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The effect of monetary policy shocks on macroeconomic variables: Evidence from the Eurozone

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*Highlights (for review)

Highlights

- I propose a narrative approach, along with a novel database of the European Central Bank, to construct a new measure of monetary policy shocks for the Eurozone.
- Industrial production responds to an unpredictable 100 bps monetary policy shock with a decline of over 0.5%, starting ten months after the shock.
- The response of inflation is weaker and close to an overall decline of 0.05% in the twenty-four months after the shock.

The Effect of Monetary Policy Shocks on Macroeconomic Variables: Evidence from the Eurozone

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October 2019

ABSTRACT:

This paper investigates how European Central Bank (ECB) monetary policy shocks impact industrial production (output) and inflation (prices). I gather a novel dataset of macroeconomic forecasts, and using a narrative approach I construct a new measure of monetary policy shocks. Industrial production responds to an unpredictable monetary policy shock of 100 basis points with a decline of over 0.5%. On the contrary, inflation responds weakly with a very modest decrease of 0.05%.

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Keywords: Monetary Policy, Narrative Identification, Macroeconomic Forecasts.

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This paper investigates how European Central Bank (ECB) monetary policy shocks impact industrial production (output) and inflation (prices). I gather a novel dataset of macroeconomic forecasts, and using a narrative approach I construct a new measure of monetary policy shocks. Industrial production responds to an unpredictable monetary policy shock of 100 basis points with a decline of over 0.5%. On the contrary, inflation responds weakly with a very modest decrease of 0.05%.

1 INTRODUCTION

In this research, I analyse the response of industrial production (output) and inflation (prices) to monetary policy shocks by exploiting a new sample data of the European Central Bank (ECB).[1] Following the narrative approach of Romer & Romer (2004) and gathering a novel dataset of macroeconomic forecasts, I derive a new measure of monetary policy shocks for the ECB across the 2000–2016 sample period.

Consistent with the existing literature, I find that output is more responsive to monetary policy shocks, having a decline of over 0.5% and starting its downward path 10 months after a 100 basis points[2] shock. Conversely, the response of inflation to a monetary policy shock is very weak. My results on output are in line with past findings which used data from central banks in the United Kingdom, United States and Canada. On the other hand, the response of inflation is weaker when compared to studies in the United Kingdom and the United States. Moreover, similar to past research, I document both a "price" and an "output" puzzle when estimating the impact of shocks

[1] I will from now on refer to the European Central Bank as ECB for simplicity.
[2] I will from now on refer to basis points as bps for simplicity.

with the ECB policy rate instead of my measure of monetary policy shocks. To estimate the impulse responses of inflation and industrial production, I follow two different methods. First, I estimate the impulse response functions with a classical baseline VAR approach to make my results as comparable as possible with other empirical studies. Second, as my sample is considerably smaller than that of the existing research in other countries, I rely on local projections a là Jordà (2005),[3] to overcome my data constraints.

Past studies have used different VAR approaches to overcome the endogeneity issue of monetary policy and macroeconomic variables (Christiano, Eichenbaum & Evans, 1996; Christiano, Eichenbaum & Evans, 1999; Uhlig, 2005). These studies find very little effect of monetary policy on macroeconomic variables in terms of magnitude. On the contrary, Romer & Romer (2004) present evidence of significant effects of monetary policy shocks on macroeconomic variables in the United States. Their approach, unlike previous studies, estimates monetary policy shocks that are orthogonal, with respect to the information set available to policy makers at the decision time. The orthogonality of the shocks series resolves both the issue of endogeneity and anticipatory movements. Coibion (2012) finds a middle ground between past results and Romer & Romer (2004). Cloyne & Hürtgen (2016) assess the effect of monetary policy shocks on macroeconomic variables in the United Kingdom while Champagne & Sekkel (2018) also find similar evidence in Canada.

