Working Paper 02-2019

Firms' Expectations and Monetary Policy Shocks in the Eurozone

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Firms' Expectations and Monetary Policy Shocks in the Eurozone*

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February 14, 2019

Abstract

The purpose of this paper is to investigate the impact of monetary policy shocks on firms' selling price and production expectations. We estimate a panel structural vector autoregressive (SVAR) model for 10 euro-area economies using monthly survey data for the period from 1999:1 to 2018:6. To identify the monetary policy shocks, we use narrative and high frequency instruments taking into account the central bank's announcements regarding its policy decisions. The impulse responses from a panel SVAR analysis indicate that firms typically revise their expectations in a manner consistent with imperfect information theoretical settings, e.g., increasing their production and selling price expectations after an unanticipated interest rate hike. Interestingly, we observe an overshooting pattern where following the initial surprise that leads imperfectly informed firms to raise (reduce) their production and selling expectations after an unanticipated interest rate hike (M1 expansion), firms gradually come to expect contractionary (expansionary) monetary policy shocks to eventually decrease (increase) production and then inflation, thus revise their expectations accordingly by decreasing (increasing) first their production expectations and then their selling price expectations in accordance with this learning experience over time.

Keywords: Rational inattention, imperfect information, survey data, SVAR, narrative shocks, interest rate shock, divisia index.

JEL Classification: E31, E52

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*The authors are grateful to Nicoletta Pashourtidou for comments and suggestions.

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1 Introduction

Monetary policymakers' objective is to maintain price and production stability, both of which depend on firm-level decisions. Since current production and price choices made by firms depend directly upon their expectations of future economic developments, for monetary policymakers to achieve their policy goals it is crucial to understand how firms form their expectations.[1]

Beyond its policy importance, the question of how policy decisions affect economic agents' expectations is one of the most fundamental and highly debated questions in macroeconomics. Surveys of consumers, firms, and professional forecasters have been used to study the impact of macroeconomic developments on expectation formation (see, for example, Carvalho and Nechio (2014), Coibion and Gorodnichenko (2015), Coibion et al. (2015), Geiger and Scharler (2016) and Eminidou et al. (forthcoming)). As firms play a key role in setting prices in the economy, we find it useful to focus on firms' expectations and analyze how monetary policy affects them.

We use monthly survey data on firms' expectations for the period 1999:1 - 2018:6, and focus on ten euro-area economies which are: Austria, Belgium, Germany, Greece, Spain, Finland, France, Italy, Netherlands, and Portugal. We investigate the impact of exogenous monetary policy shocks on firms' selling price and production expectations, using the methodology developed by Stock and Watson (2012) and Mertens and Ravn (2013) and applying it in the context of estimating a panel VAR model in the spirit of Pesaran and Smith (1995).

We find that a contractionary monetary policy shock increases firms' selling price or production expectations, but this impact becomes negative about a year after the shock occurred. The impulse responses indicate that first, firms start to revise their production expectations, and then selling price expectations adjust accordingly. Moreover, distinguishing between firms producing durable versus non-durable consumer goods,

[1] As Bernanke et al. (2007) put it: "on which measure or combination of measures should central bankers focus to assess inflation developments? ... Information on the price expectations of businesses who are, after all, the price setters ... is particularly scarce".

we find that an overshooting pattern exists in both cases irrespective of the type of good the firm produces. However, firms producing durable goods are more sensitive to monetary policy shocks as compared to those producing non-durable goods.

Previous related work includes Andrade and Le Bihan (2013), who use a survey of professional forecasters to examine expectations at the micro-level and find results supportive to rational inattention. They suggest a setup where agents imperfectly process information due to both sticky information and noisy information model. Similarly, Coibion and Gorodnichenko (2015) studying inflation expectations from the US Survey of professional forecasters, find that professional forecasters, who are considered to be more informed as compared to consumers or firms, form their expectations in a way which is inconsistent with fully informed rational expectations. Coibion et al. (2015) use quantitative survey data of firms in New Zealand and find that firms' expectations formation is consistent with rational inattention and that their inattentiveness is systematically related to firms' incentives to process and collect such information. Overall, these empirical studies support models of the expectation formation process that allow for the existence of information rigidities.[2]

In general, when forming their expectations, firms face a trade-off between the cost of information acquisition and the expected benefit. If firms are aware that the collection of information is costly for them then they rationally take a decision not to pay attention to this information (see, for example, Reis (2006)).[3] Furthermore, according to Melosi (2016), monetary policy actions provide new information to price setters by signaling the view of the central bank regarding macroeconomic developments, and they revise their expectations accordingly. Economic agents may in fact interpret monetary policy changes in two different ways. First, if they are aware that the Central Bank has

[2]Such models include the sticky information model (e.g., Mankiw and Reis (2002), where agents do not update their information set due to costs associated with collecting and processing information, and the noisy information model (e.g., Sims (2003), and Mackowiak and Wiederholt (2009)), where agents continuously update the information set but never fully observe the true macroeconomic state.

[3]According to Reis (2006), even if some information can be obtained for free by the producers, they still face time costs of collecting and processing the available information, and costs of hiring advisors to interpret this information.

more information than they have, they may interpret an unanticipated decrease in the interest rate as a signal that the policymaker is worried about deflation, and decrease their production and price expectations. Second, they may increase their production or price expectations after an expansionary monetary policy shock along the lines of the typical textbook channels.

Our paper empirically assesses the different theoretical channels by examining how firms' selling price and production expectations respond to monetary policy changes. Our findings, are in line with the study of Reis (2006), who argues that a producer faces costs of collecting and processing information so that firms rationally choose to be inattentive to news and only sporadically update their information set. This is exactly what we find in our study. For the first eight or twelve months, depending on whether we consider production or selling price expectations, firms behave in a manner consistent with imperfect information theoretical settings. Then, as time passes, firms acquire more information about the monetary shock and come to expect that an expansionary monetary policy will increase economic activity or inflation. Our paper is closely related to recent empirical work on the expectations formation process and information rigidities. Studying firms expectations in the euro-area countries, we draw similar conclusions in that firms are found to revise their expectations in response to monetary policy changes, in a manner consistent with rational inattention. But, given that formation of inaccurate expectations is costly to a producer or a price-setter, over time, firms appear to update their information set and revise their expectations along the lines of textbook or new-Keynesian channels.

Building on the existing literature and methodologies used so far, we deliver new insights both on the identification of monetary policy shocks and on the econometric framework that we use. In identifying monetary policy shocks, we do not make direct assumptions on structural parameters as is sometimes done in the literature, but we impose covariance restrictions from instruments that we construct for the Euro Area. Following a new promising approach of Stock and Watson (2012) and Mertens and

Ravn (2013), we proxy the monetary policy innovations with external instruments that include additional information regarding monetary policy beyond the information contained in the estimation of the panel VAR model. Thus, following the narrative based approach of Romer and Romer (2004) and the high frequency identification approach from Gurkaynak et al. (2004) and Gertler and Karadi (2015), we construct external instruments for the euro area based on ECB announcement dates. In particular, following the Romer and Romer (2004) methodology we construct a narrative monetary shock for the Euro Area, as a deviation from the policy rule, given the information set of the central bank as reported by internal forecasts. We also construct high frequency identified factors for the Euro Area, using changes in Euribors with different maturities around ECB announcement dates, as in Gurkaynak et al. (2004).

We utilize the thus constructed external instruments as proxies in our panel SVAR analysis along the lines of Stock and Watson (2012) and Mertens and Ravn (2013). In our analysis, monetary policy innovations derive by estimating a panel VAR model in the spirit of Pesaran and Smith (1995), allowing for cross-country heterogeneity that may exist across the euro area economies. Thus, beyond the construction of instruments for the euro area and the identification of exogenous monetary policy shocks which are free of endogenous and anticipated movements, we estimate a panel "proxy SVAR" model instead of limiting our analysis to individual country proxy SVARs.

The rest of the paper is organized as follows. Section 2 describes the data and provides some preliminary data analysis. The following section describes how we construct the narrative and high frequency external instruments used to identify monetary policy shocks and how we estimate their impact on firms' expectation for euro area countries using a panel proxy SVAR model. Section 4 illustrates the estimated impulse response functions including a set of robustness checks, and the last section briefly concludes.

2 Data and preliminary analysis

2.1 Description of the data

Firms' expectations

Data for firms' expectations are from the Joint Harmonised EU Programme of Business and Consumer Surveys database, which is published monthly by the European Commission. In our study, we mainly focus on the total manufacturing sector and two of its main subsectors comprising of firms that produce durable and non-durable consumer goods. We choose these two main subsectors as they are economically meaningful in that the formation of expectations and the attention to macroeconomic developments might differ across firms producing durable versus non-durable consumer goods since the expected duration until subsequent price or production decisions is different (see, for example, Coibion et al. (2015)).

The sample size for each survey varies across countries according to their respective population size. The nominal sample of the industry survey includes more than 38000 firms that are surveyed every month, and the data that we use is qualitative and covers the period 1999:1 - 2018:6. The main questions in this survey refer to the assessment of recent trends in production, of the current levels of order books and stocks, along with expectations about production, selling prices and employment. We focus on the following two questions: Q5, "How do you expect your production to develop over the next 3 months? It will..." increase, remain unchanged, decrease; and Q6, "How do you expect your selling prices to change over the next 3 months? They will..." increase, remain unchanged, decrease. Since, the monthly data obtained from the Business and Consumer Surveys is qualitative, they are quantified using the simple balance statistic, given as the difference in the percentages of respondents giving positive and negative replies. Thus, balance values range from -100, when all respondents choose the negative option to +100, when all respondents choose the positive option. The Commission calculates those aggregates on the basis of the national results and seasonally adjusts

Figure 1

(a) Selling price expectations balances. (b) Production expectations balances

the balance series that we use in our study.

Figure 1a and Figure 1b plot the time series balances of firm selling price and production expectations for the next 3 months in the euro area as a whole over the period 1999:1 - 2018:6. As we can see in Figure 1a, selling price expectations declined sharply from + 20 on July 2008 to - 16 on March 2009. Comparing selling price expectations balances between firms producing durable consumer goods versus those producing non-durable goods, we see that price expectations for firms producing durable consumer goods were often slightly higher than those producing non-durable goods during the period under study. Moreover, as we can see in Figure 1b, the number of firms expecting their production to fall increased dramatically after the Lehman Brothers Collapse. We also note that firms in the total manufacturing sector and firms producing durable goods, observed a higher decline in their production expectations during the Crisis period as compared to firms producing non-durable goods.

Macroeconomic data

In general, the macroeconomic variables we use in our analysis are similar to those used in Eminidou et al.(forthcoming) and they are extensively described there. These are as follows: inflation rate, industrial production, unemployment rate, short term interest rates, and price of crude oil. As in Eminidou et al.(forthcoming), inflation rates were obtained from OECD Stat. The harmonized unemployment rate for all persons, and industrial production are both seasonally adjusted and are from the OECD's Short-Term Economic Indicators. Data for the Europe Brent Spot Price FOB (Dollars per Barrel) is from the THOMSON REUTERS database. Data for short term interest rates is taken from the OECD's Monthly Monetary and Financial Statistics.

