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Income-specific inflation rates and the effects of monetary policy: the case of North Macedonia

Abstract

In this paper, we investigate the effects of monetary policy concerning the inflation rates specific for each income group of households. We find that the prices specific for high income households are generally more rigid and less volatile compared to the prices specific for middle and lower income households. This means that monetary policy can differently affect the different inflation rates specific for each of the income groups. By using a Factor-Augmented VAR (FAVAR) model, we show that a monetary policy shock affects high income households less compared to middle and lower income households, although the differences between the separate income groups are generally small. Then, by using a small scale gap model, we find that the prices of low income households are the most sensitive to a monetary policy shock, while the prices of the top income households are the least sensitive to the shock, which is in line with our empirical findings.

JEL Classification Numbers: E31, E52.
Keywords: Inflation, monetary policy, distributional effects.

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Contents

1. Introduction

The focus on the distributional consequences of macroeconomic policies is a relatively new phenomenon, having entered the development literature from fiscal policy incidence analysis in high income countries. Nevertheless, theoretical and empirical literature that investigates and evaluates the impact of macroeconomic policies on income distribution, inequality and poverty, is already vast and extensive. Authors have been focused on the likely impact of fiscal policy stance, monetary or exchange rate policy on poverty and distribution of income and wealth among individuals and firms, as well as on the most effective macroeconomic policy setting to encourage investment and productivity and to achieve long-term, sustainable and inclusive growth.

When it comes to monetary policy, there are few theoretical channels through which monetary policy might affect income and consumption inequality, depending on the income composition of economic agents (income composition channel), the amount of currency held by different income groups (portfolio channel), the active participation of economic agents in financial market transactions (financial segmentation channel) and whether the economic agent is a saver or a borrower (savings redistribution channel). Empirical studies for the United States (Coibion, Gordnonichenko, Kueng, & Sylvia, 2016) and for the United Kingdom (H. Mumtaz & A. Theophilopoulou, 2015) show that surprise policy rate hikes increase income inequality, whereas surprise policy rate cuts reduce income inequality in the short term. Moreover, results suggest that the income composition channel exhibits the strongest distributional effects; there is some evidence in favor of other channels but the impact is marginal. However, despite the fact that empirical evidence on the distributional consequences of monetary policy is found, the magnitude of the effects is estimated to be comparatively weak.

Another important aspect when it comes to analyzing distributional consequences of monetary policy is the possible effects of the unconventional monetary policy instruments. In the last decade, central banks worldwide reduced their policy rates to historically low levels and undertook a range of unconventional policy measures. Having in mind the current COVID-19 unprecedented economic effects, it is clear that this monetary policy stance will continue at least in the near term future. Among other things, this has sparked a heated debate over whether and in what way unconventional monetary policy affects the distribution of income and wealth. So far, the research in this area found some evidence that non-standard monetary policy measures increase inequality; however, as argued in the literature this evidence was derived from a limited number of studies and partial analysis. Therefore, more research is needed in this area in order to draw any firm conclusions and recommendations.

In our paper, we investigate a relatively new transmission mechanism, first proposed and explored by Cravino, Lan, and Levchenko (2018), through which a monetary policy shock might have distributional consequences. More precisely, the authors argue that a monetary policy shock affects prices faced by different income groups differently and thus, creates distributional changes. This happens because of two reasons. First, the effects of a monetary shock on prices is heterogeneous across types of goods and second, consumption baskets differ across the income distribution.

Generally, our research consists of two parts. In the first part, we focus on computing and analyzing inflation rates for ten income-based decile groups of households by using data from the Household Budget Survey (HBS). We discuss the dynamics of inflation rates alongside the income distribution, with focus on specific shock episodes from the past. For example, we noticed a widening of the gap between the inflation rate of the lowest income group compared to the inflation rate of the higher income groups around 2008, when global prices of oil and food increased dramatically. Following Cravino et al. (2018) we calculated indicators for flexibility and volatility of income-specific inflation rates and found out that in North Macedonia lower income households face comparatively more flexible and more volatile prices.

Having in mind these differences between the income-specific inflation rates, in the second part of the paper we analyze the impact of a monetary policy shock on the inflation rates specific for each of the different income groups. Then, we estimate the impact of the monetary policy shock by using the FAVAR approach, following Bernanke, Boivin, and Eliasz (2005). One of the main advantages of the FAVAR methodology over the VAR framework is that the FAVAR identifies a monetary policy shock by using a large amount of information without losing degrees of freedom. In addition to the FAVAR estimation, we use a small-scale gap model that reflects the structure of the Macedonian economy to evaluate how monetary shocks affect consumption price indices for households at different points of the income distribution in a model consistent framework. The standard model structure is augmented by adding ten inflation equations, one for each income group and assuming that the total inflation in the economy is equal to the weighted sum of the ten income-specific inflation rates.

The paper is organized as follows. Section 2 presents the literature review. Section 3 discusses the data sources used in the research and comments on the approach that was implemented to compute income-specific inflation rates. Section 4 documents consumption basket differences across households and describes the dynamics and specifics of different inflation rates. Section 5 and 6 present the FAVAR results and the model simulations. Section 7 concludes and gives some recommendations for future research.

2. Literature review

Empirical literature on this topic is quite extensive. The literature review presented in this section is motivated by our core research topic – distributional effects of monetary policy on the consumer price indices (CPIs) specific for households which belong to different income groups. The research topic which we examine assumes that households belonging to different income groups are faced with different inflation rates. Therefore, monetary policy is expected to have different effects on the different types of households based on the income they receive. To that end, we review a group of papers that investigate the differences in inflation rates among different groups of households, as well as papers concerned with the distributional consequences of monetary policy.

Previous literature suggests that inflation is in fact heterogeneous and hence different socio-economic and demographic groups of economic agents, experience different levels of inflation (Argente & Lee, 2017; Cravino & Levchenko, 2017; Kaplan & Schulhofer-Wohl, 2017; Jansky & Hait, 2014; Fessler & Fritzer, 2013; Pfajar & Santoro, 2008; Doepke & Schneider, 2006; Toussaint-Comeau & McGranahan, 2006; Hobijn & Lagakos, 2005; Lieu, Chang, & Chang, 2004; Garner, Johnson, & Kokoski, 1996; Amble & Stewart, 1994; Hagemann, 1982; Michael, 1979). Michael (1979) and Hagemann (1982), for example, are some of the early studies which argue about the variation of inflation rates among different types of households. For instance, Michael (1979) argues that in the period 1973-1974, low income households experienced high rates of inflation, similar to the elderly people who were faced with higher inflation rates in the period 1967-1974, although these between-group differences do not appear to be stable over time. Some studies have attempted to discover the reasons behind inflation heterogeneity. For example, Hobijn and Lagakos (2005) find that in the U.S. during the period 1987-2001, heterogeneity of inflation across households appeared as a result of relative price changes in specific categories such as education, health care (these categories experience higher inflation compared to the average rate) and gasoline prices (which exhibit high volatility). Past studies have even made attempts to construct measures of inflation specific for separate groups, such as the elderly people (Amble & Stewart, 1994), or the poor people (Garner et al., 1996). Evidence of heterogeneity in inflation rates experienced at the household level has been presented by Kaplan and Schulhofer-Wohl (2017) as well, who find that, on average, higher inflation rates are specific for lower income households. Fessler and Frizter (2013) find that in Austria, inflation is lower for more educated people and for people with higher income, while it is substantially high for blue-collar workers, unemployed people and retired people. Also, substantial differences in inflation rates among different households have been reported in the case of the Czech Republic, where most of the time, pensioners and low income households were found to experience higher inflation rates compared to the average inflation rate for the whole population.