The paper is organised as follows. Section 2 provides a description of my dataset. Section 3 presents the methodology to compute the series of monetary policy shocks. Section 4 presents the baseline results for the effects of monetary policy and section 5 offers my conclusions.

[3] I thank the anonymous referee for the suggesting this methodology.

2 DATA

Over the sample period 2000-2016 I gathered data on 187 monetary policy meetings from the ECB website (www.ecb.europa.eu). The gross domestic product (GDP) and inflation forecasts, available at a quarterly frequency, are retrieved from the Survey of Professional Forecasters and the Economic Bulletin of the ECB. The unemployment rate and the total assets of the ECB are available at a monthly frequency from the ECB Statistical Data Warehouse (sdw.ecb.europa.eu). To match these data for the first stage of my analysis, run at a meeting-by-meeting frequency, I follow the matching methodology proposed by Romer & Romer (2004).[4] The second stage of the empirical analysis is further run at a monthly frequency including the CPI index, the industrial production index and the ECB commodity index, all available at a monthly frequency and also retrieved from the ECB Statistical Data Warehouse (sdw.ecb.europa.eu).

3 ECB MONETARY POLICY SHOCKS

3.1 THE IDENTIFICATION STRATEGY

The identification strategy I adopt in my paper has been proposed by Christiano, Eichenbaum & Evans (1996) and assumes that the intended change in interest rate, S_t, is the combination of a systematic component ($f(\Omega)$), which is a function of the information set, available to policy makers at the decision point,[5] and an unexpected component ε_t . Equation [1] formalises the function for S_t :

$$S_t = f(\Omega_t) + \varepsilon_t \quad [1]$$

[4]The matching methodology, follows the logic of the "information availability" concept. The data are matched considering which information is available to policy makers at the meeting date and were not available at the previous meeting date. For a detailed description of the dataset construction see Section 1, *"Sources"* in Romer & Romer (2004). The same data construction has also been applied to the Bank of England by Cloyne & Hürtgen (2016) and to the Bank of Canada by Champagne & Sekkel (2018).

[5] By "decision point" I mean the meeting date, when policy makers have to deliberate on the interest rate level.

The narrative approach of Romer & Romer (2004) aims to identify the component ε_t, which should be exogenous with respect to the information set available to policy makers at the meeting time (t).

3.2 A MONETARY POLICY SHOCKS MEASURE FOR THE ECB

Following Romer & Romer (2004), I estimate a reduced form VAR regression (equation [2]), to separate the systematic component $f(\Omega_t)$ from the unexpected component ε_t:

$$\begin{aligned}\mathbf{\Delta}_{im} &= \alpha + \beta_1 \Psi_{(1y)m} + \beta_2 \Psi_{(2y)m} + \beta_3 \Delta \Psi_{(1y)[m-(m-1)]} + \\ &+ \beta_4 \Delta \Psi_{(2y)[m-(m-1)]} + \beta_5 \Pi_{(1y)m} + \beta_6 \Pi_{(2y)m} + \\ &+ \beta_7 \Delta \Pi_{(1y)[m-(m-1)]} + \beta_8 \Delta \Pi_{(2y)[m-(m-1)]} + \beta_9 \upsilon_m + \beta_{10} i_{(m-14)} + \beta_{11} A_m + \varepsilon_m\end{aligned} \qquad [2]$$

The detailed description of the variables[6] included in equation [2], is provided in Table 1.

