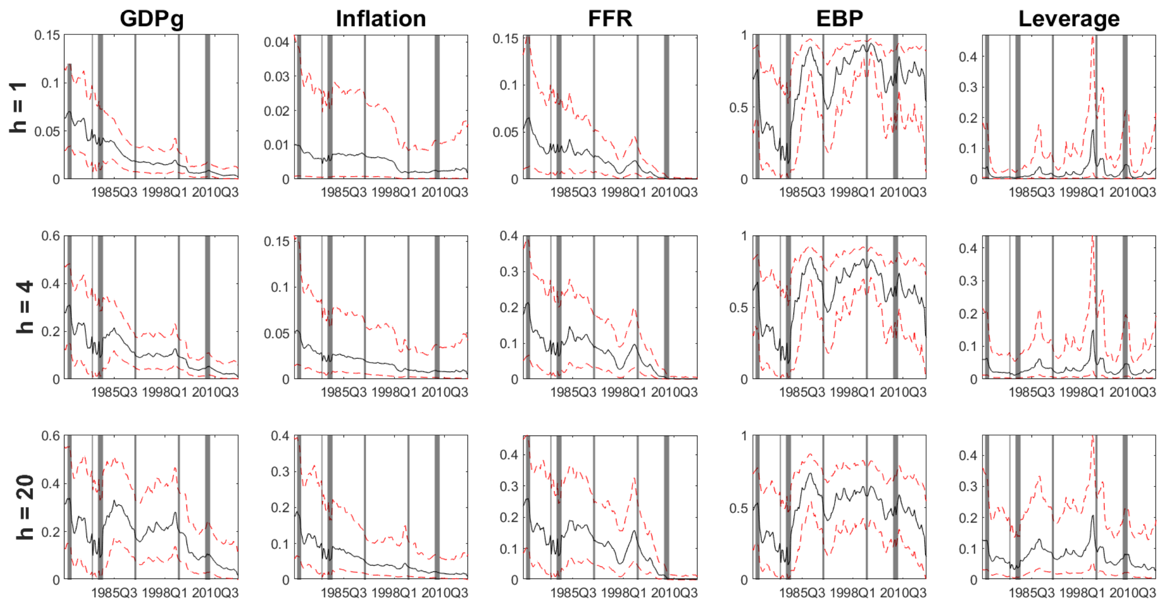
The last column in figure 2 offers additional insights about the impact of credit supply shocks on leverage. The relationship between expansions in credit supply and indebtedness in the economy is not trivial and fundamentally an empirical question because it depends on the capacity of agents in the economy of channelling credit to growth generating activities. We see that before 1985, the impact of credit supply on leverage was approximately nill in the long-run (h=20). One interpretation of this result is that, credit was innocuous in terms of leverage in cumulative terms because enough economic value was being generated so as to compensate the expansion of liabilities in the balance sheets of agents in the economy. However, from 1985 onwards, credit supply expansions generate leverage. Notoriously, in the early 2000s an expansion of credit supply equivalent to 1 standard deviation of the EBP, lead to approximatly an increase in leverage of 5 standard deviations in the long-run (equivalent to 21 % increase in the credit-to-gdp gap). The framework used in this paper does not allow us to make conjectures about what lies behind such structural changes in the relationship between credit supply and leverage. However, the patterns observed coincides with the period of financial liberalization of the 1980s and the credit boom of the early 2000 that lead to the Great Recession.

6.2 Changing relevance of Credit Supply shocks

The results discussed so far shed light on the importance of credit supply shocks in absolute terms (per se). However, what is the relative importance of credit supply innovations and how did they change over time ? We will examine this question by looking at the Forecast Error Variance Decomposition of the orthogonalized innovations of our time-varying VAR as suggested below.

The first column in the graph above indicates the portion of variation in the output gap (h-steps ahead) that is due to credit supply shocks. One can observe that the importance of credit supply shocks decreases through time, explaining a smaller portion of the variation of economic developments in the latest periods. For instance, in the beginning of the sample, credit supply explained about 28 % of the dynamics of the output gap, 4-steps ahead. This value plummeted to

Figure 3: Time-Varying Forecast Error Variance Decomposition of all endogenous variables with respect to credit supply shocks.