For all Euro Area countries, the 3-month "European Interbank Offered Rate" is used as of the date the country joined the euro. Thus, from January 1999 short term interest rates are identical for 9 countries (i.e., excluding Greece) and become identical for all 10 euro area countries that we examine as of January 2001. By April 2015, short term interest rates are exactly equal to zero, and they take negative values since that date. Taking into account that since the recent Crisis, the traditional instrument of monetary policy is close to the zero lower bound, we study an alternative monetary policy indicator that relates to surprise changes in the quantity of money. Data for the monetary aggregate M1, is from the Statistical Data Warehouse of the European Central Bank. These time series are working day and seasonally adjusted. Also, in the robustness section we use two alternative measures of monetary policy which are Divisia M1 and Divisia M2 along with the corresponding user cost of money. Divisia monetary aggregates and the user cost of money for the euro area are constructed by Zsolt Darvas and are extensively described in his paper Darvas (2015).[4]

Finally, our analysis takes into account financial market risk aversion measured by the implied volatility index for the major stock market index.[5] Given the pattern that firms' expectations follow in Figure 1a and Figure 1b, we see that the global financial crisis influenced firms' expectations and thus find it useful to include a variable that relates to economic risk and uncertainty (see, for example, Gambacorta et al. (2014)).

[4]http://bruegel.org/publications/datasets/divisia-monetary-aggregates-for-the-euro-area/

[5]CBOE Volatility Index Futures (VIX) are a popular measure of the national stock market's expectation of volatility. The VIX, is an indicator for financial market risk aversion capturing uncertainty shocks that have likely been important during the crisis (see, for example, Bloom (2009),Gambacorta et al. (2014), and others)

2.2 Preliminary Analysis

In what follows, we assess the statistical properties of the variables that we use in our analysis. We first implemented the Im-Pesaran-Shin panel unit root test (Im et al. (2003)) for the variables involved in the panel VAR model. Since industrial production and the unemployment rate contain unit roots we first differences of their log levels. As the price of crude oil is also found to contain a unit root, we smooth the log of commodity price by removing the trend using a Hodrick-Prescott time series filter and then take the smoothed change of the price of crude oil which is used as an exogenous variable in the panel VAR analysis. For the short term interest rate we reject the unit root null in favor of trend stationarity. In the case of inflation and firms' selling price and production expectations, we strongly reject the null hypothesis of a unit root, irrespective of the industry being considered. For M1 we cannot reject the null hypothesis of a unit root, thus in our estimations we use the growth rate of M1.

3 Estimation of the panel proxy structural VAR model

In this section we describe how we estimate a panel structural VAR (SVAR) model and the assumptions we make to derive monetary policy shocks.

3.1 Mean-group estimator of the panel VAR model

We first estimate a balanced panel VAR model built on the same logic as standard VARs commonly used in the existing policy literature to deal with dynamic systems of equations (see, e.g., Bernanke et al. (1997), Christiano et al. (1999), and Sims and Zha (2006)). The use of a panel VAR allows us to obtain more efficient estimates relative to individual country estimations. In its unrestricted form, the estimation of a panel VAR for country i at time t with i = 1, ... , N and t = 1,..., T is described by

$$A_{0,\mathrm{i}} y_{\mathrm{i,t}} = A_{1,\mathrm{i}} Y_{\mathrm{i,t\text{-}1}} + A_{2,\mathrm{i}} Y_{\mathrm{i,t\text{-}2}} + ... + A_{\rho,\mathrm{i}} Y_{\mathrm{i,t\text{-}}\rho} + C_{\mathrm{i}} X_{\mathrm{t}} + e_{\mathrm{i,t}} \tag{1}$$

where $y_{\mathrm{i,t}}$ is a (1xn) vector of endogenous variables for country i at time t, $\mathrm{Y_t} = (y'_{1,\mathrm{t}}, y'_{2,\mathrm{t}}, \ldots, y'_{\mathrm{N,t}})'$ is a vector of n variables for each country i, $\mathrm{X_t}$ is a (1xm) vector of exogenous variables (common to all units i), and $\mathrm{e_{i,t}}$ is (1xn) vector of structural white noise shocks. Finally, ρ is the number of lags used in the estimation of panel VAR model. The matrices $\mathrm{A_{1,i}}$,$\mathrm{A_{2,i}}$,..., $\mathrm{A_{\rho,i}}$ [6] with dimensions $(n \times N * n)$ and the matrix $\mathrm{C_i}$ with dimension $(1 \times N * n)$ are parameters to be estimated. If we have N equations like (1) for each country i, we would then have to estimate n*(N*n*p+m) coefficients for each country and as a result, N*n*(N*n*p+m) coefficients for the panel VAR.

While estimating an unrestricted panel VAR model would be ideal, this is infeasible given the large number of parameters to estimate.[7] The existing literature suggests different ways to deal with the dimensionality problem.[8] In our analysis, we deal with the dimensionality problem by estimating a panel VAR model using the mean-group estimator described in Pesaran and Smith (1995). In contrast to the standard fixed effects panel estimator, the mean group estimator allows for cross-country heterogeneity. Thus, in our estimations we avoid making the strong assumption of identical economic structure and dynamics for these euro area economies.[9]

Mean group estimator

In what follows we describe in detail how we derive the reduced form residuals for each country i, estimating a panel VAR model in the Pesaran and Smith (1995) framework. Then, we explain how we identify the exogenous monetary policy shocks, which could

[6] For each lag length p, the matrix $\mathrm{A_i}$ includes $(\mathrm{N*n})^2$ autoregressive coefficients and there are N*n*(N*n+1)/2 parameters in the error covariance matrix.

[7] The unrestricted panel VAR model is a tool which takes into account dynamic and static interdependencies among countries as well as cross-section heterogeneities. In particular, it allows lagged variables of foreign countries to have an impact on domestic variables. By static interdependencies between two variables of two countries it allows the covariance between the two to be unequal to zero. Finally, this model would allow the coefficient matrices to vary across economies.

[8] From a Bayesian perspective, the most commonly used way is to make the assumption of homogeneity, no dynamic and no static interdependencies (see, for example, Abrigo and Love (2015) and Canova and Ciccarelli (2013)). Moreover, Canova and Ciccarelli (2009) allowing for static and dynamic interdependencies propose the cross sectional shrinkage approach. George et al. (2008), Korobilis (2016), Koop and Korobilis (2016) use the hierarchical prior identification approach.

[9] Given that we are restricted with a relatively small sample period and have ten different countries, we are not able to allow for cross- country spillover effects. However, we take into account cross-country heterogeneity.

be in the form of unanticipated interest rate hike innovations or monetary base (M1) expansions. These monetary shocks are unanticipated in the sense that they cannot be predicted by market participants given the information contained in the panel VAR model and, based on the particular identification approach that we follow, given current and expected changes in interest rate contracts. Moreover, this shock is also unanticipated by the central bank in the sense that it cannot predict it given the information contained in its internal forecasts.

The general structural form of the panel VAR for each country i is given by equation (1). Multiplying each side of the equation by A_0^{-1} we get the reduced form representation

$$y_{\mathrm{i,t}} = B_{1,\mathrm{i}} Y_{\mathrm{i,t\text{-}1}} + B_{2,\mathrm{i}} Y_{\mathrm{i,t\text{-}2}} + ... + B_{\rho,\mathrm{i}} Y_{\mathrm{i,t\text{-}}\rho} + D_{\mathrm{i}} X_{\mathrm{t}} + u_{\mathrm{i,t}} \tag{2}$$

where $B_{j,i} = A_{0,i}^{-1} A_{j,i}$ and $\mathrm{u}_{\mathrm{i,t}}$ denote the reduced form residuals which are related to the structural shocks by: $u_{\mathrm{i,t}} = A_{0,i}^{-1} e_{i,t}$. The variance-covariance matrix of the reduced form model is then equal to $\Sigma_i = E[u_{\mathrm{i,t}} u_{\mathrm{i,t}}'] = A_0{}^{-1} A_0{}^{-1\prime}$.

Following the Pesaran and Smith (1995) framework, we assume that the N countries of the model are characterized by heterogeneous VAR coefficients, but these coefficients are random processes sharing a common mean. Similarly, we assume that the residual variance-covariance matrix, is heterogeneous across countries but is characterized by a common mean. Making the assumptions above, we can estimate a single and homogeneous VAR model for the countries where the parameters of interest are the average effects of the countries. In particular, given the assumptions above, we obtain:

$$\begin{bmatrix} y_{1,\mathrm{t}} \\ y_{2,\mathrm{t}} \\ . \\ . \\ . \\ y_{\mathrm{N,t}} \end{bmatrix} = \begin{bmatrix} B_1{}^1 & 0 & 0 & 0 \\ 0 & B_2{}^1 & 0 & 0 \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ 0 & 0 & 0 & B_{\mathrm{N}}{}^1 \end{bmatrix} \begin{bmatrix} y_{1,\mathrm{t\text{-}1}} \\ y_{2,\mathrm{t\text{-}1}} \\ . \\ . \\ . \\ y_{\mathrm{N,t\text{-}1}} \end{bmatrix} + ... + \begin{bmatrix} B_1{}^{\mathrm{p}} & 0 & 0 & 0 \\ 0 & B_2{}^{\mathrm{p}} & 0 & 0 \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ 0 & 0 & 0 & B_{\mathrm{N}}{}^{\mathrm{p}} \end{bmatrix} \begin{bmatrix} y_{1,\mathrm{t\text{-}p}} \\ y_{2,\mathrm{t\text{-}p}} \\ . \\ . \\ . \\ y_{\mathrm{N,t\text{-}p}} \end{bmatrix} + \begin{bmatrix} D_{1,\mathrm{t}} \\ D_{2,\mathrm{t}} \\ . \\ . \\ . \\ D_{\mathrm{N,t}} \end{bmatrix} X_{\mathrm{t}} + \begin{bmatrix} u_{1,\mathrm{t}} \\ u_{2,\mathrm{t}} \\ . \\ . \\ . \\ u_{\mathrm{N,t}} \end{bmatrix} \tag{3}$$

and

$$\Sigma_i = \begin{bmatrix} \Sigma_1 & 0 & 0 & 0 \\ 0 & \Sigma_2 & 0 & 0 \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ 0 & 0 & 0 & \Sigma_\mathrm{N} \end{bmatrix} \tag{4}$$

Stacking over T periods for each country i we get the standard OLS model

$$\mathbf{y}_i = \mathbf{X}_i \beta_\mathrm{i} + \mathbf{u}_i \tag{5}$$

where:

$$\mathbf{y}_\mathrm{i} = \begin{bmatrix} y'_{\mathrm{i,1}} \\ y'_{\mathrm{i,2}} \\ . \\ . \\ . \\ y'_{\mathrm{i,T}} \end{bmatrix}_{T\times n} \quad \mathbf{X}_\mathrm{i} = \begin{bmatrix} y'_{\mathrm{i,0}} & \cdots & y'_{\mathrm{i,1\text{-}p}} & x'_1 \\ y'_{\mathrm{i,1}} & \cdots & y'_{\mathrm{i,2\text{-}p}} & x'_2 \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \\ y'_{\mathrm{i,T\text{-}1}} & \cdots & y'_{\mathrm{i,T\text{-}p}} & x'_\mathrm{T} \end{bmatrix}_{T\times(np+m)} \quad \beta_\mathrm{i} = \begin{bmatrix} (B^1{}_\mathrm{i})' \\ . \\ . \\ . \\ (B^\mathrm{p}{}_\mathrm{i})' \\ (D_\mathrm{i})' \end{bmatrix}_{(np+m)\times n} \quad \mathbf{u}_\mathrm{i} = \begin{bmatrix} u'_{\mathrm{i,1}} \\ u'_{\mathrm{i,2}} \\ . \\ . \\ . \\ u'_{\mathrm{i,T}} \end{bmatrix}_{T\times n} \tag{6}$$

and $\beta_i = b + b_i$ with b a $(n * p + m) \times 1$ vector of parameters and $b_\mathrm{i} \sim N(0, \Sigma_\mathrm{b})$. This implies that the coefficients of the VAR in different countries differ but have similar means and variances. Once the estimator $\hat{\beta}_\mathrm{i}$ is obtained for all units, the mean-group estimator for b is given by $\hat{b} = 1/N \sum_{i=1}^{N} \hat{\beta}_i$, while the standard error for the mean-group estimator is given by:

$$\hat{\Sigma}_b = 1/N(N-1) \sum_{i=1}^{N} (\hat{\beta}_i - \hat{b})(\hat{\beta}_i - \hat{b})' \tag{7}$$

An estimate of the residual variance-covariance matrix Σ for each country i equals $\hat{\Sigma}_i = (1/T - k - 1)u_i^{'}u_i$ and the variance-covariance matrix of the mean-group estimator can then be obtained as $\hat{\Sigma} = 1/N \sum_{i=1}^{N} \hat{\Sigma}_i$.