Table 1: Variables Description

Symbol	Name	Description
$\mathbf{\Delta}_{im}$	Interest Rate change (MRO Interest Rate)	The change in the MRO rate of ECB at the meeting date ($\Delta_{im} = i_m - i_{m-1}$)
$\Psi_{(1y)m}$	1 Year ahead Inflation Forecasts	The inflation forecast level for 1 year ahead
$\Psi_{(2y)m}$	2 Years ahead Inflation Forecasts	The inflation forecast level for 2 years ahead
$\Delta \Psi_{(1y)[m-(m-1)]}$	1 Year ahead Inflation Forecasts Revision from the previous meeting	The revision of 1 year ahead inflation forecast from the previous meeting ($\Psi_{(1y)m} - \Psi_{(1y)m-1}$)
$\Delta \Psi_{(2y)[m-(m-1)]}$	2 Years ahead Inflation Forecasts Revision from the previous meeting	The revision of 2 years ahead inflation forecast from the previous meeting ($\Psi_{(2y)m} - \Psi_{(2y)m-1}$)
$\Pi_{(1y)m}$	1 Year ahead GDP Forecasts	The GDP forecast level for 1 year ahead
$\Pi_{(2y)m}$	2 Years ahead GDP Forecasts	The GDP forecast level for 2 years ahead
$\Delta \Pi_{(1y)[m-(m-1)]}$	1 Year ahead GDP Forecasts Revision from the previous meeting	The revision of 1 year ahead GDP forecast from the previous meeting ($\Pi_{(1y)m} - \Pi_{(1y)m-1}$)
$\Delta \Pi_{(1y)[m-(m-1)]}$	2 Years ahead GDP Forecasts Revision from the previous meeting	The revision of 2 years ahead GDP forecast from the previous meeting ($\Pi_{(2y)m} - \Pi_{(2y)m-1}$)
υ_m	Unemployment Rate	The unemployment rate level at the meeting date
$i_{(m-14)}$	MRO Interest Rate Level	The interest rate level two weeks before the meeting date
A_m	Total Asset	The logarithm of the Total Assets of the ECB

Source: The Survey of Professional Forecasters, The ECB Statistical Data Warehouse (sdw.ecb.europa.eu)

[6] All the variables are at a meeting–by–meeting frequency, as defined in the subscription *m*.

The variables included in the information set of monetary policy makers are the forecasts for inflation and GDP for two years ahead. The change in forecasts from the previous meeting are also included to control for the policy makers' expectations revisions. The interest rate level two weeks prior to the meeting and the current unemployment rate are included as state of the economy controls. Furthermore, differing from the original methodology of Romer & Romer (2004), the logarithm of the total assets of the ECB was included [7] to control for the unconventional monetary policies put in place by the Governing Council of the ECB. [8] The residuals of equation [2] represent the component ε_t of equation [1], and therefore my new measure of exogenous monetary shocks for the Eurozone.[9] Following Romer & Romer (2004), I convert the monetary shocks series from meeting-by-meeting frequency to a monthly frequency, by assigning each shock to the month in which the corresponding meeting had occurred. When in a month there was no meeting I assigned a 0% shock. My series of monetary shocks should be unpredictable and orthogonal with respect to macroeconomic forecasts; therefore, to verify these properties I have conducted a series of Granger tests against macroeconomic variables.[10] The new monetary policy shocks series is plotted in Figure 1.

[7] Burriel & Galesi (2018) include the total assets of the ECB as a measure of unconventional monetary policy.
[8] I thank an anonymous referee for this suggestion.
[9] The results of equation [2] are presented in Appendix A, Table A.1.
[10] The results of these tests can be found in Appendix B and confirm the unpredictability of the series, allowing me to use it in the second stage of the research.