Note: Forecast Error Variance Decomposition for the horizons $h = \{1, 4, 20\}$ (in quarters) in the system to a credit supply shock in a time-varying parameter VAR following specification (3). The credit supply shock is identified via Cholesky factorization. The red dashed lines delimit the 16th - 84th percentiles of posterior densities. Grey bands highlight NBER recessions.

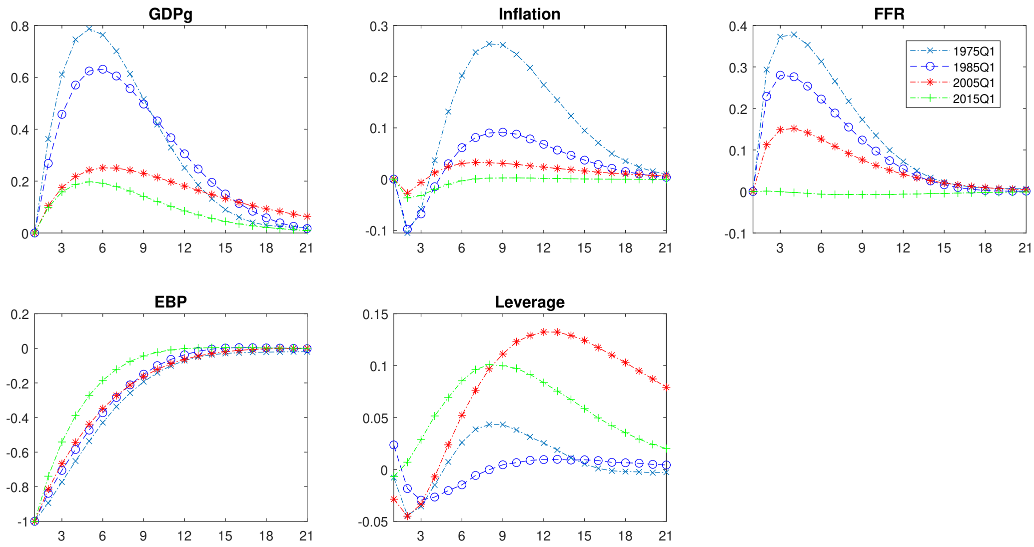
less than 5 % in the later part of the sample. A similar pattern can be observed for different horizons and different variable with one noticeable exception - leverage. The portion of the variability of the Credit-to-GDP gap, which measures leverage, does not exhibit a well defined trend but was notoriously high in the early 2000s. This result corroborates the findings previously reported of an increasing importance of credit supply in steering leverage dynamics.

6.3 The role of Credit Supply shocks across Business Cycles

Credit supply shocks are found to be particularly important as determinants of leverage during the mid-2000s. A detailed description of this result is provided below.

The figure characterizes the macroeconomic outcomes of credit supply shocks across different economic eras of the past decades. The response of the output gap to a 1 standard deviation shock to credit supply (0.5 %) is evidently more pronounced in 1975Q1 and 1985Q1, peaking at about

Figure 4: Impulse responses to credit supply shocks across Business Cycles.



Note: Impulse response functions result from the estimation of a time-varying parameter VAR. The credit supply shock is identified recursively. Time series are standardized. Impulse response functions for t = {1975Q1,1985Q1,2005Q1,2015Q1}.