Group of authors were focused on inflation rates faced by heterogeneous agents during different shocks that hit the economy at specific points in time. Argente and Lee (2017) argued that, during the Great Recession (caused by the financial crisis of 2007-2008), households of different income groups exhibited different cost of living inflation, so that on average, high income households were characterized by lower annual cost of living inflation compared to lower income households and this inflation gap continued after the recession. Similarly, two years after the Mexican peso devaluation in 1994, low income households experienced substantially higher rates of inflation relative to the high income households (Cravino & Levchenko, 2017). Moreover, Doepke and Schneider (2006) argue that in the case of an inflationary episode, borrowers (generally young households with a fixed-rate mortgage debt) are in a better position compared to savers (generally old and wealthier households who are the dominant bondholders).

Recent literature related to the distributional consequences of monetary policy argues that monetary policy decisions can result in different effects among different groups of economic agents (Auclert, 2017). Monetary policy decisions have a direct impact on price changes and therefore it is natural to expect that such decisions would have a different impact on the savers and borrowers welfare (Doepke & Schneider, 2006). Williamson (2008) finds that monetary policy decisions affect connected economic agents (agents which frequently engage in financial market transactions) differently relative to unconnected economic agents (agents which infrequently engage in financial market transactions). Moreover, Wong (2018) argues that consumption of younger people is more responsive to monetary policy shocks compared to consumption of older people and the results are mainly driven by homeowners engaged in mortgage-related activities (which are generally younger people). Clayton, Jaravel, and Schaab (2018) discover that price rigidity is more specific for sectors related to college-educated households, which means that the consumption of these households is generally more responsive to monetary policy shocks. Cravino et al. (2018) find that following a monetary policy shock, inflation rates specific for high income households react less compared to the inflation rates specific for middle income households. Moreover, the optimal policy rule might differ if the assumption of heterogeneity of inflation is taken into consideration when making monetary policy decisions (Kaplan & Schulhofer-Wohl, 2017).

3. Data

The data that we use in this research is obtained from the State Statistical Office (SSO) of the Republic of North Macedonia. More specifically, we use data from the Household Budget Survey (HBS) and the consumer price indices for a period of 10 years (2007-2017), which are both compiled and published

by the SSO. In addition to the HBS and consumer prices data, we also used a set of macroeconomic variables and survey data for the estimation of the FAVAR model which is presented in Appendix 1.

HBS is conducted on a sample of 5,040 households, located across the whole country. This survey consists of two methods, which are the method of keeping diaries and the method of interviews which is based on questionnaire forms. The income data is collected over a period of three months, while the expenditure data is collected over a period of 15 days and during this period, each household records its expenditure in their diary.

HBS data is used to compile income-specific expenditure shares for ten different income groups of households. More specifically, the HBS provides information on the consumption of 12 groups of products and services (alcohol and tobacco, clothing, communication, culture, education, food, furnishing, health, housing, restaurants and hotels, transport and other goods and services)[2] for each of the ten different income groups of households. Most of the empirical research in this area uses micro data from the HBS to classify households according to their income or wealth in percentiles. This data is further used to analyze differences in the consumption structure between specific percentiles of households (e.g. 40-60 percentiles that represent the middle income households as opposed to the top 1 percentile), as well as to construct percentile-specific expenditure shares. However, we do not have access to the HBS micro data to create different percentiles of households. Instead, we rely on the published data which aggregates households into decile groups. This significantly reduces the number of available observations and might mask some important results.

We create the income-specific expenditure shares by dividing the specific decile group consumption for each group of goods and services by the total consumption of that decile group for each year. Since the survey is published on an annual basis, we assume that the expenditure shares by income-specific group remain the same during a period of one year. Expenditure shares for each decile group are presented and discussed in the next section.

In the next step, we create the income-specific price indices for the ten different income groups. First, we use consumer price indices to proxy the price dynamics of the 12 different groups of products/services. Next, we combine the constructed income-specific expenditure shares and average prices for the 12 different groups of products/services to compile the income-specific inflation rates for the ten income groups.

[2] The 12 groups of products and services are the same as those used by the SSO for the construction of the CPI.

4. Stylized facts

In this section, we present some stylized facts concerning the dynamics and characteristics of income-specific inflation rates.

We start with a discussion on the income-specific expenditure shares calculated as explained in the previous section. As dynamics is concerned, we can see from Figures 1 and 2 that generally, the expenditure shares for each group of products and services across the different income-specific deciles in 2007 remain very similar when compared to 2017. Namely, in both 2007 and 2017, the general expenditure structure is such that lower income households spent more for food relative to higher income households. In fact, lower and even middle income households spend a significant part of their income on food. As income increases, the shares spent for food decrease, relative to the other categories of products and services. For example, as income rises, the amount spent for housing, transport, clothing and communication increases, meaning that higher income households generally spend much more on these types of products and services in relative terms, compared to lower income households and this holds for both 2007 and 2017.

Figure 1: Expenditure shares over household income deciles, 2007

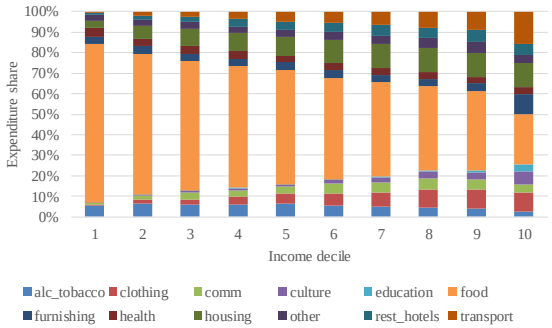


Figure 2: Expenditure shares over household income deciles, 2017

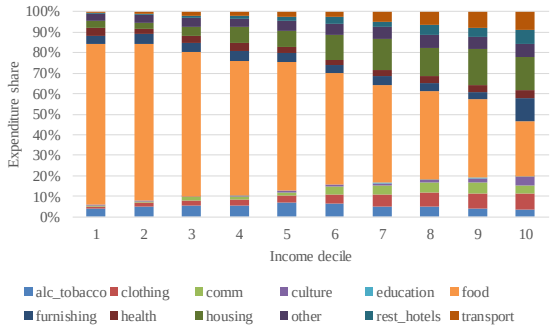
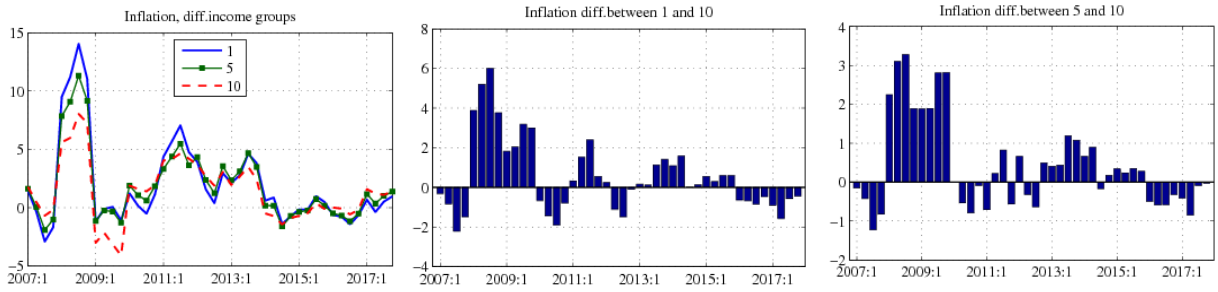


Figure 3 shows inflation rates for selected income-specific inflation rates in the period 2007-2017. Generally, income-specific inflation rates are highly correlated and tend to move in the same direction. However, we notice that the gap between income-specific inflation rates widens in the presence of substantial supply shocks. An example is the end of 2007 and the first half of 2008, when global food and oil prices increased dramatically. In this period, the inflation rate of lower income and middle income households (first and fifth decile) is higher when compared to wealthier households (tenth decile). After the shock, the differences between the inflation rates decrease as well. This result is expected given the specific structure of the consumption basket of lower income households in which, as already argued, food is one of the dominant categories.