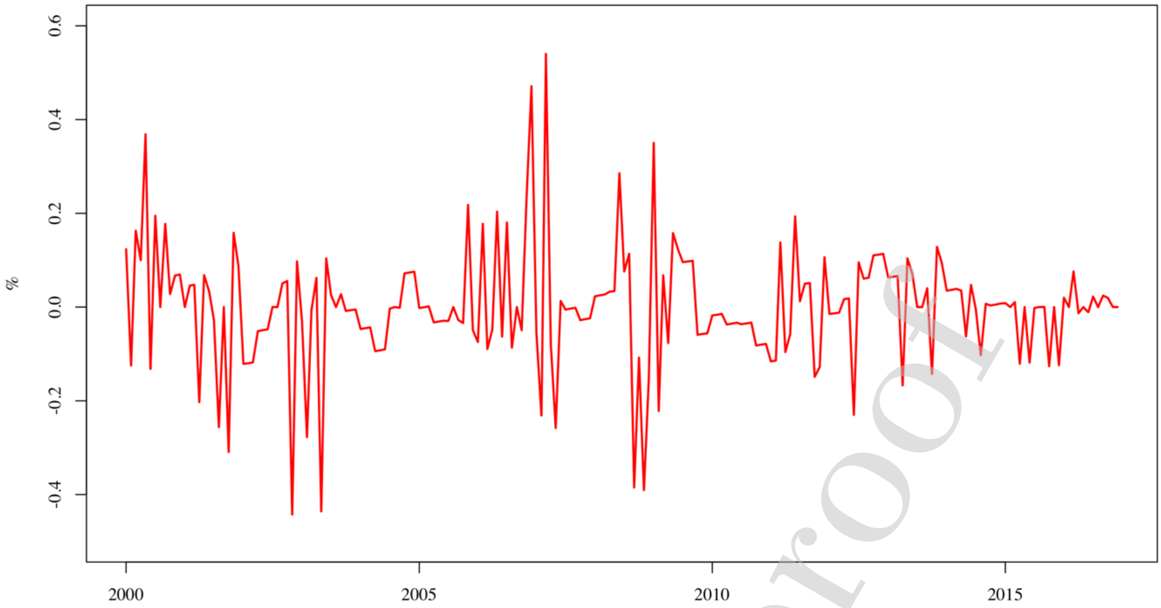

Figure 1. Exogenous Monetary Shocks ECB
Notes: New Monthly shock series for the Eurozone. Sample: 2000–2016

The series of monetary policy shocks shows a high level of volatility around the period of the 2008 financial crisis and a more modest level of volatility in the pre-crisis period and across the last part of the sample. Several facts need to be recalled to correctly interpret the series. First, after the 2008 financial crisis, the ECB put in place unconventional monetary policy programs, differing from the countries included in past studies (Cloyne & Hürtgen, 2016; Champagne & Sekkel, 2018). Second, the 2011 crisis had undoubtedly a greater impact on the Eurozone than on other economic areas. Third, past studies included different sample periods, which makes the comparisons less reliable. Cloyne & Hürtgen (2016) do not include the 2008 financial crisis in their sample, Champagne & Sekkel (2018) include 2008–2014 in their sample period, although they found greater volatility in the monetary shocks series between 1974 and 1994.

The sharp increase and then decline of the interest rate between 2000 and 2004, is responsible for the sustained volatility of the shock series in the pre-crisis period. For most of the monetary policy institutions around the world interest rates have been, on the aftermath of the financial crisis, maintained steadily low and combined with other monetary policies. The persistence of negative shocks in the last part of the sample (particularly after 2014) could be due to the presence of these additional unconventional monetary policy programs.

A portion of the literature has focused on estimating monetary shocks, or unpredictable monetary policy changes, with financial market based measures. Jarocinski & Karadi (2019) and Kerssenfischer (2019), have recently focused on the "information effect", conveyed in monetary policy and macroeconomic announcements. Comparatively, my monetary policy shocks series is computationally very different from the series of Kerssenfischer (2019)[11], as he estimates two different series, defining them as "information shock" and "pure policy shock". The effects of these shocks series on inflation are diametrically different, a contractionary "pure policy shock" will lower inflation expectations, while a positive "information shock" raises them.

4 The Macroeconomic Effects of Monetary Policy Shocks

To investigate the macroeconomic effects of my new series of monetary policy shocks I employ two different methodologies. First, and in order to make my results comparable with previous studies, I compute the impulse response function of industrial production and inflation with a VAR model, both with my new monthly shocks series and with the ECB policy rate. Second, I adopt a single regression approach, based on Jordà (2005)'s local projections.[12] All three analysis are conducted at a monthly frequency.