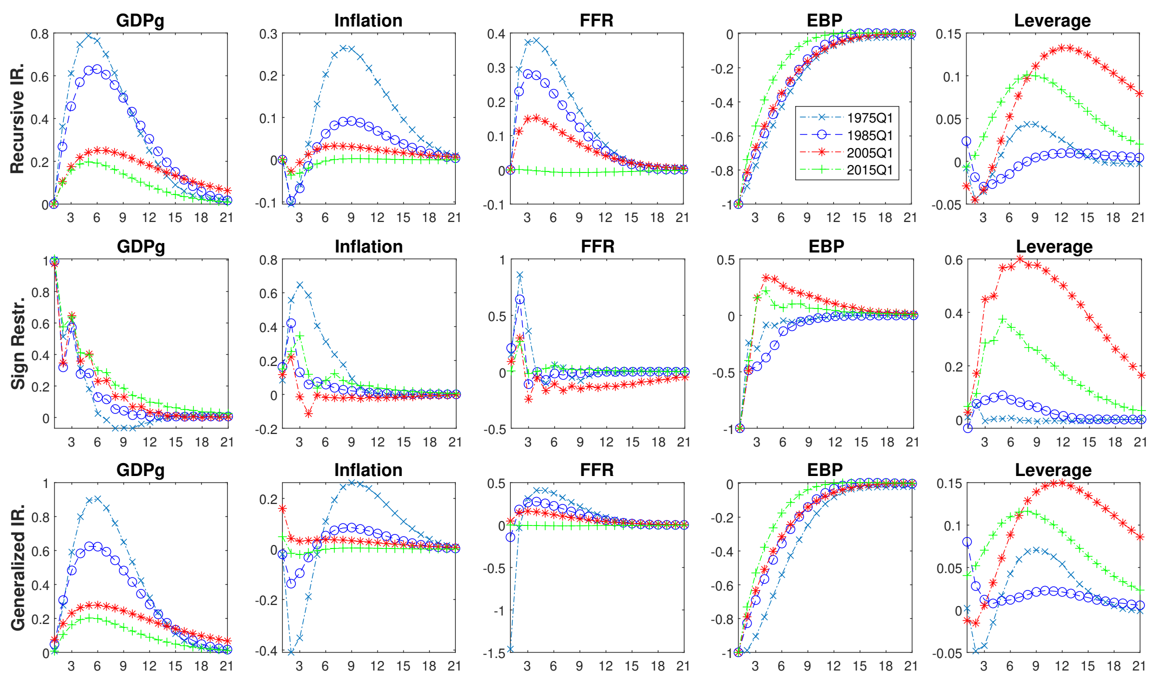
5 quarters and exerting an impact of up to 0.8 and 0.6 standard deviations (which correspond to a 1.68 and a 1.26 increase in the output gap) as compared with up to roughly 0.25 and 0.20 standard deviations 2005Q1 and 2015Q1 (ie, approximately 0.42 and 0.52 percentage points increase in the output gap). A similar conclusion can be drawn about the reaction of inflation and interest rates. Whereas, leverage is more sensitive in 2005Q1 and 2015Q1 as compared to earlier dates. In reaction to a credit supply shock, leverage soars for about 12 quarters in 2005Q1, peaking at just over 0.1 standard deviations (0.43 %). While in 1975Q1 leverage doesn't seem to increase in response to easier credit.

6.4 Sensitivity to alternative identification strategies

To rule out the possibility that our results are driven by the specific identification strategy adopted, in this section we study the extent to which the main results change with alternative identification schemes.

One common critique to recursive identification schemes which are the classic way to identify structural shock in a VAR system, is that the results are overdependent on the specific ordering of the variables in the model. In our baseline VAR, the credit supply and leverage equations are ordered last. We further employ a sign restriction routine by restraining on impact the output gap to react positively to an increase in credit supply. The response of all remaining variables to a credit supply shock are left unrestricted, in accordance with theory. In addition, to understand the sensitivity of the results to ordering, we adopt Pesaran and Shin (1998) approach and compute generalized impulse response functions. The greatest advantage of this approach is that it relaxes the assumption that ordering should reflect the degree of exogeneity of the variables in the system (ie, variables ordered first are assumed to determine all remaining variables but are not contemporaneously affected by a shock to other variables ordered last). The major caveat of this identification strategy is that it is incapable of producing orthogonalized shocks. Therefore, any attempt to evaluate the independent role of credit supply shocks in the economy is invalid. With that in mind we examine the results below.

Figure 5: Alternative Impulse responses functions to a credit supply shock.



Note: Impulse response functions result from the estimation of a Bayesian VAR. Credit supply shocks are identified recrusively, via sign restrictions, whereby the sign of the output gap is restricted to be positive on impact. Generalized Impulse Responses are calculated according to Pesaran and Shin (1998). All variables are standardized.

The figure plots impulse response functions identified through the two alternative identification strategies discussed. Three main messages can be obtained from the graph. First, some variables, noticeably inflation, exhibit an immediate reaction to a credit supply shock when the zero restrictions on impact are relaxed. Overall, credit supply shocks seem to be characterized as being inflationary, independently of the identification scheme adopted. Nevertheless, this result should be read with caution since we have seen that the posterior credibility set around the median impulse responses of inflation is wide. Second, results suggesting that real economic activity became less sensitive to credit supply shocks do not hold across identification schemes. Identification via sign restrictions does not seem to suggest significant changes in such relationships. Third, the key result that leverage has become more sensitive to credit supply shocks is particularly evident in the long-run and holds across all specifications considered.