Figure 3: Inflation rate of 1st, 5th and 10th decile group



In the remaining part of the section, we present some evidence of the flexibility and volatility of income-specific inflation rates, following Cravino et al. (2018).

Analysis of flexibility of price changes requires measure of income-specific weighted frequencies of price changes. We calculate the income-specific weighted frequency of price changes for a specific year as:

$$\bar{\theta}_h = \sum_{i=1}^{n} w_i^h \theta_i \tag{1}$$

,where $\bar{\theta}_h$ is the income-specific frequency of price changes, w_i^h is the income-specific expenditure share for each group of products and services calculated as explained in the previous section, and θ_i is the product specific frequency of price changes. The best approach for calculation of the product specific frequency of price changes is by using detailed, product level CPI database as in Nakamura and Steinsson (2008)[3]. However, this dataset is not publicly available for our country. Therefore, instead of calculating product specific frequency of price changes for our country, we had to use reported frequencies of price changes for some other country. Cravino et al. (2018) also followed this approach and used frequencies of price changes reported by Nakamura and Steinsson for the U.S. economy. In our research, we proxied the frequencies of price changes of goods and services in our economy with the estimated frequencies of price changes for the Belgian economy[4]. Aucremanne and Dhyne (2004) estimated frequencies of price changes at a product level for the Belgian economy. They also reported aggregated frequencies of price changes for the 12 COICOP groups that are used in our research. Finally, in our research, we assume that the frequencies

[3] Alternatively, one might use results from firm level survey analysis. However, this approach usually provides information on the aggregate frequency of price changes.

[4] Our choice to use estimated frequencies of price changes for the Belgian economy instead the ones estimated for the USA was determined by the fact that the Belgian economy is more similar to our economy as both are small, open, European economies.

of price changes for the 12 groups of products and services, as specified in section 2, remain stable over the analyzed period.

Figure 4 presents the weighted frequencies of price changes for the ten different income groups averaged over the whole period, the frequency of each product group being proxied by the estimates for the Belgian economy. We also looked at individual years, but the picture remains generally very similar throughout the years. Evidently, the weighted frequency of price changes is lower for higher income households, or in other words, the prices tend to be more rigid and less flexible for the households which belong in higher income groups. On the other hand, lower and middle income households face similar frequency of price changes and, compared to high income households, face more flexible prices (have higher weighted frequency of price changes).

Volatility of income-specific inflation rates is compiled by calculating the standard deviation for each of the income-specific inflation series. As Figure 5 shows, the standard deviation of the income-specific inflation rates is higher for the lower income households and declines as income increases. In other words, low income households exhibit higher average price volatility, while higher income households exhibit lower average price volatility.

Figure 4: Weighted frequency of price changes, average for the period 2007-2017

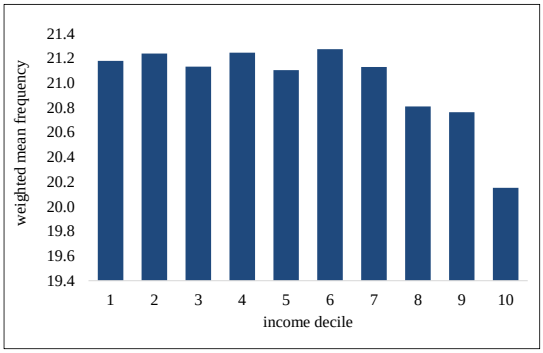
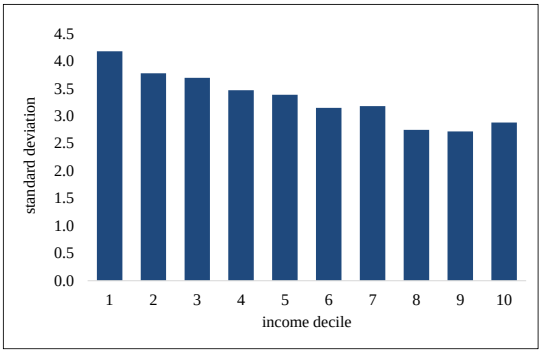


Figure 5: Standard deviation of the changes in the consumption price indices



Our findings differ slightly from the findings of Cravino et al. (2018), who find an inverted U shaped curve for the flexibility, as well as for the volatility of income-specific price indices. Namely, they find that, in general, the middle income households experience higher price flexibility and higher volatility of prices compared also to lower income households which is not the case in our data. Kronick and Villarreal (2020) also find hump-shaped result for the variations in inflation across the consumption baskets associated with different income quintiles, with high income households in Canada experiencing lower volatility compared with middle income households. This difference in the results might be explained by several facts. First, our research is conducted for a small and emerging economy whose consumption

structure alongside the income distribution might differ significantly from the one in the developed economies such as the US and Canada and this can lead to different results. Second, we work with aggregated data, whereas both of the aforementioned studies use micro data. This, as previously stated, is one of the most important shortcomings of our study and might influence the results of the research. Third, when constructing the indicator for price flexibility we used estimated frequencies for price changes for the Belgian economy. Ideally, one should use frequencies of price changes estimated for the economy in question.

Nevertheless, having in mind that we found evidence that consumption baskets differ alongside the income distribution and that different income groups face different prices regarding the degree of flexibility and volatility, in the next two sections we continue by evaluating the likely impact of monetary policy on income-specific inflation rates.

5. FAVAR model

In this section, we estimate Factor-Augmented Vector Autoregression (FAVAR) model in order to check whether a monetary policy shock affects differently inflation rates of different income-specific household groups. As discussed in the previous section, higher income households face relatively stickier prices (lower weighted frequency of price changes) compared to middle income and low income households which are associated with more flexible prices (higher weighted frequency of price changes). Moreover, we also find that as income increases, the volatility of the inflation decreases, meaning that higher income households generally exhibit less volatile inflation rates relative to middle and lower income households which are actually associated with higher inflation volatility.

In our analysis, we use the FAVAR approach of Bernanke, Boivin, and Eliasz (2005) (BBE) and Boivin, Giannoni, and Mihov (2009). FAVAR model combines VAR methodology with factor analysis. BBE provide great discussion on the advantages of this method over using simple Vector Autoregression (VAR) model. When it comes to analyzing monetary policy, one of the most important advantages, as stated by BBE, is that the FAVAR identifies monetary policy shocks by using a large amount of information. For comparison, within the standard VAR framework, the analysis is carried out with no more than eight variables in order to conserve degrees of freedom. A relatively smaller set of information creates at least three potential problems. First, given that the private sector and the policy makers when deciding on their future actions are using all of the information available to them, shocks identified using standard VARs are likely to be contaminated. Second, a VAR model implicitly assumes that we know the correct observable measure that represents some theoretical concept. However, this might not be true in reality. For example,

the concept of "economic activity" may not be perfectly represented by industrial production or real GDP. Third, when using VAR, one can observe impulse responses only for the included variables and the number of the included variables is relatively small given that it is limited by the degrees of freedom problem.

In defining the FAVAR, we follow the BBE methodology that assumes the existence of a large number of economic series, whose behavior is driven by a vector of common components. This vector includes the policy rate and a small number of unobserved common factors Ft. The joint evolution of the policy rate and the vector of factors, Ct, is characterized by a VAR:

$$C_t = \begin{bmatrix} F_t \\ i_t \end{bmatrix}, \qquad C_t = \Phi(L) C_{t-1} + v_t \tag{2}$$

where Φ(L) is a lag polynomial and v_t is an i.i.d. error term.