3.2 Construction of Instruments for the Euro Area

In this section, building on the work of Romer and Romer (2004), Gurkaynak et al. (2004), Gertler and Karadi (2015) and others, we construct the external instruments that we use in our panel SVAR analysis. We construct a narrative monetary measure for the Euro Area following the Romer and Romer (2004) methodology. Moreover, following the High Frequency Identification (HFI) approach along with principal components analysis, we construct the two main factors as in Gurkaynak et al. (2004), using changes in Euribors with different maturities around ECB announcement dates.

Narrative approach

Following Romer and Romer (2004), we derive a monetary measure for the Euro Area which is relatively free of endogenous and anticipated movements. Since ECB's internal forecasts contain reliable information about future economic developments, we estimate the intended changes of ECB's key interest rate on ECB's internal forecasts around ECB announcement days. Doing so, we isolate shifts of monetary policy that are not due to systematic responses to current and future economic conditions.

The Governing Council of the ECB announces on its website[10] its policy decisions for the level of three official interest rates: the main refinancing operations (MRO), the rate on the deposit facility, and the rate on the marginal lending facility. To construct the narrative measure of monetary policy, we first derive a series of initial and intended changes of the MRO rate, which is one of the ECB's key indicators. Second, to isolate exogenous shifts in the MRO rate not due to current or forecasted economic conditions, we use the ECB's internal forecasts of the harmonized consumer price index and of real GDP.[11] Third, we regress the intended changes of the MRO around ECB announcement dates on these internal forecasts.[12] The residuals from this regression show changes in

[10] https://www.ecb.europa.eu/press/govcdec/mopo/1999/html/index.en.html

[11] Twice a year, both ECB staff (March and September) and Eurosystem staff (June and December) publish macroeconomic projections for the euro area, available at https://www.ecb.europa.eu/mopo/strategy/ecana/html/table.en.html

[12] Our estimation is based on daily changes around the ECB's announcements days instead of intraday data that Gurkaynak et al. (2004) use which focus on changes in the futures rate in narrow windows around the FOMC announcements.

the official interest rate that are not in response to information about current and future economic developments.

In line with Romer and Romer (2004), the equation we estimate to derive the narrative monetary measure that we later use as one of the instruments in our proxy SVAR in order to identify our monetary shock, is as follows:

$$\Delta MRO_m = a + bMRO_m + \sum_{t=-1}^{2} \gamma_t GDP^f_{mt} + \sum_{t=-1}^{2} \delta_t (GDP^f_{mt} - GDP^f_{m-1,t}) + \sum_{t=-1}^{2} \phi_t HICP^f_{mt} + \sum_{t=-1}^{2} \delta_t (HICP^f_{mt} - HICP^f_{m-1,t}) + u^{RR}_m \tag{8}$$

where ΔMRO_{m} is the change in the MRO around Governing Council meetings, m, $\mathrm{MRO_m}$ is the level of the MRO before any changes associated with meeting m, GDP^{f} and $HICP^{\mathrm{f}}$ are the respective forecasts of real activity (GDP) and of the harmonized consumer price index, and subscript t indicates the horizon of the forecast (-1 is the previous quarter, 0 is the current quarter and so on). We include forecasts up to two quarters ahead. We do not include the unemployment forecast in our analysis because these are available only as of 2014.

Both the MRO series we derive and the ECB forecast data correspond to Governing Council meetings. Thus, for the sample period that we examine, the number of observations is equal to 253. The residuals derived from equation (8) correspond to ECB meetings and were regarded by Romer and Romer (2004) as a measure of monetary shocks. Here, we go a step further and use this series as an external instrument in our panel SVAR analysis as in Mertens and Ravn (2013). For further analysis, we convert the residuals $\hat{u}_{\mathrm{m}}{}^{\mathrm{RR}}$ to a monthly series by assigning each shock to the month in which the corresponding meeting occurred. As in Romer and Romer (2004), if there is more than one meeting in a given month, we sum the residuals, while if there is no meeting in a given month we record a value of zero for that month.

High Frequency Identification of monetary policy surprises

We now construct the two main factors describing the effects of monetary policy actions as in Gurkaynak et al. (2004), to be used as external instruments in our proxy SVAR in order to identify monetary policy shocks. The reason for examining two-dimensional measures of monetary policy actions instead of focusing on one particular interest rate with a certain maturity date (see, for example, Kuttner (2001)) is that beyond the change in the current interest rate, we also want to capture the effect of monetary policy announcements through the expected interest rate path. The two-factor approach developed by Gurkaynak et al. (2004) distinguishes the effect of monetary policy to the "target" and "path" factors. In their study, "target" factor corresponds to the surprise changes in the current interest rate target, while the "path" factor corresponds to changes associated with central bank announcements and forward guidance. We thus construct the corresponding two factors for the Euro Area.

For each monetary policy announcement, we measure the surprise component of the change in the Euribor with one week, one month, two months, three months, six months, nine months and 12 months of maturity. In particular, we construct a (T x n) matrix G with rows corresponding to monetary policy announcements and columns corresponding to the change in the Euribor. We decompose matrix G into its principal components after normalizing each column to have mean zero and unit variance.

Supposing that matrix G can be represented as $G = F\Lambda + \eta$, where F is a $T \times m$ matrix of unobserved factors, Λ is a matrix of factor loadings, and η is a $T \times n$ matrix of white noise disturbances, we estimate the first two unobserved factors by principal components. This procedure decomposes the matrix G into a set of orthogonal vectors F_i, i = 1,...,n, where F_1 is the vector that has maximum explanatory power for G, and F_2 is the vector that has maximum explanatory power for the residuals of G after projecting it on each column of F_1. We focus only on the first two factors (F_1 and F_2) since they together explain about 93.4 percent of the variation in G. As these two unobserved factors do not have any structural interpretation, we follow Gurkaynak et al. (2004) and rotate these factors into two new factors Z_1 and Z_2 that correspond respectively to surprise changes in the current interest rate and to movements in interest rate expectations that are not driven by changes in the current interest rate.

In this section, we have constructed an instrument based on a narrative measure of monetary policy, $\hat{u}_m^{RR}$, and two additional instruments, Z_1 and Z_2, based on high frequency Euribor changes. These instruments will be used to proxy the panel VAR residuals. The advantage of the use of external instruments in our identification method is that they capture information outside the panel VAR model. In our study, monetary policy shocks are exogenous in the sense that they are not anticipated by market participants nor by the central bank.

3.3 Identification of monetary policy shocks

Beside the dimensionality problem described earlier in this section, we have to deal with the identification problem which arises when estimating any VAR model of simultaneous equations. Since the innovations $e_{i,t}$ are contemporaneously correlated and are mutually dependent across the endogenous variables, we cannot identify the specific monetary policy structural shock which derives from a monetary policy indicator without further assumptions.[13] We follow the promising new approach of Mertens and Ravn (2013) with the introduction of external series for the identification of exogenous shocks. More precisely, we proxy the reduced form monetary policy residuals that derive from the estimation of the mean-group estimator of Pesaran and Smith (1995), with the instruments that we constructed in the previous subsection based on narrative and high frequency monetary policy series.

Studying how monetary policy affects firms' expectations and therefore economic activity, we take into account that monetary policy not only affects, but also responds

[13]Common identification methods to identify monetary policy shocks include the Cholesky decomposition factor of the variance-covariance matrix of the residuals, e.g. in Sims (1980), the SVAR of Blanchard and Watson (1986) and Bernanke (1986), narrative approach of Romer and Romer (2004), the high frequency identification approach (see, for example, Kuttner (2001), Gurkaynak et al. (2004), Gertler and Karadi (2015)), and proxy SVARs introduced by Stock and Watson (2008) and developed by Stock and Watson (2012) and Mertens and Ravn (2013). Moreover, Miranda-Agrippino and Ricco (2018) building on the intuition provided by models of asymmetric and imperfect information, suggest a new method to identify the transmission of monetary policy shocks using Bayesian Local projection analysis.

to the state of the economy. In monetary policy transmission mechanism analysis, the endogeneity issue has been addressed in alternative ways. On the one hand, vector autoregressions (VARs) with common identification methods such as timing and sign restrictions have been used (see,for example, Sims and Zha (2006), Christiano et al. (1999), Geiger and Scharler (2016)). On the other hand, Romer and Romer (2004) use the narrative approach to identify a new measure of monetary policy shocks. Moreover, the high frequency identified approach (see, for example, Kuttner (2001), Gurkaynak et al. (2004), and others), utilizes unexpected changes in the federal funds rate and Eurodollar futures to measure policy surprises around Federal Open Market Committee (FOMC) meetings.[14]

The new "proxy SVAR" approach developed by Stock and Watson (2012) and Mertens and Ravn (2013) we follow here, combines the strength of both SVARs and the narrative approach. This method is a promising new approach which incorporates external series for identification, such as series based on narrative evidence or high frequency information. This method was first applied to identify monetary shocks by Gertler and Karadi (2015) who combined traditional VAR analysis with high frequency identified shocks in a proxy SVAR.

The main idea of the identification procedure we follow is to avoid imposing any direct timing assumptions on the contemporaneous impact of matrix A_0^{-1} shown in equation (1). The method we use exploits the advantage of information contained in narrative accounts of policy changes (see, e.g., Mertens and Ravn (2013)) and information contained in daily changes of market-based interest rates around ECB's announcement dates (see, for example, Gertler and Karadi (2015)). Thus, following Stock and Watson (2008) and Mertens and Ravn (2013), we proxy the monetary policy residuals that we derived previously from the estimation of a panel VAR, with the external instruments containing additional information beyond that already contained in the panel VAR.

In line with previous studies of the monetary policy transmission mechanism (see, for

[14]The use of futures data in measuring monetary policy shocks was introduced by Rudebusch (1998).

example, Sims and Zha (2006), Christiano et al. (1999), Leeper and Roush (2003), and Belongia and Ireland (2015)), we assume that vector $\mathbf{y}_{i,t}$ in equation (5) includes the following variables with the following ordering: short term nominal interest rate, M1 growth rate, firm-specific selling price or production expectations, inflation rate, the differenced log of industrial production, the differenced unemployment rate, and the level of implied stock market volatility index VIX. The vector with exogenous variables includes a dummy for the post crisis period and the smoothed change in the log of the price of crude oil.

As we are interested in the identification of specific variables contained in vector $\mathbf{y}_{i,t}$ and not in the other shocks, we distinguish among the residuals contained in vector $\mathbf{u}_{\mathrm{i,t}}$. Also, due to the fact that our sample includes the period during which the traditional instrument of monetary policy is close to the zero lower bound, beyond the conventional policy shocks, we explore the impact of monetary policy through alternative measures (see, e.g., Curdia and Woodford (2011), Belongia and Ireland (2015), Darvas (2015) and Keating et al. (2014))[15]. Thus, depending on the policy indicator that we consider, the monetary policy shock relates to unexpected changes in the short term interest rate, or to unanticipated changes in M1, or to the Divisia M1 and the Divisia M2.