4.1 VAR with Monetary Shocks Series

The estimated second stage VAR is:

$$Z_t = P(L)Z_{t-1} + \varepsilon_t \qquad [3]$$

[11] Further details on this comparison are given in Appendix D.
[12] I thank an anonymous referee for suggesting this additional methodology.

where *P(L)* is a lag polynomial with 5 lags,[13] including a constant and a time trend. The vector of observables Z_t is defined as: [Y_t , P_t , $P.Com_t$, $C.shock_t$] . Where Y_t is the industrial production index, P_t is the CPI index,[14] $P.Com_t$ is the ECB commodity index[15] and $C.schock_t$ is my measure of monetary policy shocks. Since in the VAR models the levels of variables are usually included, I cumulate the monetary policy shock series and order it last in the VAR[16]. Figure 2 presents the response functions for industrial production and inflation. Panel A, in particular, presents the response function of industrial production to a 100 bps contractionary monetary shock. In the first five months the output, represented by the industrial production, shows a small increment of about 0.15% and starts its downward path after 10 months.

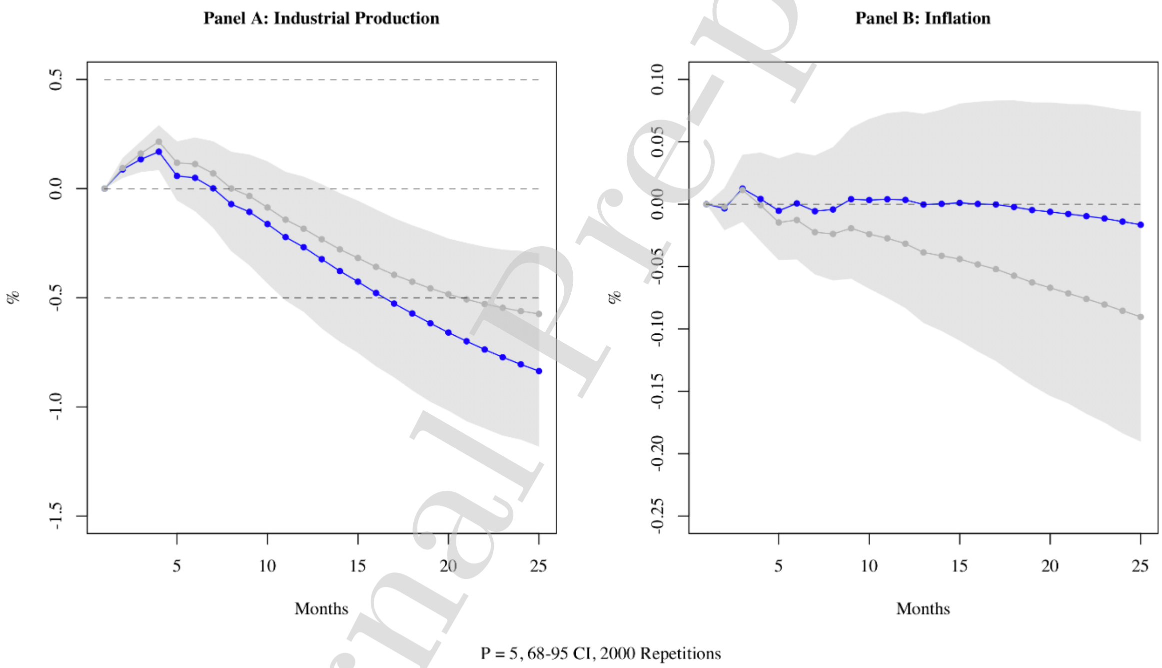

Figure 2. The Response Functions to a Monetary Policy Shock.
Note: In Panel A, the blue path corresponds to the impulse response of output to a 100 bps contractionary monetary policy shock, plotted along with 68 and 95 confidence bands (grey area). In panel B, the blue path corresponds to the impulse response of inflation to a 100 bps contractionary monetary policy shock, plotted along with 68 and 95 confidence bands (grey area). The grey dotted line corresponds to the impulse responses of output and inflation (Panel A and B respectively) to a 100 bps monetary policy shock, computed with the traditional methodology of Romer & Romer (2004) in the first stage regression. Sample: 2000–2016.