However, the vector Ft is unobservable. What is observed is a large number of economic series Xt. The FAVAR approach assumes that this set of economic series is characterized by a factor model:

$$X_t = \Lambda C_t + e_i \tag{3}$$

where Λ is the matrix of factor loadings. This representation provides a great deal of parsimony because in practice Xt includes hundreds of series, whereas the dimensionality of the vector of common factors Ft is typically small.

The information variable vector Xt includes the income-specific price indices, as well as the additional variables such as sector-level producer price indices, sector-level industrial production, labor market indicators, credit and monetary indicators, external sector indicators, economic sentiment indicators and other relevant variables. The time frequency is monthly, and the time period is 2007m1-2017m12. All variables are seasonally adjusted and transformed in order to achieve stationarity. The complete list of the variables is presented in Appendix 1.

We estimate our FAVAR model with the two-step principal components approach as in BBE[5]. In the first step, the common components are estimated using the first K+M principal components of Xt, whereas Yt is not observed. In the second step, the FAVAR equation is estimated by standard methods.

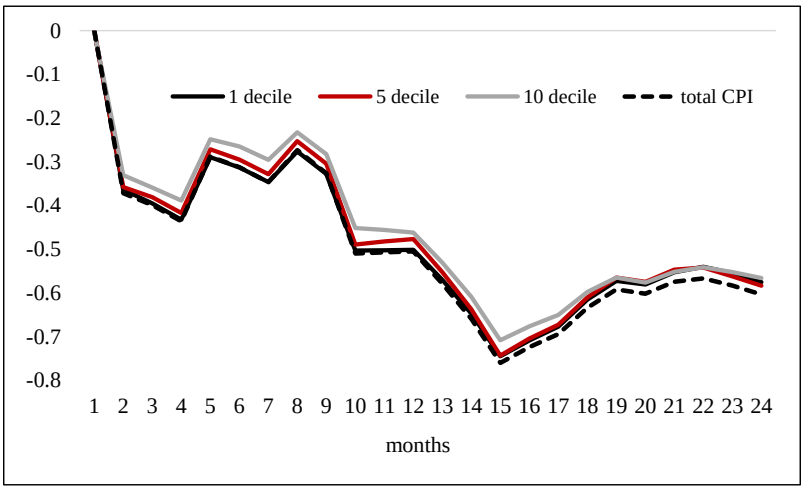
The monetary policy shock, same as in BBE (2005), is identified in a recursive manner i.e. the policy rate is ordered last and we treat its innovations as the policy shock. The recursive ordering means

[5] We also estimated the FAVAR by using the likelihood-based Gibbs sampling techniques which provides joint estimation of both equations i.e. estimates the factors and the FAVAR simultaneously. Generally, the results were very similar i.e. the response of inflation of lower and middle income households was higher in comparison to the response of higher income households, but the difference was very small.

that the unobserved factors do not respond to the policy rate contemporaneously. To implement this identification, we classified the information variables in two groups - slow-moving and fast-moving variables (presented also in Appendix 1). Slow-moving variables, such as wages for example, do not respond contemporaneously to shocks, whereas fast-moving variables, such as asset prices, in fact do.

We estimated the FAVAR model with three factors and 13 lags. The monetary shock is standardized to correspond to a 25-basis-point increase in the policy rate. Figure 6 plots the impulse responses of income-specific inflation rates of selected decile groups – first, fifth and the tenth and the impulse response of the total CPI inflation. An increase in the policy rate leads to a decline in all of the inflation rates and the path of the responses is similar. However, one can notice that inflation of the tenth decile group (high income households) responds less than the inflation of the first decile group (low income households), as well as the inflation of the fifth decile group (middle income households) and the total inflation. After six months, high income households respond 15.3% less compared to low income households and 10.2% less compared to middle income households; after 12 months the difference is smaller – higher income households respond 7.9% and 3.1% less than lower income and middle income households, respectively. By the end of the 24th period, the responses converge.

Figure 6: Income-specific CPI impulse responses to a monetary policy shock



Even though we found some evidence of heterogeneous responses of income-specific inflation rates to a monetary policy shock, the difference is very small. Cravino et al. (2018) find that even after 36 months the CPI of the top 1% high income households responds by 38% less than the CPI of the households in the middle of the income distribution (40–60th percentiles). After 48 months, the difference is 33%. However, the results are not directly comparable because of the different level of disaggregation of the databases. Namely, we are working with deciles (10 income-specific inflation rates) which is a relatively high level of

aggregation, while Cravino et al. (2018) are working with percentiles (100 income-specific inflation rates) which allows them to analyze specifically the behavior of the top 1% income group.

In order to confirm the econometric results and to analyze in more depth the transmission mechanism of monetary policy to income-specific inflation rates, in the next section we use small-scale gap model that reflects the characteristics of our economy.

6. Small-scale model simulations

This section sets up a small-scale gap model that reflects the structure of the Macedonian economy to evaluate how a monetary shock affects inflation rates for households at different points of the income distribution. To that end, the standard model structure is augmented by adding ten inflation equations, one for each of the ten income groups of households.

6.1. Model structure

This section describes the core structure of the small model. The model is a simplified version of the core forecasting model of the National Bank of the Republic of North Macedonia - MAKPAM model (Hlédik, Bojceva-Terzijan, Jovanovic, & Kabashi, 2016). We use a system consistent Kalman filter in order to derive the gaps and trend values.

The structure is fairly standard for this type of models – we have three main building blocks of equations: prices, the real economy and monetary policy.

The price developments are modeled through a New-Keynesian, forward-looking, Phillips curve. Equation 4 defines the consumer price inflation of households from one decile group (π_t^h, where h stands for the decile group) as a function of the expected inflation (π_{t+1}), lagged inflation (π_{t-1}), the output gap as a proxy for the real marginal cost ($ygap_t$) and changes in imported prices (foreign effective inflation, π_t^{ef} and oil prices, π_t^{oil}):

$$\pi_t^h = \alpha_1^{\pi_{t+1}} \cdot \pi_{t+1} + \alpha_1^{\pi_{t-1}} \cdot \pi_{t-1} + \alpha_1^{\pi_t^{oil}} \cdot \pi_t^{oil} + (1 - \alpha_1^{\pi_{t+1}} - \alpha_1^{\pi_{t-1}} - \alpha_1^{\pi_t^{oil}}) \cdot \pi_t^{ef} + \alpha_1^{ygap} \cdot ygap_t + \varepsilon_t^{\pi_t} \quad (4)$$

Given the specific nature of our research question, we have ten Phillips curves of the same type for each of the household decile groups. The total inflation is a weighted average of the individual income-specific group inflations, with all weights (s^h) being equal to 0.1 (equation 5).

$$\pi_t^{TOT} = \sum_h s^h \pi_t^h \tag{5}$$

The real economy is represented by the IS curve (equation 6) that links the output gap ($ygap_t$) with real exchange rate gap ($qgap_{t-1}$), real interest rate gap ($rgap_{t-1}$) and foreign demand gap ($yfgap_{t-1}$):

$$ygap_t = \alpha_2^{ygap_{t-1}} \cdot ygap_{t-1} + \alpha_2^{qgap_{t-1}} \cdot qgap_{t-1} + \alpha_2^{rgap_{t-1}} \cdot rgap_{t-1} + \alpha_2^{yfgap_{t-1}} \cdot yfgap_{t-1} + \varepsilon_t^{ygap_t} \tag{6}$$

The real exchange rate is the difference between the consumer price inflation in the domestic economy and the foreign effective inflation (under a fixed exchange rate relative to the Euro).