We examine the impact of unanticipated changes of two distinct policy indicators on firm's expectations in two different specifications. In the first specification, we study the impact of monetary policy shocks on selling price expectations for the total manufacturing sector and two of its main subsectors. In the second specification, we study firms' production expectations.

To identify structural monetary policy shocks we follow the following steps: First, we estimate a panel VAR model using the mean-group estimator methodology dis-

[15] Belongia and Ireland (2015) found that Divisia measures of money contain information and have significant explanatory power comparable to that found in interest rates and thus, including measures of money in the SVAR's information set helps reduce the so called "price puzzle". Keating et al.(2014) identify the effects of monetary policy shocks on macroeconomic variables in VARs using the Divisia measure of money instead of the Federal funds rate as the policy indicator variable. He showed that a SVAR model using Divisia-money worked well for the period before the crisis as well as in the period of zero lower bound.

cussed in subsection 3.1. Thus, we obtain an estimate of β_{i} for each country i, $\hat{\beta}_{\mathrm{i,t}} = (X'_{i,t}X_{i,t})^{-1}X'_{i,t}y_{i,t}$, by standard OLS estimation. Then, we get the vector with reduced form residuals $\hat{\mathbf{u}}_{i,t}$ for each country i, $\hat{\mathbf{u}}_{i,t} = \mathbf{y}_{i,t} - \mathbf{X}_{i,t}\hat{\beta}_{\mathrm{i,t}}$. Letting $y_{\mathrm{i,t}}{}^{\mathrm{pi}}$ be the policy indicator contained in vector $\mathbf{y}_{i,t}$ and $\mathbf{y}_{i,t}^{others}$ the rest of the variables contained in vector $\mathbf{y}_{\mathrm{i,t}}$, we then partition the vector of reduced form residuals $\mathbf{u}_{i,t} = [u_{i,t}^{pi'}, \mathbf{u}_{i,t}^{others'}]'$, where $u_{i,t}^{pi}$ is the reduced form vector of residuals for the policy indicator and the $(n-1)\times 1$ vector $\mathbf{u}_{\mathrm{i,t}}{}^{\mathrm{others}}$ contains all other $n-1$ reduced form residuals. Similarly, $e_{i,t}^{pi}$ denotes the shocks of interest to us, and the $(n-1)\times 1$ vector $\mathbf{e}_{\mathrm{i,t}}{}^{\mathrm{others}}$ contains all other $n-1$ shocks.

To investigate the impact of monetary policy shocks on firms' expectations for each country i, we then estimate

$$y_{i,t} = \sum_{j=1}^{p} \beta_{i,j} y_{i,t-j} + \mathbf{s}e_{i,t}^{pi} \tag{9}$$

As in the Pesaran and Smith (1995) approach, the parameter of interest is the mean effect b, we take the average effects and derive the impulse responses by using the equation below:

$$y_{i,t} = \sum_{j=1}^{p} b_j y_{i,t-j} + \mathbf{s}e_{t}^{pi} \tag{10}$$

Using the mean-group estimator in the Pesaran and Smith (1995) methodology, the mean-group residuals for the policy indicator are given by $e_t = 1/N \sum_{i=1}^{N} e_{i,t}^{pi}$. As we are interested only on the impact of the monetary policy shock, e_t^{pi} and not all other shocks, we do not have to identify all the coefficients of A_0^{-1} but just the elements in column $\mathbf{s}$ denoting the column in matrix A_0^{-1} corresponding to the impact of the structural policy shock $e_{i,t}^{pi}$ on each element of the vector of reduced form residuals $\mathbf{u}_{i,t}$.

Following Stock and Watson (2008), Mertens and Ravn (2013) and Gertler and Karadi (2015), we let $\mathbf{Z}_{\mathrm{t}}$ be a vector with proxy variables that are correlated with the structural shock of interest but orthogonal to other shocks. Given that conditions $E[\mathbf{Z}_{\mathrm{t}} e_{\mathrm{i,t}}{}^{\mathrm{pi'}}] = \Phi$ and $E[\mathbf{Z}_{\mathrm{t}} e_{\mathrm{i,t}}{}^{\mathrm{others'}}] = 0$, where $\mathbf{Z}_{\mathrm{t}} = [\hat{u}_{i,t}^{RR}, Z_1, Z_2]$, are satisfied, we can obtain estimates of the elements of vector $\mathbf{s}$ from equation (9) for each country i by estimating two stage least squares (2SLS) regression of $\mathbf{u}_{i,t}^{others}$ on $u_{i,t}^{pi}$, using the instrument set $\mathbf{Z}_t$. In particular, in the first stage, we estimate the reduced form residuals of policy indicator $u_{i,t}^{pi}$ on $\mathbf{Z}_{\mathrm{t}}$ to form the fitted values $\hat{u}_{\mathrm{i,t}}{}^{\mathrm{pi}}$ for each country i. In the second stage, we regress the vector $\mathbf{u}_{\mathrm{i,t}}{}^{\mathrm{others}}$ on fitted values, $\hat{u}_{\mathrm{i,t}}{}^{\mathrm{pi}}$ and get the estimates for $\mathbf{s}$.

Given estimates of β_{ij} and $\mathbf{s}$ we can use equation (9) to compute impulse responses to monetary policy shocks for each country i. Finally, the impulse responses for the average effect $\mathrm{b_j}$ based on the mean-group estimator approach are estimated using equation (10).

4 Estimation Results

In this section, we present individual country impulse responses from the estimation of equation (9), and impulse responses for the average country from the estimation of equation (10) using the mean-group estimator. In each case, the figures report the estimated impulse responses along with 90 percent confidence intervals[16], computed using bootstrap methods.[17] In all cases, the number of lags we use in our estimations is equal to four.[18]

In Figure 2, we show the responses of selling price expectations to two distinct monetary policy shocks, namely an interest rate hike innovation and M1 expansion, for the total manufacturing sector and two of its main sub-categories. As we can see, unanticipated increases in the short term interest rate lead to an increase of selling price expectations and this positive impact remains significant eight months after the shock occurs. This result is consistent with imperfect information theory models where unanticipated

[16]A number of papers that utilize survey expectations data, e.g., D'Amico and King (2017) and Ueda (2010), use much narrower bands, e.g., 68 percent confidence intervals, recognizing the relatively high uncertainty characterizing survey expectations data and model parameters in this case.

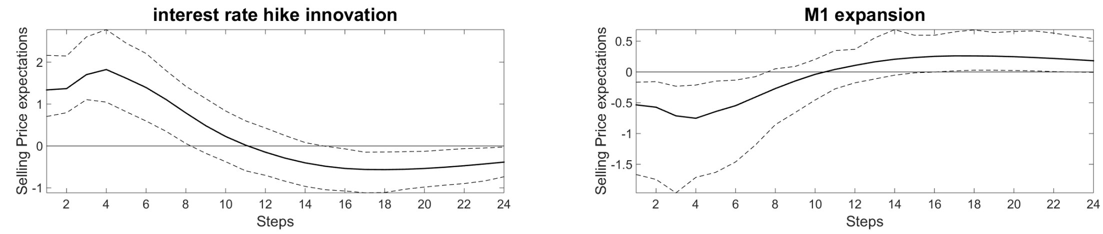
[17]In line with Mertens and Ravn (2013) and Gertler and Karadi (2015), we avoid any potential "generated regressor problem" using wild bootstrap that generates valid confidence bands under heteroskedasticity and the use of instruments. The estimation errors related to the instrumental variable regression is taken into account when calculating the confidence bands, since both stages of the impulse response estimation are included in the bootstrapping procedure.

[18]We note, however, that our results are robust using 2 or 6 lags.

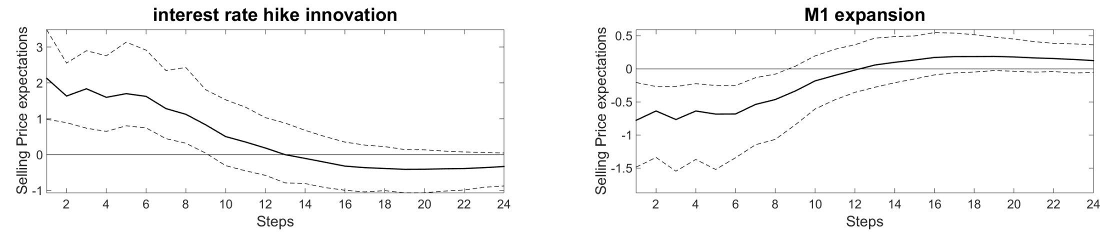
increases in the interest rate are interpreted by previously unaware price-setters as revealing that the central bank is worried about inflation, which leads them to raise their selling price expectations. Consistent with this, expansionary monetary policy shocks lead to a decrease of selling price expectations, and this impact remains statistically significant about eight months after the shock occurs. These results are then consistent with the signaling effect mentioned in Melosi (2016) where central bank actions signal to unaware price-setters their view about the economy thus influencing their expectations.

Figure 2: Selling price expectations' responses

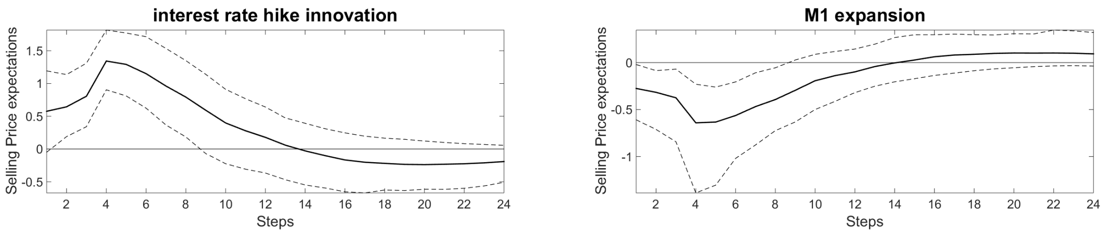
(a) Total manufacturing sector



(b) Firms producing durable consumer goods



(c) Firms producing non-durable consumer goods



However, over time, firms appear to learn that contractionary (expansionary) monetary policy reduces (increases) inflation and thus start decreasing (increasing) their selling price expectations which become negative (positive) at about 14 months following the shock, as shown in the two panels of Figure 2(a) for an interest hike shock and M1 expansion shock respectively.