6.5 Implications for Theories of Macroeconomic Dynamics

Our main finding, which holds across different identification schemes, is that leverage became more sensitive to credit supply shocks. We find that more recently, a credit supply shock generates leverage in the long-run. While this was not the case in the early periods of the sample considered. The reduced form nature of our exercise does not allow us to explore the exact mechanisms which might explain such a result. Nevertheless, a licit interpretation of this finding is that, as agents in the economy accumulated greater amounts of debt, the marginal value generated by taking on more debt decreased and therefore leverage increases. The second key result is that the importance of credit supply shocks in driving leverage in the economy tends to rise before recessions. This evidence highlights the increasing importance of credit supply in driving financial imbalances in the economy that eventually have real economic costs. It favours the view of Peydro et al. (2015) that credit supply driven credit booms sow the seeds of financial crisis. However, it also highlights that this may not always be the case. For instance, the posterior median of the impulse response function of leverage, with respect to a credit supply shock is indistinguishable from zero in the long-run until the mid 1980s. One interpretation of this result is that the marginal credit in the economy was generating enough economic value such that its impact in terms of leverage was nill, which stresses the idea that credit supply shocks need not always be associated with increasing financial imbalances in the economy. Galati et al. (2016) and Drehmann et al. (2012), find that financial cycles are longer and more ample than business cycles [3] and financial and business cycles are not synchronized. It is therefore plausible that credit supply shocks are important elements that build up financial imbalances in the economy, driving the financial cycle which only materializes in economic costs in the long-run.

Next, Mian and Sufi (2018) argues that credit supply shocks tend to be inflationary because the local demand channel of credit supply dominates the production capacity channel. Our analysis offers less definite answers in this domain because the posterior of the impulse response function of inflation with respect to a credit supply shock is wide. Nevertheless, there is evidence that, in the first part of the sample (up until 1998Q1), credit supply shocks tended to be inflationary in the long-run. This result is consistent across the different identification schemes employed.

7 Conclusion

This paper studies the extent to which the macroeconomic impact of credit supply shocks changed over time. A preliminary exercise suggests that the relationship between credit supply and the macroeconomy may be subject to structural changes and that the nature of the relationship between credit supply, inflation and leverage is empirically ambiguous. We re-examine such relationships using a vector autoregression in which the parameters are allowed to move smoothly over time. The key finding is that credit supply shocks generate leverage in the economy in recent periods. Their importance as a determinant of leverage in the economy tends to be particularly high before recessions. Evidence regarding the inflationary nature of credit supply innovations is less definite because inference in this domain is imprecise. Nevertheless there is some evidence suggesting that credit supply shocks tended to be inflationary in the long-run. However, this result

[3]Financial cycles are though to span several business cycles. According to Borio et al. (2018), they last on average 15-20 years since the 1980s as opposed to the average business cycle lasting up until 8 years.

is more discrete in recent periods. The results may help guide the nascent theoretical literature on the role of credit supply in the economy. While theory offers ambiguous answers about the way credit supply generates leverage and inflation in the economy, our results are consistent with the idea that credit supply has been an important determinant of financial imbalances in the economy that build up in good times and sow the seeds of a financial crisis. We observe that credit supply is associated with an increase in leverage after 1985.

References

Adrian, T. and Shin, H. S. (2009). The Shadow Banking System : Implications for Financial Regulation. *Federal Reserve Bank of New York Staff Reports*.

Allen, F. and Rogoff, K. (2010). Asset Prices, Financial Stability and Monetary Policy. In *Swedish Riksbank Workshop on Housing Markets, Monetary Policy and Financial Stability*.

Atif Mian and Sufi, A. (2014). *House of Debt, how they (and you) caused the great recession, and how we can prevent it from happening again*. University of Chicago Press.

Baron, M. and Xiong, W. (2017). Credit expansion and neglected crash risk. *Quarterly Journal of Economics*, 132(2):713–764.

Bassett, W. F., Chosak, M. B., Driscoll, J. C., and Zakrajšek, E. (2014). Changes in bank lending standards and the macroeconomy. *Journal of Monetary Economics*, 62(1):23–40.