13 The lags were chosen conducting different lag length tests. When setting the maximum lag length at 12, the Akaike Information Criterion (AIC) suggests 7 lags, whereas the Schwarz Criterion (BIC) suggests 5 lags. As my sample is small, I rely on the BIC test.
14 The results remain unchanged when using the Harmonised Index of Consumer Prices (HICP), observed by the ECB as an inflation headline.
15 The ECB commodity index was included as a control variable following Cloyne & Hürtgen (2016) and Champagne & Sekkel (2018).
16 As the monetary policy shocks series is exogenous, the results are robust even when ordering the variable first in the baseline VAR. Evidence is provided in Appendix C.

The decline persists for 24 months, reaching 0.5% after 15 months. Similarly, Cloyne & Hürtgen (2016) and Champagne & Sekkel (2018) find that output declines consistently up to 1%, around 18 to 24 months after the shock[17]. Panel B documents a weak response of inflation with a very modest decreasing tendency at the end of 24 months. The weak response of inflation is also documented by Champagne & Sekkel (2018), who find a modest 0.4% decline after 36 months. The grey line presents the responses of industrial production and inflation computed with the monetary shock series of Romer & Romer (2004), excluding the total assets control variable. The results display a similar path, although it slightly enlarge the effects on inflation and reduces the effects on industrial production.

4.2 VAR WITH ECB POLICY RATE

The "price puzzle", an increase in inflation consequent on a tight monetary policy, was first documented by Sims (1992) and subsequently confirmed by other authors. Barakchian & Crowe (2013) document an output puzzle. Romer & Romer (2004) and Cloyne & Hürtgen (2016) document a price puzzle when conducting a traditional recursive-identified VAR with the interest rate. However, they find that the new series of monetary policy shocks, computed with the narrative methodology, partially resolves this price puzzle.

Figure 3 shows the impulse functions for industrial production and inflation computed with both the VAR with the new monetary policy shock series (black) and the ECB policy rate (blue). The output presents a large increase, peaking after 24 months at 2%, whereas inflation presents a milder increase of 0.2%. Output remains more responsive than inflation, in line with previous results.

[17] Recently, Pellegrino (2018) found evidence that during uncertainty periods the response of output for the Eurozone is weaker when compared to normal times. This explanation could also be applicable to my sample period, bearing in mind the inclusion of both the 2008 and 2011 financial crisis.