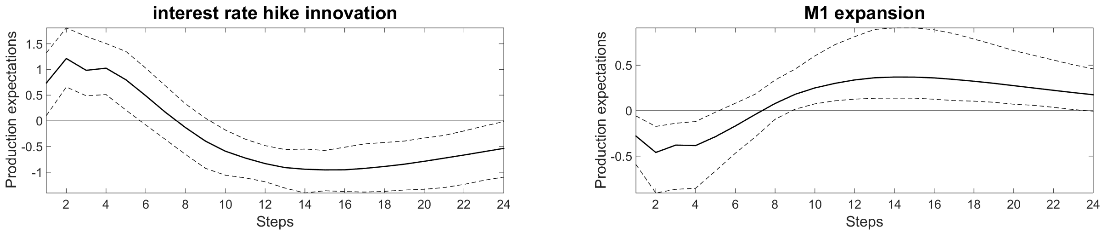
Comparing the responses between firms producing durable versus non-durable goods shown in Figure 2b and Figure 2c respectively, we see that the impact of monetary policy shocks is stronger on the expectations of firms producing durable consumer goods as compared to those producing-non durable goods. For example, a one standard deviation unanticipated increase in the interest rate induces firms selling price expectations to increase by 2.1 on impact and then gradually start to decrease and begin receiving negative values thirteen months after the shock occurred. In the case of firms producing non-durable goods, selling price expectations increase only by .6 on impact, peaking at 1.4 on the 4th month and then gradually decrease and take negative values beginning at fourteen months after the shock occurred. Because durable goods last for a long time they tend to be more expensive to both manufacture and purchase while non-durable goods have a shorter life span and usually cost less to produce and procure. Importantly, the pricing decision of the firm for durables involves the assessment of market conditions and uncertainty over a longer horizon as compared to non-durables. These differences in characteristics make a firm's pricing decision for durables distinct from the case of non-durables, with firms selling price expectations of the former appearing as a result to be more sensitive to monetary policy shocks than is the case for non-durables.[19]

Next, in Figure 3, we consider the responses of production expectations to monetary policy shocks. After an interest rate hike innovation, production expectations first increase significantly for the first six months, in line with imperfect information theoretical settings where firms find out after an interest rate hike shock that the Central Bank is worried about inflation thus raise their production expectations. Later, production expectations decline and become negative eight months after the shock occurred with the impact becoming statistically significant nine months after the shock and remaining so at two years out. Evidently, we have an overshooting pattern for production expectations in Figure 3, and this is now stronger than was the case for selling price expectations in Figure 2. This overshooting pattern suggests that, over time, firms

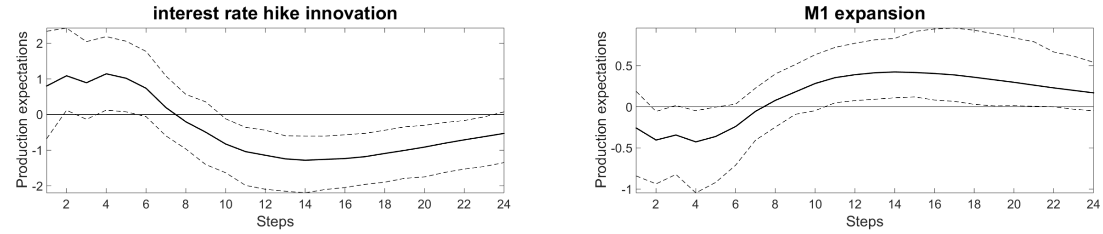
[19] The distinct dynamic nature of the pricing decision of a firm for durables versus non-durable goods is supported by Ronald Coase's assertion that "a monopolist selling a durable good is in a harder position than a monopolist of non-durable goods because with durable goods, the monopolist is essentially competing with itself over time".

Figure 3: Production expectations' responses

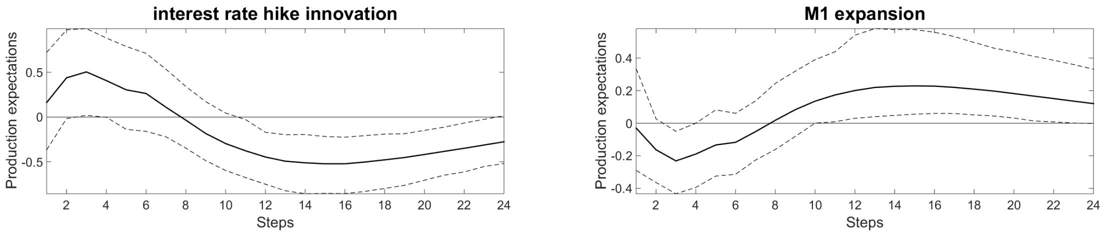
(a) Total manufacturing sector



(b) Firms producing durable consumer goods



(c) Firms producing non-durable consumer goods



come to expect that contractionary monetary policy decreases economic activity, thus start decreasing their production expectations.

Comparing the impulse responses in Figure 3 versus Figure 2, we see that production expectations start to adjust a few months earlier before firms start revising their selling price expectations which become significantly negative only 14 months after the shock occurs as compared to 9 months out for production expectations. This suggests that first the economy moves, then firms observe this and thus learn about the impact of this contractionary interest rate hike on the economy, and finally start adjusting their selling prices in accordance with this learning experience over time. Given that forming inaccurate production expectations is costly to firms, they eventually start decreasing their production expectations after perceiving the impact of the interest rate hike shock on the economy. This is consistent with Reis (2006) who argues that producers facing costs of collecting and processing information rationally choose to be inattentive to news, but sporadically update their information. We note that our results regarding the response of firms' production expectations to an M1 expansion shock are entirely analogous with the results described above regarding the impact of an interest rate hike shock, with production expectations first falling significantly and then becoming significantly positive starting at nine months out.

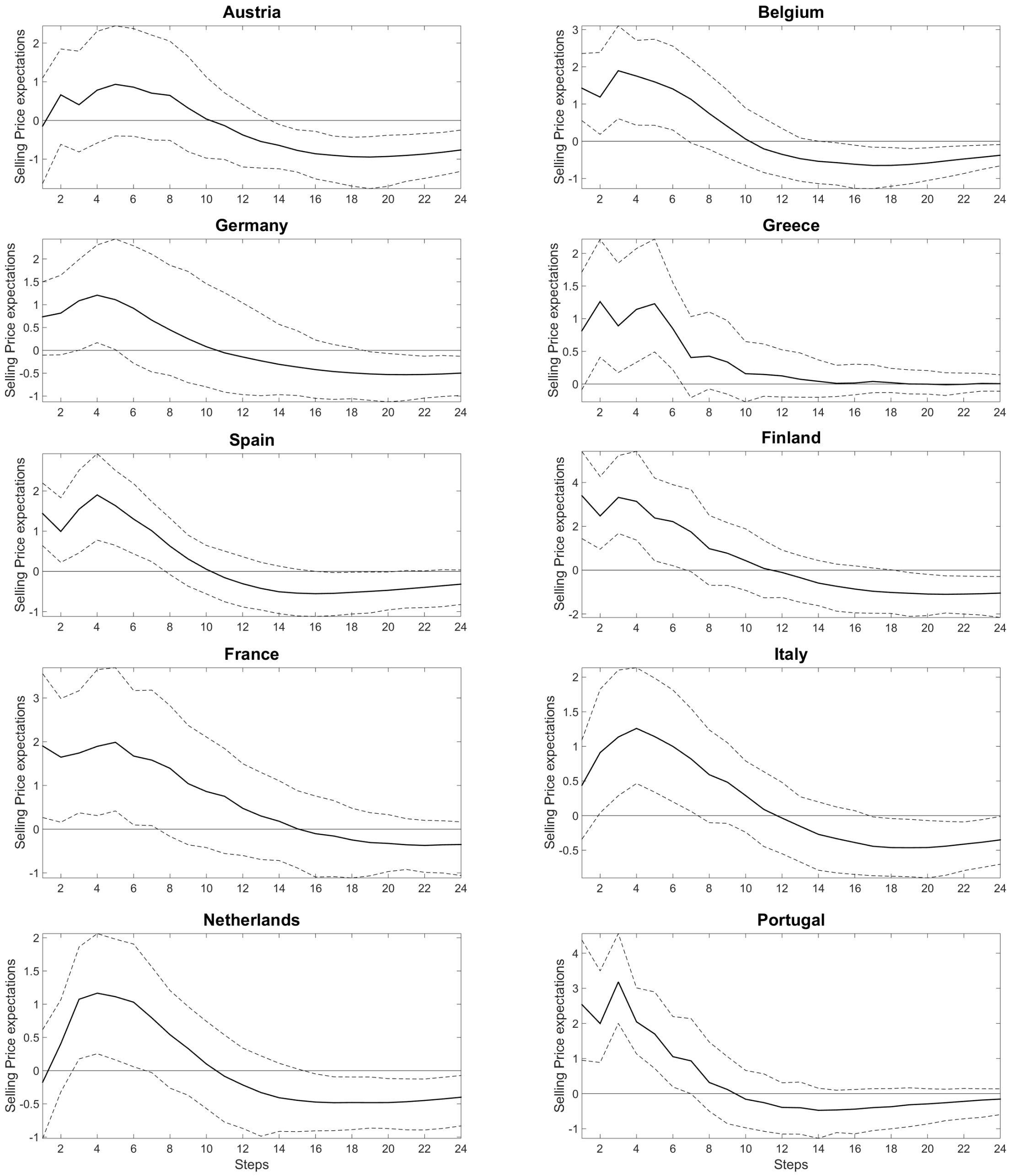
Our next finding arises comparing the impulse responses between firms producing durable versus non-durable goods as presented in Figure 3b and Figure 3c. A one standard deviation unanticipated increase in the interest rate leads production expectations of firms producing non-durable goods to increase by .2 on impact, while the increase in production expectations of durable goods is four times greater. Similarly, production expectations for firms producing durable goods are more sensitive to M1 expansion shocks than for firms producing non-durable goods. Overall, our results here, reinforce the argument that expectations of firms producing durable goods are more sensitive to monetary policy shocks as compared to firms producing non-durable goods.

Finally, looking at country specific impulse responses, we see that firms that belong to a common monetary policy union may behave differently after a monetary policy shock. Figures 4 and 5 present the responses of selling price expectations to an interest rate hike innovation and M1 expansion, respectively, while Figures 6 and 7 present the responses of production expectations to an interest rate hike innovation and M1 expansion, respectively. Each of these figures shows all the country-specific impulse responses to the monetary policy shocks. For the sake of brevity, we present only the responses of the total manufacturing sector's expectations.[20]

The impulse responses in Figure 4 indicate that firms' expectations in these euro area countries respond differently to monetary policy shocks. For example, in Austria the response of selling price expectations to an interest rate hike innovation becomes significant only thirteen months after the shock and this impact is negative, while in France an interest rate hike innovation leads to a 1.9 increase in selling price expectations on

[20]The individual country impulse responses for firms producing durable and non-durable consumers goods are given in Figure A1 to Figure A8 in the Appendix to be made available online.