Bernanke, B. S., Gertler, M., and Gilchrist, S. (1999). The financial accelerator in a quantitative business cycle framework. chapter 21, pages 1341–1393.

Boivin, J., Kiley, M. T., and Mishkin, F. S. (2010). How has the monetary transmission mechanism evolved over time? In *Handbook of Monetary Economics*, volume 3, pages 369–422. Elsevier Ltd.

Borio, C., Drehmann, M., and Xia, D. (2018). The financial cycle and recession risk. *BIS Quarterly Review*, (December):59–71.

Borio, C., Kharroubi, E., Upper, C., and Zampolli, F. (2015). Labour Reallocation and Productivity Dynamics: Financial Causes, Real Consequences. *BIS Working Paper*, (534):1–52.

Brunnermeier, M. K., Eisenbach, T. M., and Sannikov, Y. (2012). Macroeconomics with Financial Frictions: A Survey. *Advances in Economics and Econometrics: Tenth World Congress*, 2(March):1–95.

Campbell, J. Y. and Cochrane, J. H. (1999). By Force of Habit : A Consumption - Based Explanation of Aggregate Stock Market Behavior. *Journal of Political Economy*, 107(2):205–251.

Christiano, L. J., Motto, R., and Rostagno, M. (2014). Risk Shocks. *American Economic Review*, 104(1):27–65.

Ciccarelli, M., Maddaloni, A., and Peydro, J.-L. (2015). Trusting the bankers: A new look at the credit channel of monetary policy. *Review of Economic Dynamics*, 18(4):979–1002.

Cogley, T. (2005). How fast can the new economy grow? A Bayesian analysis of the evolution of trend growth. *Journal of Macroeconomics*, 27(2):179–207.

Curdia, V. and Woodford, M. (2010). Credit Spreads and Monetary Policy. *Journal of Money, Credit and Banking*, 42(6):3–35.

De Nicolo, G. and Lucchetta, M. (2010). Systemic Risks and the Macroeconomy. *IMF Working Paper*, 10/29.

Del Negro, M., Giannone, D., Giannoni, M. P., and Tambalotti, A. (2019). Global trends in interest rates. *Journal of International Economics*, 118:248–262.

Dell'Ariccia, G., Igan, D., and Laeven, L. (2012). Credit Booms and Lending Standards: Evidence from the Subprime Mortgage Market. *Journal of Money, Credit and Banking*, 44(2-4):367–384.

Drehmann, M., Borio, C., and Tsatsaronis, K. (2012). Characterising the Financial Cycle: Don't Lose Sight of the Medium Term! *BIS Working Papers*, (380):1–38.

Eickmeier, S. and Ng, T. (2015). How do US credit supply shocks propagate internationally? A GVAR approach. *European Economic Review*, 74:128–145.

Favilukis, J., Ludvigson, S. C., and Van Nieuwerburgh, S. (2017). The macroeconomic effects of housing wealth, housing finance, and limited risk sharing in general equilibrium. *Journal of Political Economy*, 125(1):140–223.

Galati, G., Hindrayanto, I., Koopman, S. J., and Vlekke, M. (2016). Measuring financial cycles in a model-based analysis: Empirical evidence for the United States and the euro area. *Economics Letters*, 145:83–87.

Gambetti, L. and Musso, A. (2017). Loan Supply Shocks and the Business Cycle. *Journal of Applied Econometrics*, 32(4):764–782.

Gennaioli, N., Shleifer, A., and Vishny, R. (2015). Neglected risks: The psychology of financial crises. *American Economic Review*, 105(5):310–314.

Gertler, M. and Karadi, P. (2011). A model of unconventional monetary policy. *International Journal of Central Banking*, 9:5–53.

Gertler, M. and Kiyotaki, N. (2015). Banking, liquidity, and bank runs in an infinite horizon economy. *American Economic Review*, 105(7):2011–2043.

Gilchrist, S. and Zakrajšek, E. (2012). Credit Spreads and Business Cycle Fluctuations. *American Economic Review*, 102(4):1692–1720.

Gopinath, G., Kalemli-Özcan, e., Karabarbounis, L., and Villegas-Sanchez, C. (2017). Capital Allocation and Productivity in South Europe*. *The Quarterly Journal of Economics*, 132(4):1915–1967.