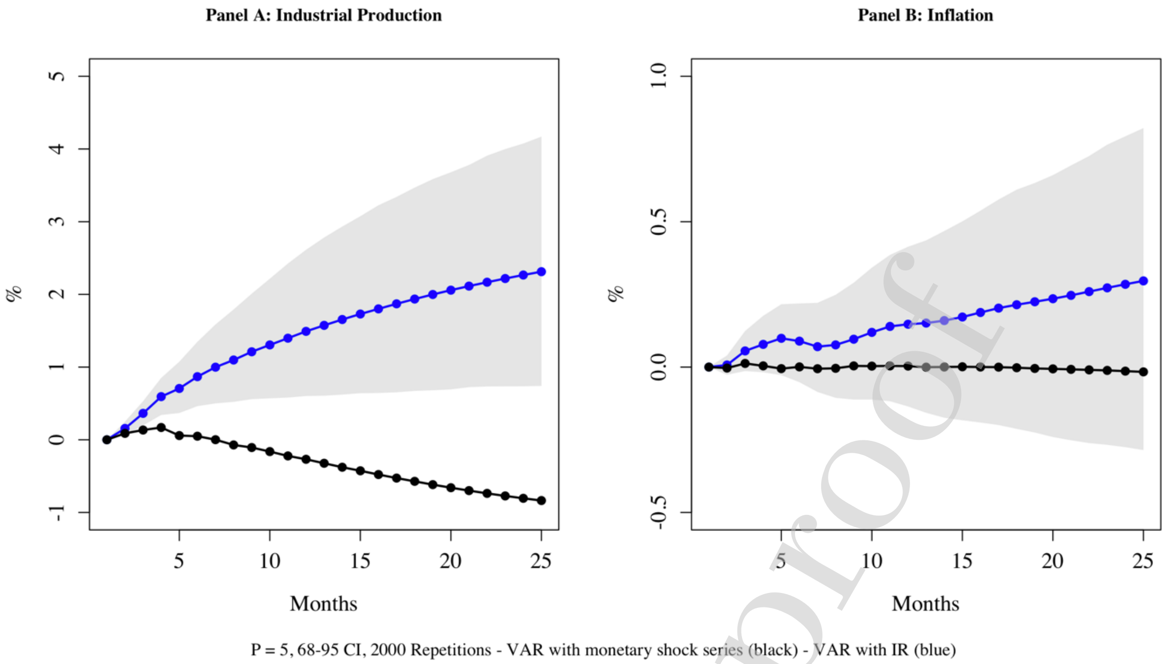

Figure 3. VAR with ECB Policy Rate.
Note: In Panel A, the blue path corresponds to impulse response of output to a 100 bps contractionary change in the interest rate, plotted along with 68 and 95 confidence bands. The black line corresponds to impulse response of output to a 100 bps contractionary monetary policy shock. In panel B, the blue path corresponds to impulse response of inflation to a 100 bps contractionary change in the interest rate, plotted along with 68 and 95 confidence bands. The black line corresponds to impulse response of inflation to a 100 bps contractionary monetary policy shock. Sample: 2000-2016

4.3 Local Projections

Single regression approaches have become increasingly popular in the literature to estimate the effects of monetary policy shocks on other macroeconomic variables, due to their flexibility and suitability for small samples.[18] Cloyne & Hürtgen (2016) and Champagne & Sekkel (2018) add the estimations with local projections to their results, finding them in line with the VAR, although slightly starker. Consequently, in this section I follow this approach to estimate the responses of industrial production and inflation given the smaller sample size employed in my research.

In particular, I estimate the following local projection model:

$$x_{t+h} - x_t = c + \Phi_h(L) z_{t-1} + \beta_h \mathbf{m}_t + \varepsilon_{t+h} \qquad [4]$$

[18] Fieldhouse, Martens & Ravn (2018) recently applied this methodology and also followed a narrative identification strategy to investigate the portfolio activity of federal housing agencies and its impact on mortgage markets and the economy.

where h = 0,1,2,…24. The variable of interest is x, $\Phi_h(L)$ is a polynomial lag operator, z_{t-1} is a vector of controls, and $\mathbf{m}_t$ is my measure of monetary policy shocks. [19]

Figure 4 shows the impulse responses to a 100 bps contractionary monetary policy shock (red), plotted along with the impulse responses estimated with the baseline VAR (blue) in Section 4.1. The results for industrial production and inflation are similar in tendency to the ones obtained with the baseline VAR methodology. As expected, the impulse response function estimated with local projections displays a more “detailed” path then the ones obtained with the VAR methodology. The response of output shows a more consistent rise in the first stage of the period. The downward path of the output begins after 10 months, consistent with the VAR estimate, and continues till the 24th month, although the estimate only predicts an overall decline of 0.5%. The response of inflation is more pronounced than the estimations obtained with the VAR, showing a more marked downward tendency after 5 months and terminating after 24 months with an overall