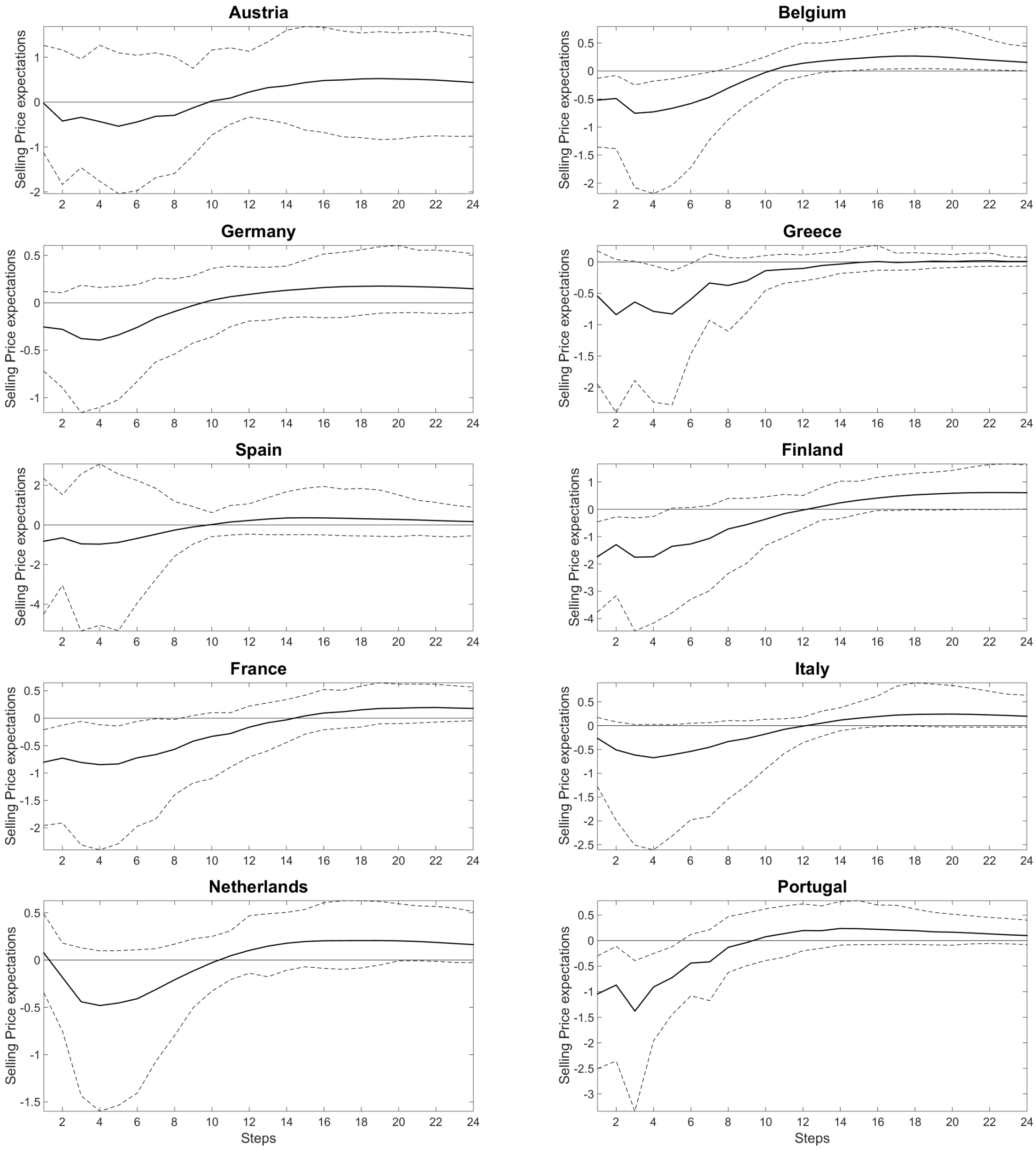
Figure 4: Selling price expectations' responses to interest rate hike innovation



impact and becomes insignificantly different than zero starting at about seven months after the shock occurs. In general, the results in Figure 4 indicate that an interest rate hike innovation signals to unaware price setters that the central bank is worried about inflation and thus they increase their selling price expectations initially. This positive impact typically remains significant for more than half a year after the shock.

Here, as in the case of the pooled impulse responses in Figure 2, following the initial

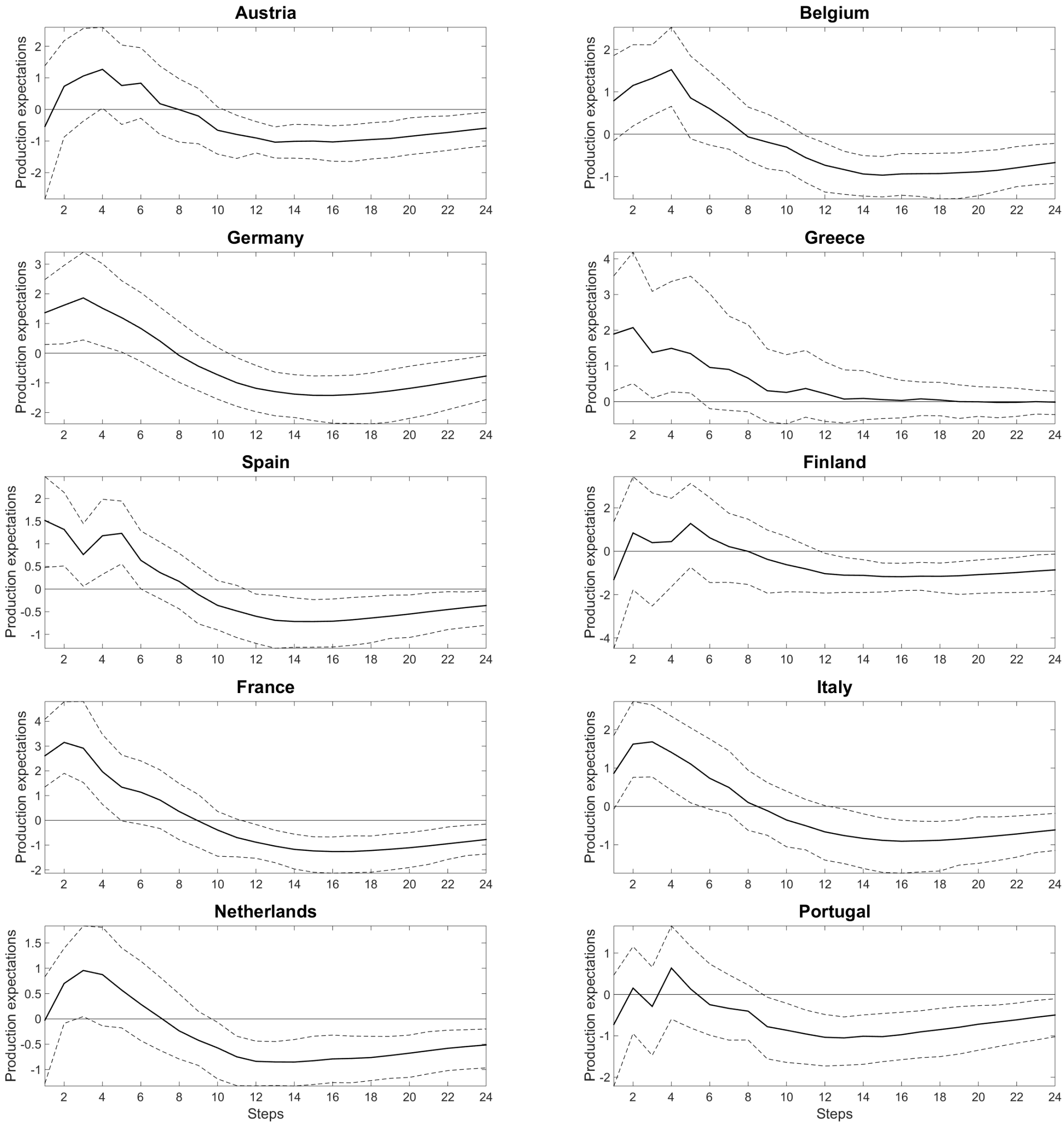
Figure 5: Selling price expectations' responses to M1 expansion



surprise firms gradually come to expect an interest hike innovation to eventually decrease inflation, thus revise their expectations accordingly by decreasing their selling price expectations. For most countries, we end up having a statistically significant negative impact between 13 to 18 months after the shock occurred. However, in Greece, Portugal and France we do not get a significant overshooting pattern, with the negative impact that follows the initial positive impact never becoming statistically significant.

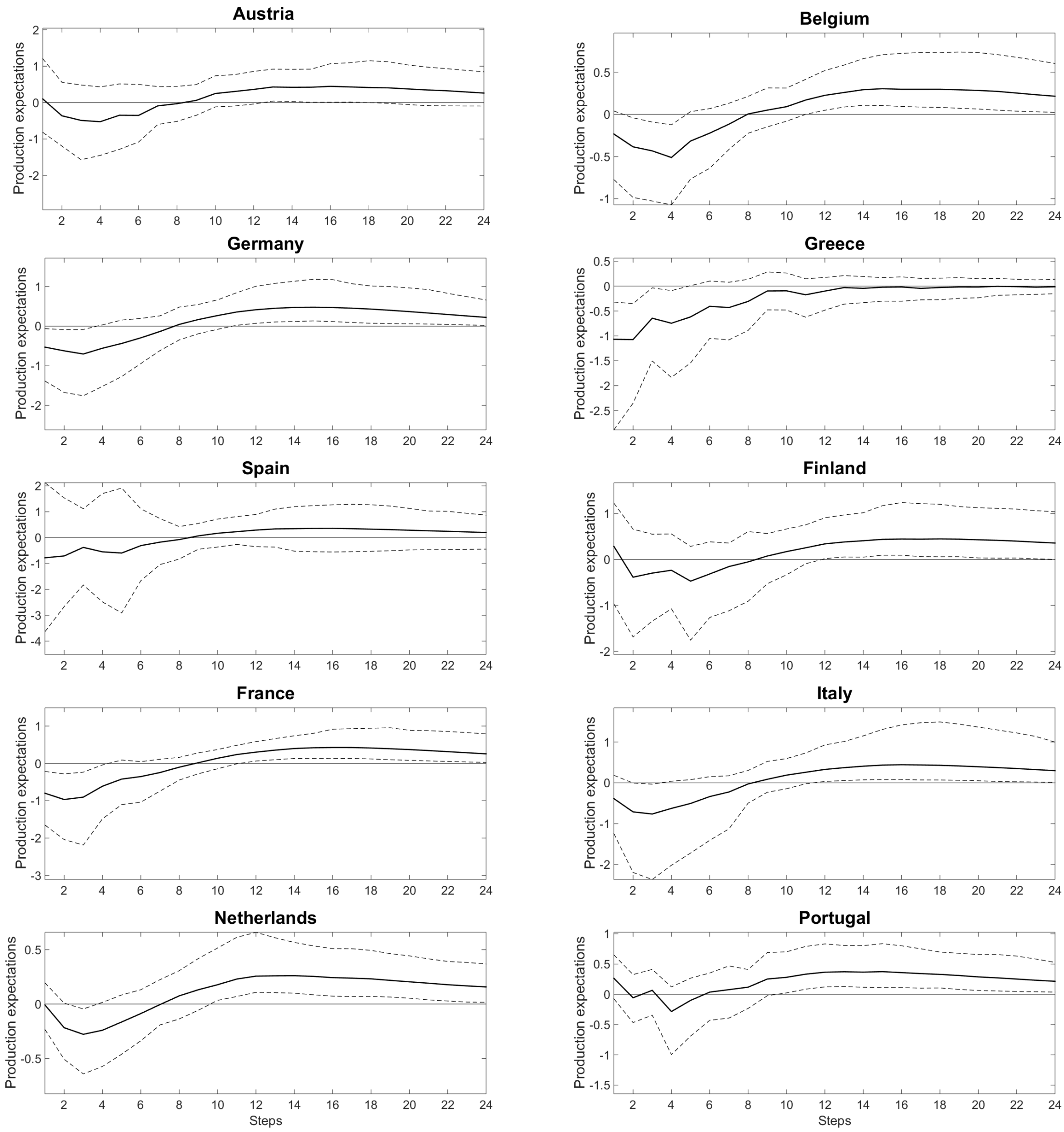
Moreover, the impulse responses of firms' selling expectations after an unanticipated

Figure 6: Production expectations' responses to interest rate hike innovation



M1 expansion in Figure 5 are consistent with our results shown in Figure 4. That is, an unanticipated M1 expansion appears to reduce selling price expectations and this impact is statistically significant in countries such as Belgium, Finland, France, and Portugal for up to six months. Once again, an expansionary monetary policy shock is interpreted by unaware and inattentive price setters as signalling that the central bank is worried about deflation, and thus they decrease their selling price expectations. But, over time, firms learn that expansionary monetary policy shocks eventually increase inflation, thus they start to increase their selling price expectations with the impact

Figure 7: Production expectations' responses to M1 expansion



on these eventually turning positive between 13 to 20 months after the shock and significantly so in the likes of Belgium, Finland, Italy and the Netherlands.