Gourinchas, P.-O. and Obstfeld, M. (2012). Stories of the Twentieth Century for the Twenty-First. *American Economic*

Journal: Macroeconomics, 4(1):226–265.

Greenwald, D. L. (2016). The Mortgage Credit Channel of Macroeconomic Transmission. *SSRN Electronic Journal*.

Hamilton, J. D. (2017). Why You Should Never Use the Hodrick-Prescott Filter. *Review of Economics and Statistics*.

Hristov, N., Hülsewig, O., and Wollmershäuser, T. (2012). Loan supply shocks during the financial crisis: Evidence for the Euro area. *Journal of International Money and Finance*, 31(3):569–592.

Jordà, Ò., Schularick, M., and Taylor, A. M. (2011). Financial crises, credit booms, and external imbalances: 140 years of lessons. *IMF Economic Review*, 59(2):340–378.

Jorda, O., Schularick, M., and Taylor, A. M. (2012). When credit cites cack: Leverage, Business cycles, and crises. *Federal Reserve Bank of San Francisco Working Paper Series*, (October):1–42.

Justiniano, A., Primiceri, G. E., and Tambalotti, A. (2015). Credit supply and the housing boom. *Working Paper*, pages 1–41.

Kiyotaki, N. and Moore, J. (1997). Credit Cycles. *Journal of Political Economy*, 105(2):211–248.

Korinek, A. and Simsek, A. (2016). Liquidity Trap and Excessive Leverage. *American Economic Review*, 106(3):699–738.

Krishnamurthy, A. and Muir, T. (2015). Credit Spreads and the Severity of Financial Crises. *Unpublished manuscript*, (January).

López-Salido, D., Stein, J. C., and Zakrajšek, E. (2017). Credit-market sentiment and the business cycle. *Quarterly Journal of Economics*, 132(3):1373–1426.

Lown, C. and Morgan, D. P. (2006). The Credit Cycle and the Business Cycle: New Findings Using the Loan Officer Opinion Survey. *Journal of Money, Credit and Banking*, 38(6):1575–1597.

Mertens, K. and Ravn, M. O. (2014). A Reconciliation of SVAR and Narrative Estimates of. *Journal of Monetary Economics*, 68S:S1–S19.

Mian, A. and Sufi, A. (2009). The Consequences of Mortgage Credit Expansion: Evidence from the U.S. Mortgage Default Crisis. *Quarterly Journal of Economics*, 124(4):1449–1496.

Mian, A. and Sufi, A. (2010). Household leverage and the recession of 2007-09. *IMF Economic Review*, 58(1):74–117.

Mian, A. and Sufi, A. (2018). Finance and Business Cycles: The Credit-Driven Household Demand Channel. *Journal of Economic Perspectives*, 32(3):31–58.

Mian, A., Sufi, A., and Verner, E. (2018). Household Debt and Business Cycles Worldwide. *Quarterly jounal of Economics*, (February):1755–1817.

Mian, A. R., Sufi, A., and Verner, E. (2017). How Do Credit Supply Shocks Affect the Real Economy? Evidence from the United States in the 1980s. *SSRN Electronic Journal*, (609).

Muir, A. K. T. (2017). How Credit Cycles Across a Financial Crisis. *NBER*.

Mumtaz, H., Pinter, G., and Theodoridis, K. (2014). What do VARs tell us about the impact of a credit supply shock ?

An empirical analysis. *Working Paper*, (716).

Mumtaz, H., Pinter, G., and Theodoridis, K. (2018). What Do Vars Tell Us About the Impact of a Credit Supply Shock? *International Economic Review*, 59(2):625–646.

Peersman, G. (2011). Bank Lending Shocks and the Euro Area Business Cycle. *Ghent University Working Paper*, (766).

Pesaran, H. H. and Shin, Y. (1998). Generalized impulse response analysis in linear multivariate models. *Economics Letters*, 58:17–29.

Pesaran, M. H. (1997). Generalized Impulse Response Analysis in Linear Multivariate Models. *Economic Letters*.

Peydró, J.-L. (2014). Systemic Risk, monetary and macropudential policy. *Estabilidad Financiera Banco de España*, 26:35–47.

Peydro, J. L., Laeven, L., and Freixas, X. (2015). *Systemic risk, Crises and macroprudential regulation*, volume 53. MIT press.