The monetary policy is modeled following the same logic as in the MAKPAM model. North Macedonia has followed a de facto fixed exchange rate monetary strategy since 1995. Therefore, the behavior of the central bank is described by a policy reaction function which reflects the central bank's commitment to maintain the fixed exchange rate regime. More precisely, equation 7 takes into account the dependence between the sustainability of the fixed exchange rate regime and the level of the foreign exchange reserves by linking the interest rate (i_t) to the foreign interest rates (i_{star_t}) and the risk premium ($risk_{premium}$). The risk premium consists of two parts – exogenous risk premium ($risk_{prem}^{SS}$) which is fixed and reflects long-term, fundamental differences between North Macedonia and the euro area, and endogenous risk premium ($risk_{prem}^{rsrgap}$) which in turn is approximated by the foreign reserves gap (deviation of the current level of foreign reserves from its long-run trend).

$$i_t = i_{star_t} + risk_{premium} + \varepsilon_t^i \tag{7}$$

$$risk_{premium} = risk_{prem}^{SS} + risk_{prem}^{rsrgap} \tag{8}$$

$$risk_{prem}^{rsrgap} = \alpha_3^{riskprem} \cdot rsrgap_{t+4} \tag{9}$$

Equation 10 models the foreign gap as a function of the deviation of the inflation from foreign inflation, domestic output gap and the foreign output gap.

$$rsrgap_t = \alpha_4^{rsrgap_{t-1}} \cdot rsrgap_{t-1} + \left(1 - \alpha_4^{rsrgap_{t-1}}\right) \cdot \left[\alpha_4^{inf} \cdot \left(\pi_t^{TOT} - \pi_t^{ef}\right) + \alpha_4^{demand} \cdot \left(\alpha_4^{ygap_{t-1}} \cdot ygap_{t-1} - \left(1 - \alpha_4^{ygap_{t-1}}\right) * yfgap_{t-1}\right)\right] + \varepsilon_t^{rsrgap_t} \tag{10}$$

The lagged term expresses the inertia in the foreign reserves motivated by real rigidities in foreign trade. Excessive domestic inflation over imported inflation might negatively influence the confidence in the domestic currency and could therefore lead to the purchase of foreign currency by domestic agents (parameter α_4^{inf} is negative). Similarly, domestic demand pressures are associated with worsening of the

trade balance and subsequently deteriorating foreign reserves (parameter α_4^{demand} is also negative). Finally, the fall in foreign output gap, is expected to result in a drop in foreign reserves via its contractionary effects on exports of goods and services.

The model is calibrated following MAKPAM's calibration and the parameters are presented in Appendix 2. Special attention was devoted to the coefficients of the income-specific inflation equation, especially the output gap coefficients which describe the pass-through of changes in interest rate to inflation. These coefficients are calibrated on the basis of the evidence from the FAVAR impulse response analysis and results from the OLS estimation of the income-specific inflation equations. The latter indicates that the output gap effects on the lowest income group inflation rate are at least two times larger compared to the effect that the output gap has on the inflation rate of the highest income group. In Appendix 2, we also present the estimated OLS output gap coefficients.

The model performance was evaluated on the basis of impulse response analysis and in-sample forecasting. In-sample forecasting refers to forecasting of key variables starting at various points in the past. It assumes that filtered trends for the whole horizon as well as the exogenous variables are all known ex-ante. Therefore, the results of the in-sample analysis show how well the model is able to replicate the cyclical movement of the economy. The final result of the in-sample analysis consists of a large number of mechanical model simulations (pseudo-forecasts). In Appendix 3, we show the impulse responses analysis of three shocks (demand shock, foreign demand shock and monetary policy shock), as well as the in-sample forecasting of the core model variables.

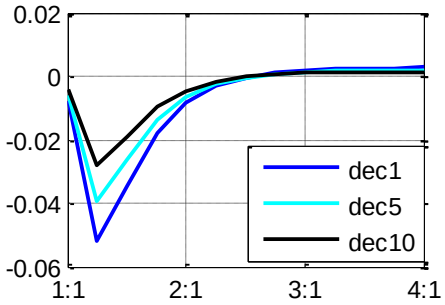
6.2. Results

In this subsection, we try to evaluate the distributional effects of monetary policy by using scenario analysis with the small-scale model. To that end, we created three scenarios – one baseline scenario, where the monetary policy reaction is driven by the model structure and the assumptions of the exogenous variables (foreign inflation, foreign demand, oil prices and foreign interest rate) and two alternative scenarios, in both of which we assume that monetary authorities decided to change interest rates below or above the interest rate predicted in the baseline scenario because of some additional factor not anticipated in the model.

Before proceeding further with the results from the scenario analysis, we discuss the impulse responses of the household-specific inflations to a one standard deviation shock to ε_t^i (Figure 7). The figure plots the response of the inflation rate of the first, fifth and tenth decile group to the monetary shock. Evidently, the shock has distributional effects – prices of low income households are the most sensitive to

the shock, whereas the prices of the top income decile group are the least sensitive. This result is in line with the estimated FAVAR model presented and discussed in the previous section. However, the effect of the monetary policy on price dynamics is relatively small. This is true for all income groups – increase in the interest rate of one standard deviation leads to a decline in the inflation rate in the range from 0.02 to 0.05 percentage points (p.p.), depending on the households' income group. Having in mind that North Macedonia implements a strategy of a de facto fixed nominal exchange rate, domestic inflation is largely influenced by foreign price developments which might explain this relatively weak transmission of changes in the policy rate to inflation.

Figure 7: Impulse responses of household-specific CPIs to a monetary shock



Next, we continue with the scenario analysis. As already explained, the first scenario assumes that the interest rate in the two-year period ahead is higher in comparison to the baseline by 2.5 percentage points. The key variables are presented in Figure 8. Higher interest rate will have an impact on the real economy and it will lead to a negative output gap, which in turn will reduce headline inflation as well as the inflation of the different income groups of households. Results of the second scenario are given in Figure 9. Here, the interest rate is lower than predicted in the baseline by 2.5 percentage points. As expected, interest rate below the baseline increases the positive output gap and the inflation.

Figure 8: Alternative scenario 1 – higher policy rate

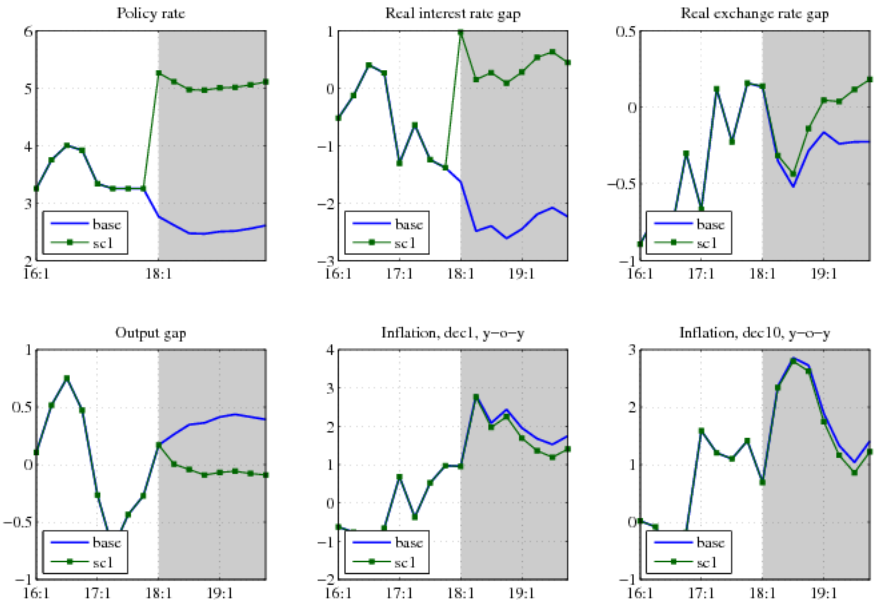
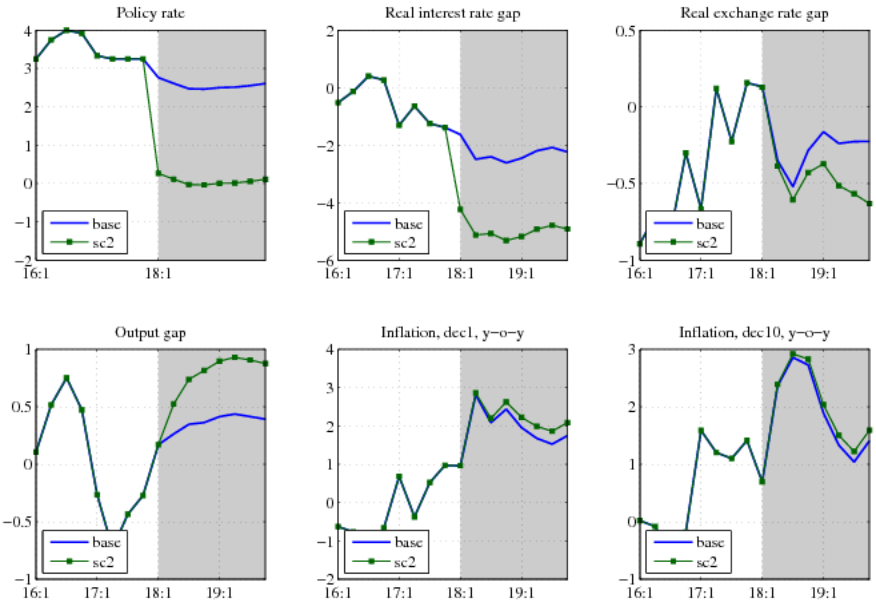