Turning now to the country-specific responses of production expectations to a monetary policy shock, we see in Figure 6 that the impact of an unanticipated interest rate shock on production expectations is positive and significantly so for about half a year in the likes of Belgium, Germany, Greece, Spain, France and Italy. Moreover, in all countries except Greece, firms are coming to understand over time that an interest rate hike will finally have a negative impact on economic activity and thus they start decreasing their production expectations a few months after the shock occurs with this impact eventually turning significantly negative ten months to a year after the shock occurred.

In Figure 7, we can see that an M1 expansion shock signals to unaware firms negative news about the state of the economy so that they decrease their production expectations on impact and significantly so for about 4 to 6 months in Belgium, Germany, Greece and France. Following this initial surprise, firms gradually come to expect this monetary expansion to eventually increase economic activity and significantly so after about one year in all countries except Greece and Spain. Thus, firms in the majority of countries revise their expectations accordingly by increasing their production expectations. This overshooting pattern is not evident in Greece and Spain. In Greece, firms' production expectations decrease on impact after an expansionary monetary policy shock and this negative impact gradually dissipates less than half a year after the shock occurred, while in Spain the impact of an M1 expansion is never statistically significant at any horizon.

5 Robustness Analysis

Alternative monetary aggregates

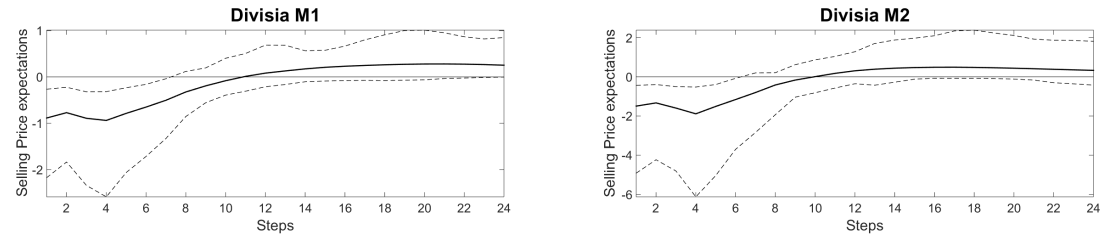
We now evaluate the robustness of the results by considering alternative measures of monetary policy. Leeper and Roush (2003), Keating et al. (2014), Belongia and Ireland (2015), and Darvas (2015) find that divisia indices of money have desirable properties as measures of money. Thus, in examining how sensitive our results are to using different monetary policy indicators other than the M1 growth rate, we consider the growth rates of the Divisia M1 or Divisia M2 as the policy indicator of the central bank.[21] The inclusion of Divisia monetary aggregates in our panel SVAR analysis, is accompanied with the inclusion of the corresponding user cost of money.

[21] Keating et al. (2014) use the divisia index of M4 as the monetary policy indicator and find that it works as well as the Federal funds rate in the pre-Crisis period but also in the post-Crisis period when the Federal funds rate reaches the zero lower bound. Moreover, Belongia et al. (2018) find that the Fed has been in fact targeting the growth rate of Divisia monetary aggregates since the arrival of the recent financial crisis.

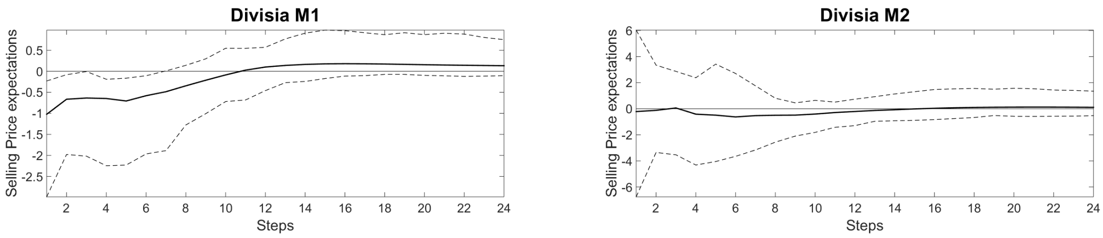
The impulse responses that we get re-estimating the proxy Panel VAR models with those two alternative measures are reported in Figures 8 and 9 for selling price and production expectations' responses respectively. Our results are mostly robust. However, in the case of the Divisia M2 growth rate the estimated impulse response functions are statistically insignificant for non-durable and durable consumer goods alike.

Figure 8: Selling price expectations' responses to Divisia monetary growth rates.

(a) Total manufacturing sector



(b) Firms producing durable consumer goods



(c) Firms producing non-durable consumer goods

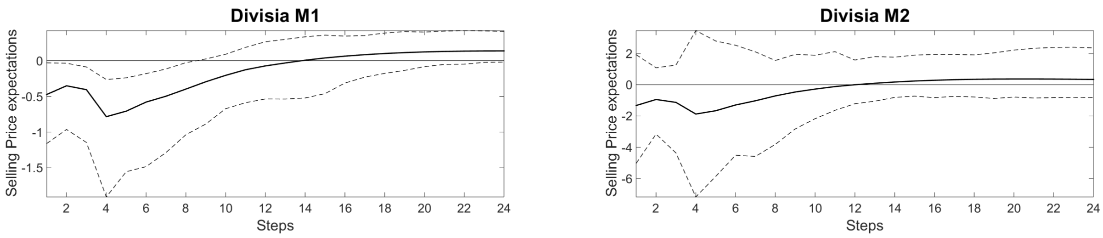
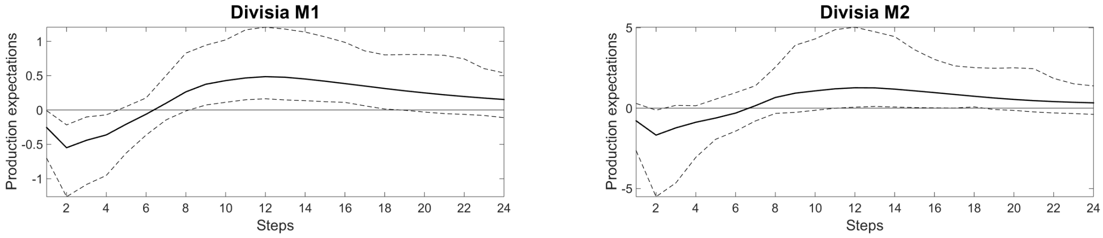
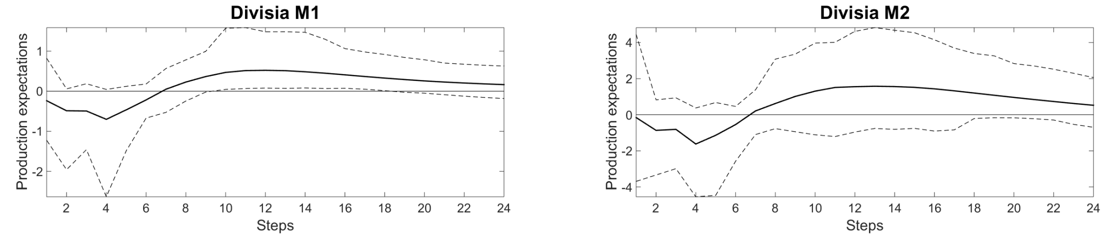


Figure 9: Production expectations' responses to Divisia monetary growth rates

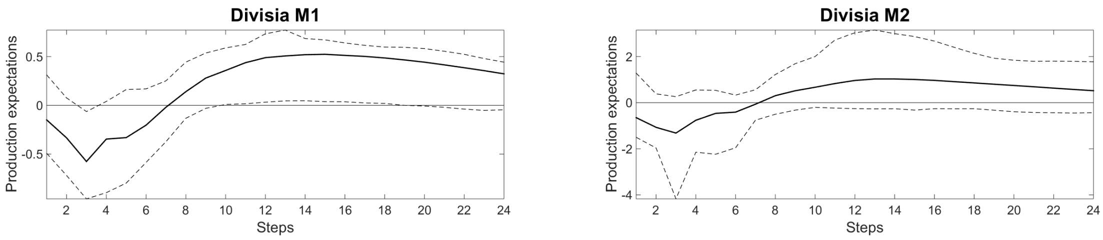
(a) Total manufacturing sector



(b) Firms producing durable consumer goods



(c) Firms producing non-durable consumer goods



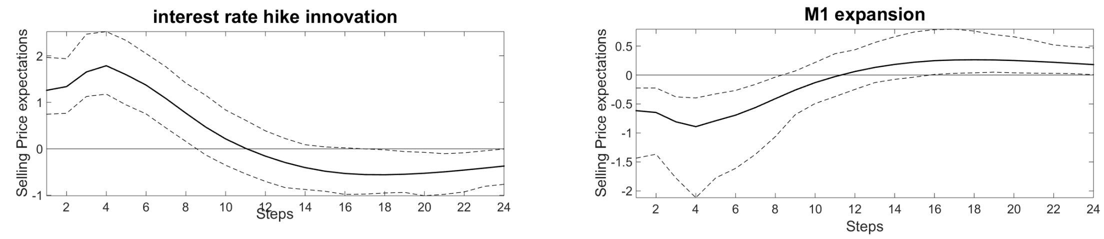
Euribor rates as external instruments

Finally, we re-estimate the panel SVAR models and the corresponding impulse responses using as external instruments daily changes in the Euribor rates with one month or three months of maturity (see, for example, Gertler and Karadi (2015)) in place of the two factors that we have used in our benchmark estimations. The impulse responses for firms' selling price and production expectations using the unanticipated changes in the current Euribor rate as an external instrument, are presented in Figure 10 and in Figure 11, respectively. The impulse responses for firms' selling price and production expectations using the 3-months ahead Euribor rate changes as the external instrument, are presented in Figure 12 and in Figure 13, respectively.

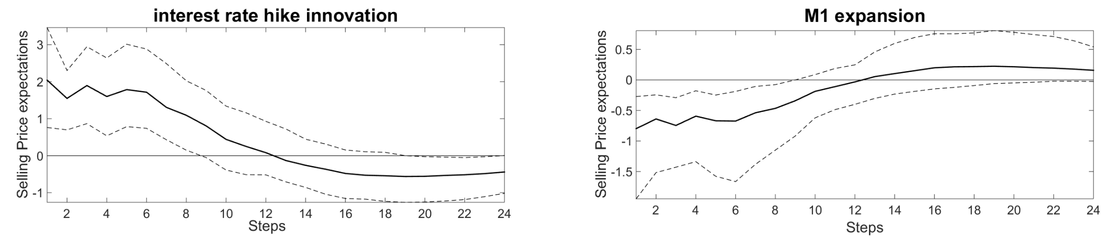
Once again, we find that our results are robust to using the daily surprise changes in the current or three months ahead Euribor rate, as external instruments. For example, in the first column of Figure 10, and exactly resembling the findings in Figure 2, we see that an interest rate hike shock has a significantly positive impact on selling price expectations for the first eight months. In analogous fashion, in the second column of Figure 10 we see that an M1 expansion shock has a significantly negative impact on selling price expectations for the first eight months. This impact of an unanticipated interest rate hike (M1 expansion) is reversed turning significantly negative (positive) at about sixteen months out in the case of total manufacturing, which again resembles the significant overshooting pattern in Figure 2. Moreover, our estimated impulse responses for production expectations in Figure 11 resemble those in our baseline estimation portrayed in Figure 3. The impact of an interest rate hike (M1 expansion) shock is significantly positive (negative) for the first six months for total manufacturing as before, and then becomes significantly negative (positive) at about nine months out as was the case in Figure 3 for our baseline. Finally, using the 3-months ahead Euribor changes as an external instrument in Figures 12 and 13 for firms' selling price and production expectations respectively, the results described above remain intact and not much changed relative to the baseline in Figures 2 and 3.