Primiceri, G. E. (2005). Time Varying Structural Vector Autoregressions. *Review of Economic Studies*, 72(3):821–852.

Reinhart, C. M. and Rogoff, K. S. (2009). *This time is different*, volume 53. Princeton University Press.

Rubio-Ramírez, J. F., Waggoner, D. F., and Zha, T. (2010). Structural Vector Autoregressions: Theory of Identification and Algorithms for Inference. *The Review of Economic Studies*, 77(2):665–696.

Schmitt-Grohé, S. and Uribe, M. (2016). Downward Nominal Wage Rigidity, Currency Pegs, and Involuntary Unemployment. *Journal of Political Economy*, 124(5):1466–1514.

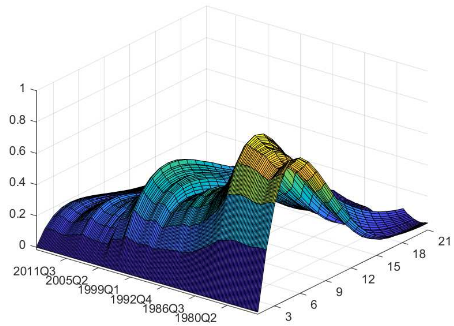
Schularick, M. and Taylor, A. M. (2012). Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870–2008. *American Economic Review*, 102(2):1029–1061.

Stein, J. C. (2013). Overheating in Credit Markets: Origins, Measurement, and Policy Responses. In *speech delivered at "Restoring Household Financial Stability after the Great Recession: Why Household Balance Sheets Matter," a symposium sponsored by the Federal Reserve Bank of St. Louis, St. Louis, February*, pages 5–7.

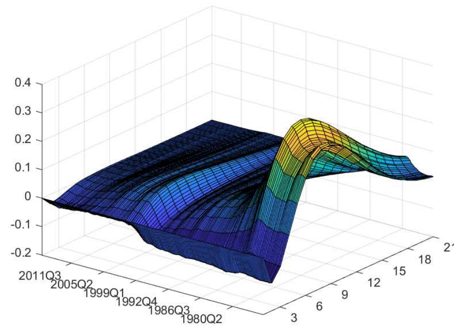
Taylor, A. M., Schularick, M., and Jordà, Ò. (2016). Macrofinancial History and the New Business Cycle Facts. *NBER Macroeconomics Annual Conference*.

A Supplementary Material

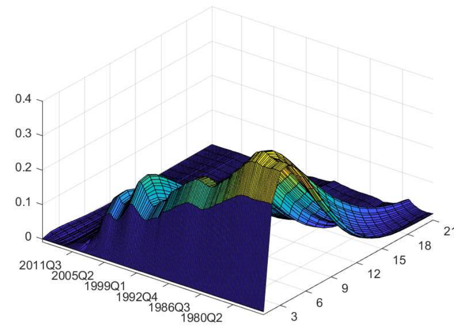
Figure 6: Dynamic Impulse Response Functions that result from the estimation of the TVP-SV-VAR. Credit Supply shock is identified in a recursive fashion.



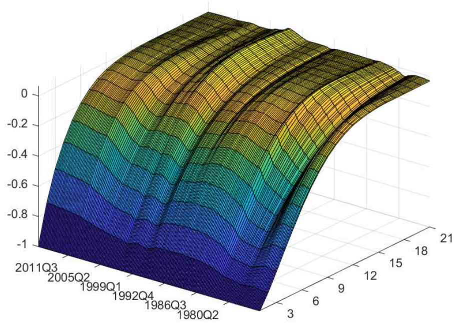
(a) EBP → GDPg



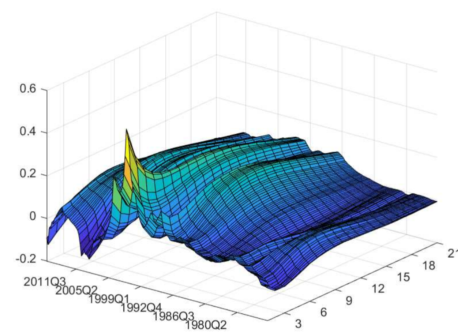
(b) EBP → Inflation



(c) EBP → FFR



(d) EBP → EBP



(e) EBP → Credit-to-GDP gap