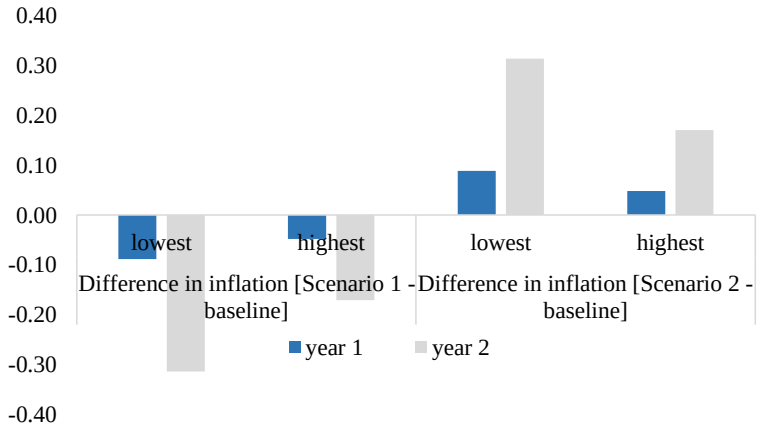
Figure 9: Alternative scenario 2 – lower policy rate



Having in mind our key question – whether monetary policy affects income-specific inflation rates differently and thus creates distributional effects, we take a closer look on the inflation rate predictions for

the first and the tenth decile group. The difference between the inflation in the baseline scenario and the inflation predictions in both alternative scenarios for the lowest and the highest income groups are plotted in Figure 10.

Figure 10: Difference in the inflation rates under different scenarios for the lowest and the highest income decile group (in percentage points)



As in the case with the impulse response analysis, model simulations confirm that monetary policy has a higher impact (in both directions) on the lower income groups. The increase in the interest rate leads to inflation of the lowest income group being lower than the baseline by 0.09 percentage points in year 1 and 0.31 percentage point in year 2[6] (average decline of 0.2 percentage points for both years) as opposed to a decline of 0.05 percentage points in year 1 and 0.17 percentage points in year 2 for the highest income group (average decline of 0.11 percentage points for both years). In scenario 2, the difference is the same in magnitude as in the first scenario which is expected given the linear structure of our model, just the sign is different. Again, similarly to the impulse response analysis, it seems that monetary policy has a relatively small impact on the inflation regardless of the income group.

One additional point is worthwhile for discussion. Food and oil price dynamics is generally driven by supply side factors and therefore the conventional wisdom is that monetary policy should not react to changes in food and oil prices. Having this in mind, a priori one might expect monetary policy to have a smaller impact on the inflation of lower income households as opposed to the inflation of higher income groups where the share of food prices is much smaller. On the other hand, Anand, Ding and Tulin in their research on inflation and monetary policy in the case of India conclude that in emerging countries, where

[6] In all scenarios and for all income groups, we notice higher differences compared to the baseline in the second year. This might be explained by the lag specification in the model. In addition, our scenarios assume that the interest rate will increase/decrease and this change will persist for a longer period. This propagates to stronger effects to the endogenous variables in the second year of the analysis.

food constitutes important fraction of the total consumption basket, monetary policy should consider reacting to food shocks (Anand, Ding, and Tulin, 2014). First, food price shocks in emerging economies are more volatile and persistent and are propagated strongly into nonfood inflation. Second, in these countries food prices seem to be the most important driver of inflation expectations. The empirical analysis that investigated the sensitivity of dissagregated inflation rates to the cyclical position of the economy confirmed that in the case of North Macedonia food prices have positive, significant and higher sensitivity to output gap than the one estimated for the headline inflation[7]. Similarly, in our analysis, the output gap effect for the lowest income group inflation rate (where the share of food is also larger) is at least two times larger compared to the one estimated for the inflation rate of the highest income group.

7. Conclusion and recommendations for future research

In our paper, we investigate a relatively new transmission mechanism through which monetary policy shocks might have distributional consequences. This channel is based on two important facts - the effect of monetary shock on prices is heterogeneous across types of goods and services and second, consumption baskets differ across the income distribution. Therefore, changes in the monetary policy stance might affect the inflation rates of different income groups differently, thus creating distributional effects.

To test for this effect, we first created income-specific expenditure shares and income-specific inflation rates. Deeper analysis of both indicators reveals interesting findings regarding the consumption and price dynamics of different income groups of households. First, we find that different income groups have different consumption baskets – lower income households spend more for food relative to higher income households. As income increases, the shares spent for food decrease, relative to the other categories of products and services. Second, income-specific inflation rates tend to diverge significantly in the presence of substantial supply shocks. For example, during the 2007-2008 period, when global food and oil prices increased dramatically, lower and middle income households faced higher inflation rates compared to higher income households. Third, lower income households are characterized by more flexible and more volatile prices relative to the prices of higher income households.

As the distributional impact of monetary policy is concerned, our findings are generally in line with the empirical literature on this topic. Both the impulse response analysis and the model simulation exercise indicate that the response of lower income households' inflation rate is higher in comparison to higher income households, meaning that changes in the policy rate might affect more the lower income households.

[7] Quarterly Report of the National Bank of the Republic of North Macedonia, October 2014.

However, given that the difference in the response between the income groups is relatively small, we can conclude that, in general the monetary policy in the Macedonian case does not have an asymmetrical effect on different income groups of households. In addition, the general impact of the monetary policy on the inflation rate in the domestic economy is also very modest. This might be expected for a country conducting a monetary strategy of a de facto fixed nominal exchange rate, as in the case of North Macedonia, where the stable exchange rate is interemediary target for maintaining the price stability.

The contribution of the research is twofold. First, this is the first paper concerning the Macedonian economy, as to the knowledge of the authors, which compiles and investigates income-specific inflation rates. More knowledge on the evolution and characteristics of income-specific inflation rates is an important complementary part to any inequality, poverty and income distribution analysis and policy design. Second, by trying to identify possible distributional effects of monetary policy shocks via a relatively novel transmission channel, this paper adds to the empirical literature on the distributional consequences of monetary policy in small and open emerging economies.