Figure 10: Selling price expectations' responses using current Euribor instrument.

(a) Total manufacturing sector



(b) Firms producing durable consumer goods



(c) Firms producing non-durable consumer goods

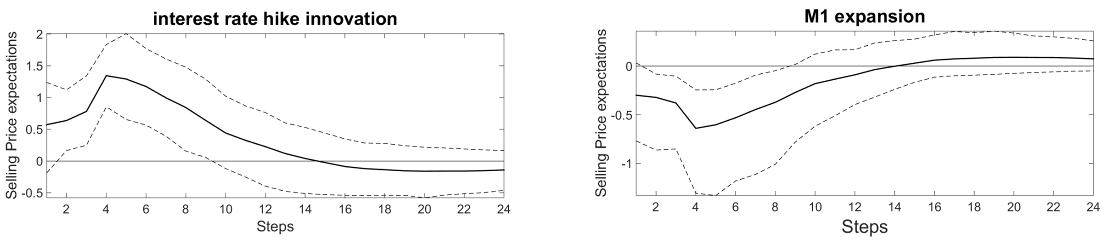
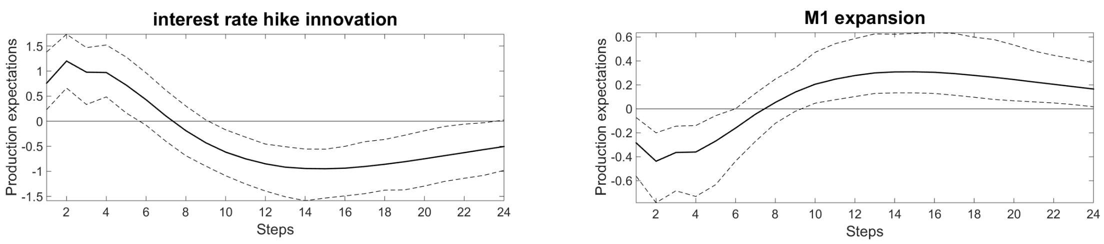
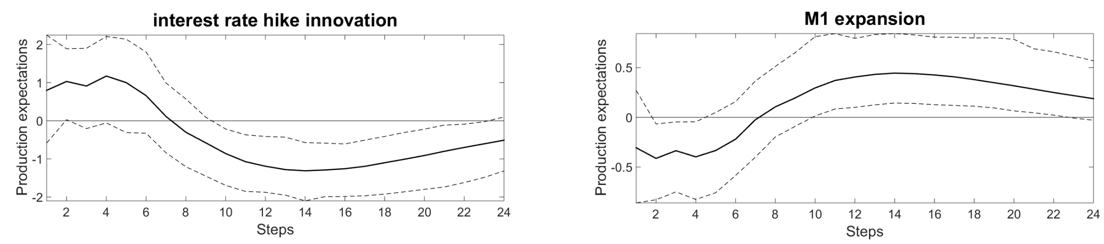


Figure 11: Production expectations' responses using current Euribor instrument.

(a) Total manufacturing sector



(b) Firms producing durable consumer goods



(c) Firms producing non-durable consumer goods

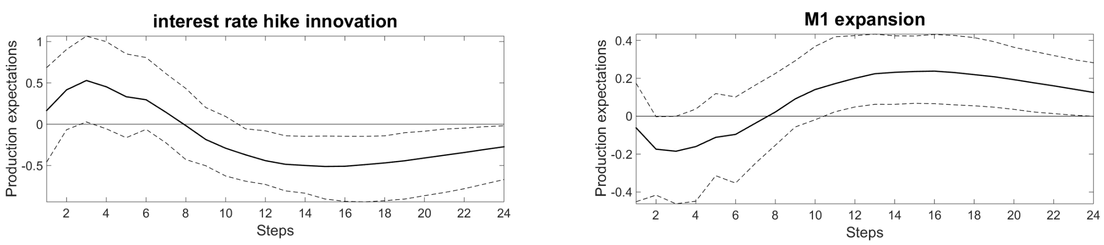
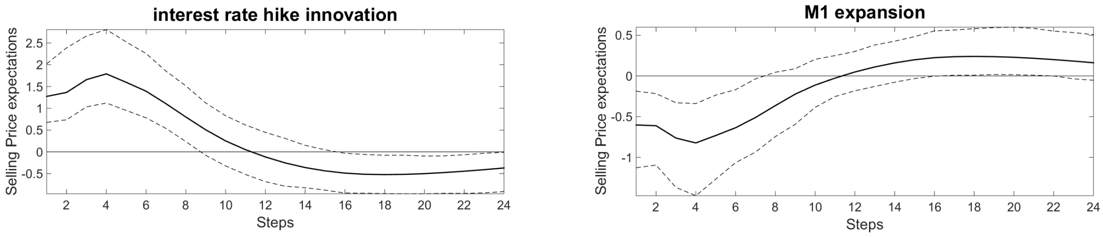
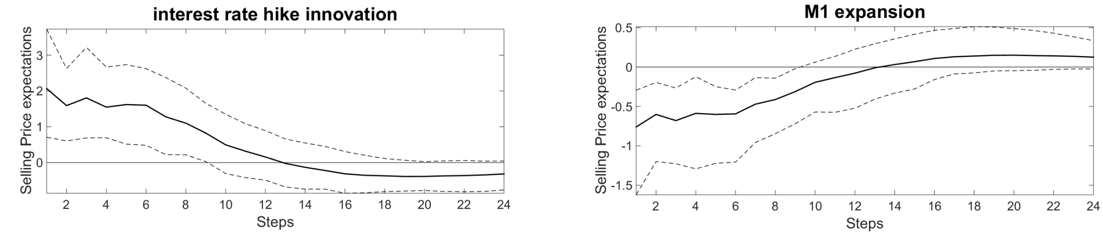


Figure 12: Selling price expectations' responses using 3-month Euribor instrument.

(a) Total manufacturing sector



(b) Firms producing durable consumer goods



(c) Firms producing non-durable consumer goods

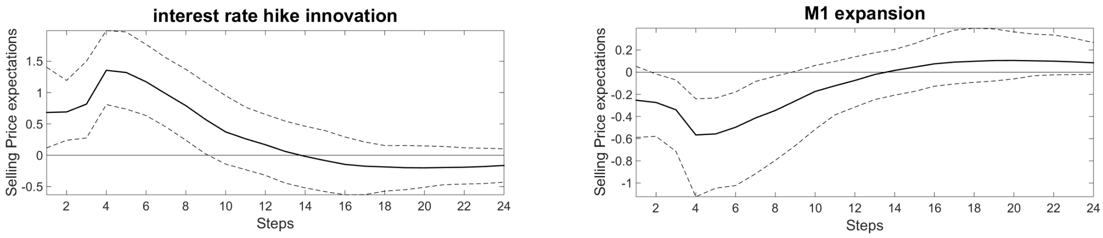
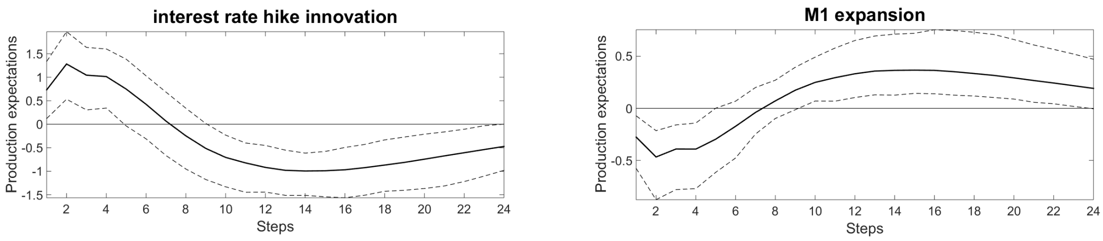
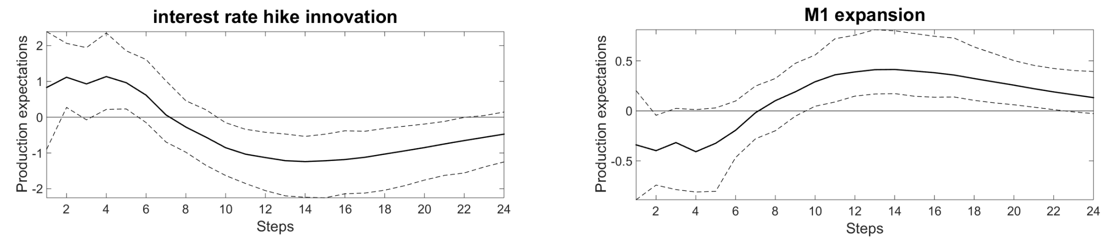


Figure 13: Production expectations' responses using 3 month Euribor instrument.

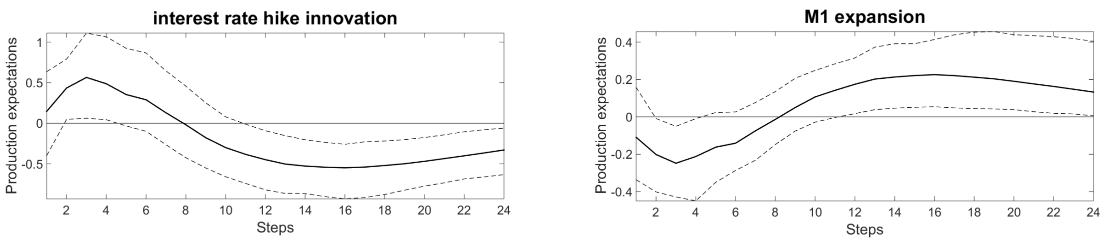
(a) Total manufacturing sector



(b) Firms producing durable consumer goods



(c) Firms producing non-durable consumer goods



6 Conclusion

There is a growing literature studying the impact of monetary policy on economic activity. Not just the magnitude but even the sign of the responses are controversial and depend on the identification strategy of the shocks and the econometric framework used. In this paper, we have investigated the impact of monetary policy shocks on firms' expectations, since firms are after all the price-setters in the economy and current production depends upon firms' expectations of future economic developments.

Following the narrative approach of Romer and Romer (2004) and high frequency identified approach of Gurkaynak et al. (2004), we constructed external instruments for the euro area based on ECB's announcement days. Then, building on a methodology developed by Stock and Watson (2012) and Mertens and Ravn (2013), we estimated a panel structural VAR, incorporating external series for identification of monetary policy shocks.

Our study delivers a number of insights. We find that an interest rate hike innovation leads to a temporary rise in firms' selling price and production expectations. This is consistent with imperfect information theoretical settings where firms exhibit rational inattention (see, e.g., Reis (2006),Coibion and Gorodnichenko (2015)). That is, given that firms are aware that the policymaker has more information than they have, they interpret the unanticipated increase in the interest rate as positive news about the state of the economy and thus increase their production and selling price expectations. This impact later becomes negative for both selling price and production expectations. The positive impact becomes negative about three quarters after the shock occurred for production expectations and within five quarters for selling price expectations. The different timing of production and selling price expectations suggests that first the economy moves and then firms observe this and learn about the contractionary impact of the interest rate hike on the economy, which leads them to adjust their production and finally their selling price expectations in accordance with this learning experience over time.

Overall, the overshooting pattern we observe suggests that following the initial surprise that leads imperfectly informed firms to raise (reduce) their production and selling expectations after an unanticipated interest rate hike (M1 expansion), firms gradually come to expect contractionary (expansionary) monetary policy shocks to eventually decrease (increase) production and then inflation, thus revise their expectations accordingly by decreasing (increasing) first their production expectations and then their selling price expectations.

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