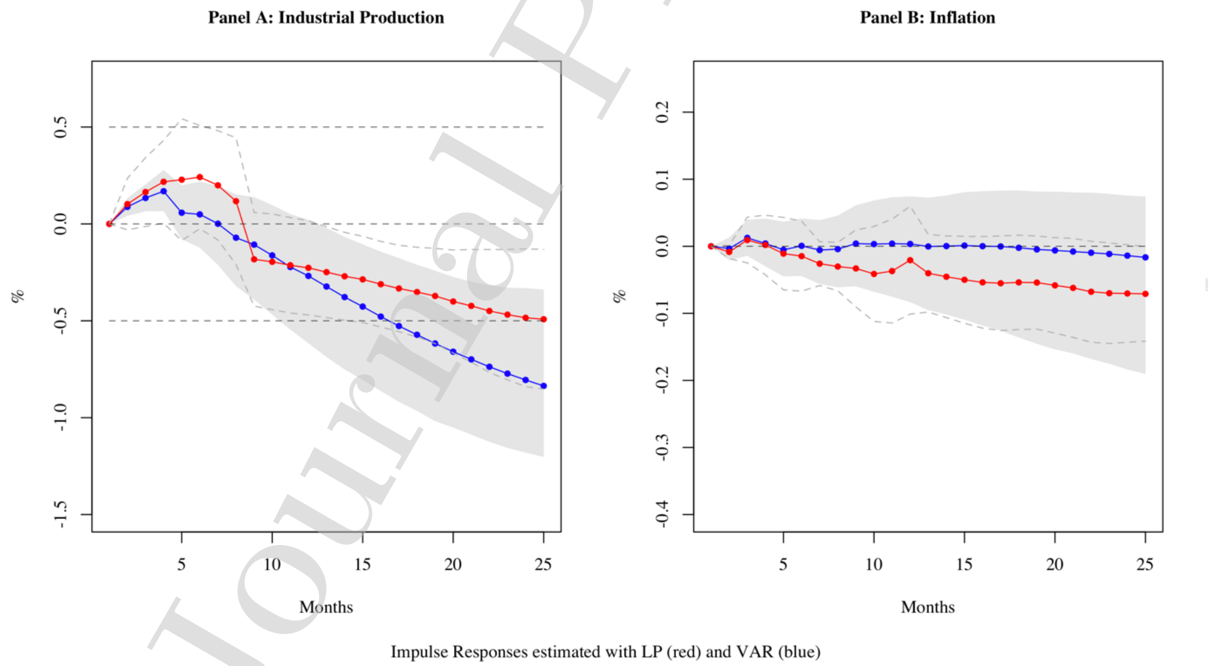

Figure 4. Impulse Responses to Monetary Policy Shocks – Local Projections
Note: In Panel A and B the blue path corresponds to impulse responses of output and inflation, respectively, to a 100 bps contractionary monetary policy shock, plotted along with 68 and 95 confidence bands (grey area), computed with the baseline VAR presented in Section 4.1. The red line corresponds to impulse responses of output and inflation (respectively) to a 100 bps contractionary monetary policy shock, plotted along with the 95% confidence intervals (the dotted grey line), and computed with local projections a la Jordà (2005). P=5. Sample: 2000-2016

[19] 5 lags were included for the analysis as in the VAR previously computed in Section 4.1.

decline of 0.05%. In line with the VAR results and past studies, output still remains more responsive than inflation to monetary shocks.

5 CONCLUSIONS

Measuring the effect of monetary policy and monetary policy shocks is one of the most debated questions in macroeconomics. This paper presents new evidence on the effects of a new measure of monetary policy shocks in the Eurozone. In line with extant literature, and by adopting a narrative approach, I present empirical findings of monetary policy shocks on Eurozone output and inflation. Specifically, my results show that output is more responsive to monetary policy shocks compared to inflation. I also document a price and an output puzzle when estimating the response with the interest rate instead of the new measure of monetary policy shocks. Overall, my findings offer new results on the response of the Eurozone economy to monetary policy shocks and acknowledge the importance of understanding the determinants of interest rate changes to correctly assess their impact.

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