Future research on monetary policy distributional effects via this channel in the case of North Macedonia should be focused on carrying out the analysis by using the HBS micro data. In fact, this is one of the most important shortcomings of our research. Micro data will allow for more disaggregated analysis on income-specific inflation rates, especially on certain percentiles such as the top 1%, where a significant part of the income and wealth is concentrated. New results based on micro data might shade some light on the findings presented in this study regarding the distribution of price flexibility and volatility indicators or the responses of income-specific inflation rates to a monetary policy shock. An interesting area for extending the analysis would be the employment of a more structural type of a model that can describe the specifics of different income groups' price dynamics more precisely. For example, a DSGE model will allow to model income-specific price stickiness more consistently. Another possible model extension might be the inclusion of different IS curves which will describe the behavior of income variables for different households. This modification will be helpful in studying the direct impact of monetary policy stance on income distribution, as well as its distributional consequences.

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Appendix 1

The transformation codes are: 1 – no transformation and 5 – first difference of logarithm. **Slow** means that the variable is assumed to be "slow-moving", whereas **fast** means that the variable is assumed to be "fast-moving" in the estimation.

variable	transformation	slow/fast	source
CPI Prices			
CPI index - first decile group (2017=100)	5	slow	constructed
CPI index - second decile group (2017=100)	5	slow	constructed
CPI index - third decile group (2017=100)	5	slow	constructed
CPI index - fourth decile group (2017=100)	5	slow	constructed
CPI index - fifth decile group (2017=100)	5	slow	constructed
CPI index - sixth decile group (2017=100)	5	slow	constructed
CPI index - seventh decile group (2017=100)	5	slow	constructed
CPI index - eight decile group (2017=100)	5	slow	constructed
CPI index - nineth decile group (2017=100)	5	slow	constructed
CPI index - tenth decile group (2017=100)	5	slow	constructed
CPI index - total (2017=100)	5	slow	SSO
Industrial production volume indices			
Total	5	slow	SSO
Energy	5	slow	SSO
Intermediate goods, except energy	5	slow	SSO
Capital goods	5	slow	SSO
Durable consumer goods	5	slow	SSO
Non-durable consumer goods	5	slow	SSO
PPI prices			
PPI index, total (2015=100)	5	slow	SSO
Energy	5	slow	SSO
Intermediate goods, except energy	5	slow	SSO
Capital goods	5	slow	SSO
Consumer goods	5	slow	SSO
Durable consumer goods	5	slow	SSO
Non-durable consumer goods	5	slow	SSO
Labour market			
Total number of registered unemployed people	5	slow	ESA
Number of persons registered as unemployed for the first time	5	slow	ESA
Number of persons who got employed	5	slow	ESA
Number of persons deleted form the register of unemployment because of legal requirements	5	slow	ESA
Average nominal net wage	5	slow	SSO
Average duration of unemployment	5	slow	ESA
Initial claims to establish unemployment status	5	slow	ESA
Claims for unemployment compensation	5	slow	ESA

Monetary and exchange rate data			
Central Bank bills policy rate	1	fast	National Bank
Banks Foreign Assets	5	fast	National Bank
Claims on central government	5	fast	National Bank
Claims on public nonfinancial corporations	5	fast	National Bank
Claims on private sector	5	fast	National Bank
Other Banks assets	5	fast	National Bank
Banks Foreign Liabilities	5	fast	National Bank
M4	5	fast	National Bank
Currency in circulation	5	fast	National Bank
Deposits	5	fast	National Bank
Total short-term deposits	5	fast	National Bank
Total long-term deposits	5	fast	National Bank
Total household deposits	5	fast	National Bank
Total enterpise deposits	5	fast	National Bank
Denar/Euro exchange rate	5	fast	National Bank
Denar/Dolar exchange rate	5	fast	National Bank
Other data from the real economy			
Housing prices	5	fast	National Bank
Value of completed construction works	5	slow	SSO
Number of tourists	5	slow	SSO
Number of nights spent	5	slow	SSO
Retail trade	5	slow	SSO
Wholesale trade	5	slow	SSO
Average level of capacity utilization of the business entities	1	slow	SSO
Index of inventories of finished goods in industry	5	slow	SSO
Effective number of hours worked in construction	5	slow	SSO
Building permits, new private housing units	5	slow	SSO
External sector data			
Exports of goods	5	slow	SSO
Imports of goods	5	slow	SSO
Exports of machinery and equipment	5	slow	SSO
Imports of machinery and equipment	5	slow	SSO
Exports of other vehicles	5	slow	SSO
Imports of other vehicles	5	slow	SSO
Exports of cars	5	slow	SSO
Imports of cars	5	slow	SSO
Exports of oil and oil derivatives	5	slow	SSO
Imports of oil and oil derivatives	5	slow	SSO
Foreign reserves to imports ratio	1	slow	National Bank
Demand for foreign exchange from the foreign exchange offices	5	slow	National Bank
Survey data			
Economic sentiment indicator - composite measure	1	fast	European Commission
Industrial confidence indicator	1	fast	European Commission
Services confidence indicator	1	fast	European Commission
Retail trade confidence indicator	1	fast	European Commission
Construction confidence indicator	1	fast	European Commission
Production expectations for the months ahead - industry	1	fast	European Commission
Expectation of the demand over the next 3 months - services	1	fast	European Commission
Business activity expectations over the next 3 months - retail	1	fast	European Commission

Appendix 2

2.1 Calibrated coefficients

Phillips curve coefficients

	dec 1	*dec 2*	*dec 3*	*dec 4*	*dec 5*	*dec 6*	*dec 7*	*dec 8*	*dec 9*	*dec 10*
$\alpha_1^{\pi_{t+1}}$	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
$\alpha_1^{\pi_{t-1}}$	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
$\alpha_1^{\pi_t^{oil}}$	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.04	0.04
α_1^{ygap}	0.46	0.46	0.40	0.40	0.35	0.35	0.30	0.30	0.25	0.25

IS curve coefficients

$\alpha_2^{ygap_{t-1}}$	0.5
$\alpha_2^{qgap_{t-1}}$	0.1
$\alpha_2^{rgap_{t-1}}$	-0.1
$\alpha_2^{yfgap_{t-1}}$	0.3

Policy rule and risk premium

$\boldsymbol{\alpha_3^{riskprem}}$	-0.4
$\boldsymbol{\alpha_4^{rsrgap_{t-1}}}$	0.5
$\boldsymbol{\alpha_4^{inf}}$	-1.5
$\boldsymbol{\alpha_4^{demand}}$	-11.5
$\boldsymbol{\alpha_4^{ygap_{t-1}}}$	0.2

Steady state values

r^{SS}	3
π^{SS}	2
q_dot^{SS}	0
yeq_dot^{SS}	3
π_{OIL}^{SS}	2
i_{star}^{SS}	2.5
$risk_{prem}{}^{SS}$	$= r^{SS} - (i_{star}^{SS} - \pi^{SS})$

2.2. Estimated output gap coefficients (OLS estimation, standard errors in parenthesis)

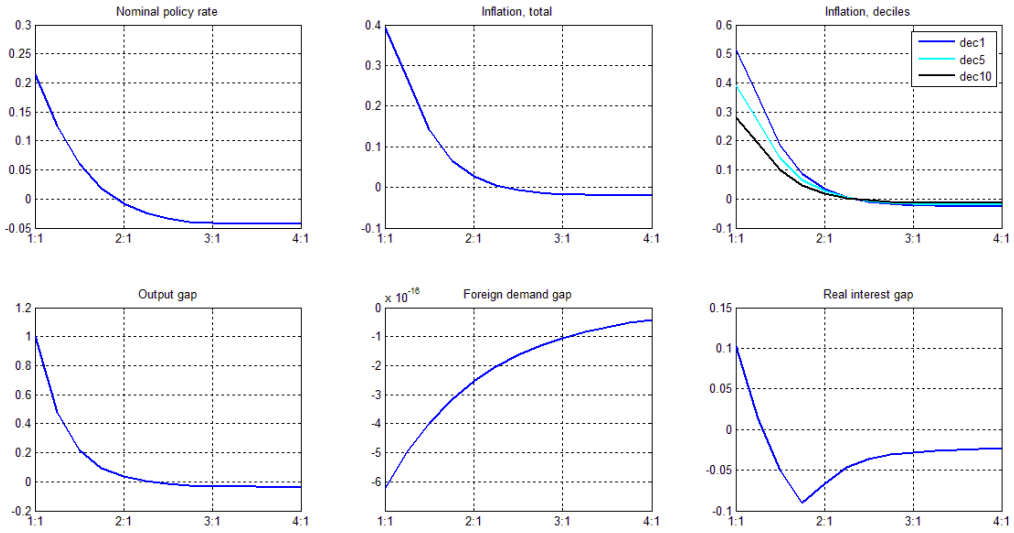
	independent variables: foreign inflation, oil prices, output gap		independent variables: foreign inflation, oil prices, output gap + inertia and expectations (proxied with one lead of the inflation rate)	
inflation - decile 1	1.125	(0.824)	1.699	(0.942)*
inflation - decile 2	0.977	(0.759)	1.490	(0.847)*
inflation - decile 3	0.863	(0.716)	1.327	(0.794)
inflation - decile 4	0.799	(0.685)	1.265	(0.741)*
inflation - decile 5	0.752	(0.664)	1.130	(0.711)
inflation - decile 6	0.603	(0.609)	0.972	(0.647)
inflation - decile 7	0.618	(0.603)	0.975	(0.633)
inflation - decile 8	0.422	(0.536)	0.699	(0.546)
inflation - decile 9	0.434	(0.524)	0.748	(0.531)
inflation - decile 10	0.282	(0.501)	0.597	(0.509)

* coefficient is significant at 10% level of significance

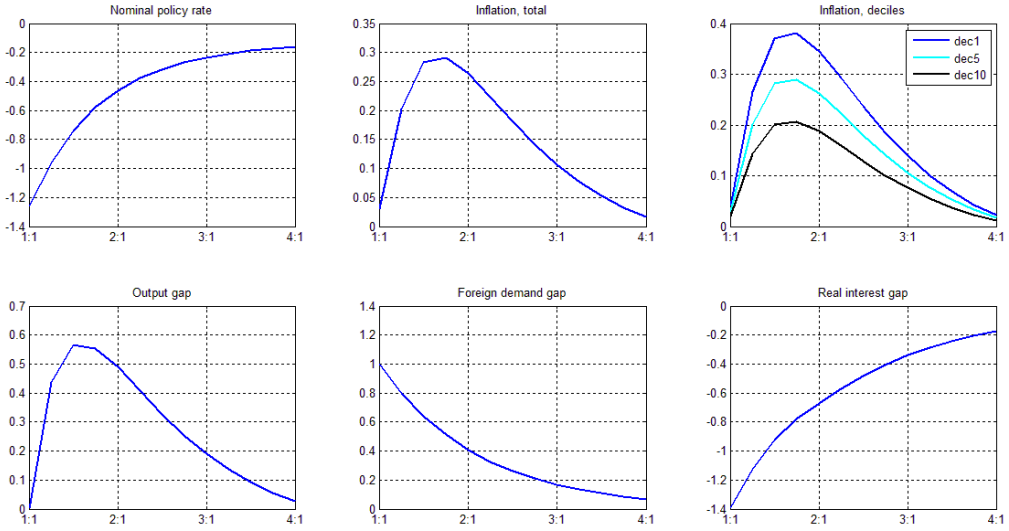
Appendix 3

3.1. Impulse responses

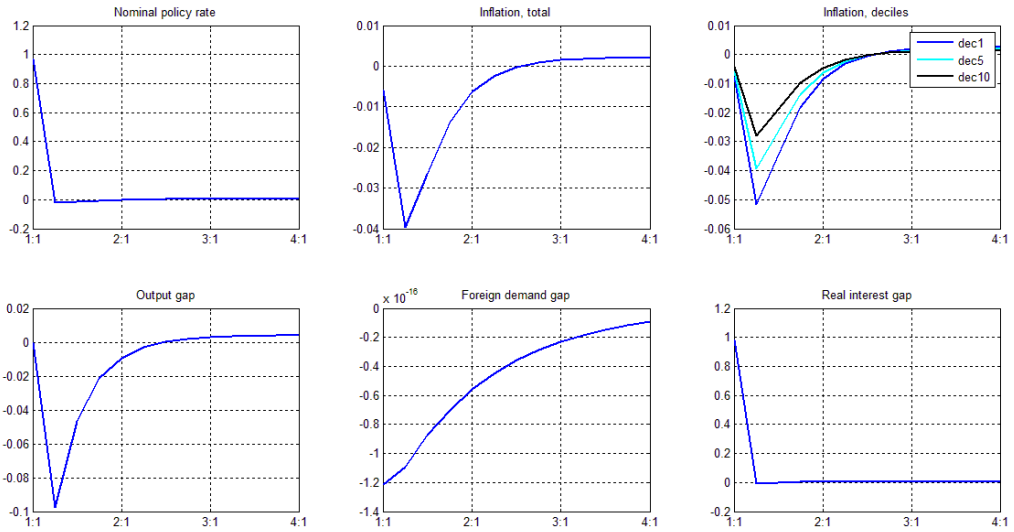
Demand shock



Foreign demand shock

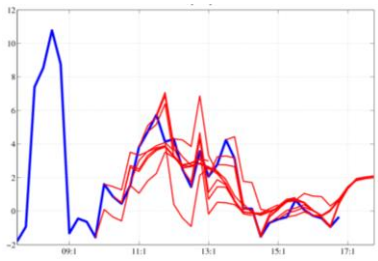


Monetary policy shock

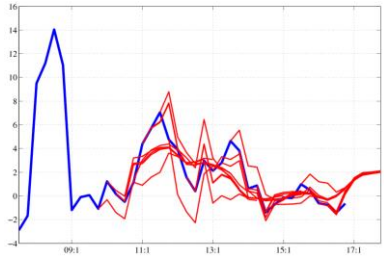


3.2. In-sample model simulations

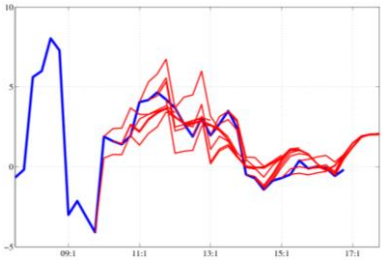
Inflation, total (y-o-y, %)



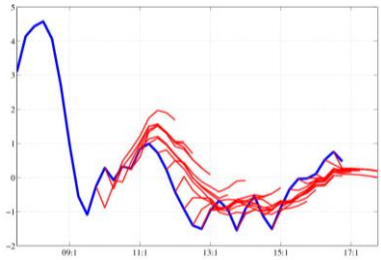
Inflation, decile 1 (y-o-y, %)



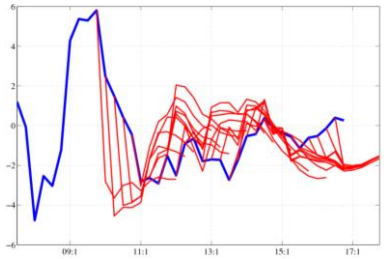
Inflation, decile 10 (y-o-y, %)



Output gap (% of potential GDP)



Real interest rate gap



Real GDP growth (y-o-y, %)