The currency board in Bulgaria and its impact on sectoral economic activity

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Abstract

This paper investigates the impulse reaction of five economic sectors to various monetary policy shocks under the currency board regime in Bulgaria. For that purpose, we have estimated five reduced form VAR models with quarterly data over the period 2001Q1 to 2019Q4 for the sectors of agriculture, manufacturing; construction; real estate, and trade, transport and accommodation activities. The relevant impulse response functions represent three monetary transmission channels, in particular via the overnight interbank market rate, the consumer price index and the real effective exchange rate. We found that there is strong heterogeneity between sectors response to the different monetary policy shocks even under a currency board regime. The differences in the reaction are both in terms of depth, direction and duration. The monetary policy has strong positive impact on construction, and to a lesser extent on manufacturing. The response of the agriculture; trade, transport and accommodation activities is rather negative especially in the long term.

Keywords: monetary policy, sectoral production, vector auto regression, impulse response

Introduction

The question of the effectiveness of monetary policy and its transmission channels has long been discussed and studied in the economic literature. While there is a growing consensus that monetary policy is effective at the aggregate level, at least in the short term, research and evidence at the sectoral level are much more limited. This neglects the possibility of asymmetric monetary shocks at a more disaggregated level, both sectoral and regional. It should be borne in mind that both individual regions and countries specialize in different industries. A monetary policy shock that has a heterogeneous effect at sectoral level would have a different impact

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on economic activity in each region depending on its specialization. Similarly, through foreign trade and capital flow channels, this shock may affect other countries unevenly.

Therefore, the asymmetry of monetary shocks is even more important for countries using a common currency, such as the member states of the European Monetary Mechanism, those seeking to become its members like Bulgaria and Croatia, and such as Bosnia and Herzegovina, and Northern Macedonia, whose currencies are pegged to the euro. The countries are not homogeneous in terms of the structure of production even within the EA. The heterogeneous response across industries has already been observed between EA member states and was pointed as the main reason for the uneven response of monetary policy on a country level (Peersman and Smets, 2005). It follows that the same shock may have a different impact across countries through that sectoral sensitivity channel. The extent and speed of the effects might not be limited to the countries in the common currency area, but also to others depending on their monetary independence (Frankel *et al.*, 2004). Based on the experience in the United States Krugman (2001) holds that the participants in a common currency will become more vulnerable to regional-specific shocks as they become more specialized. Some similar concerns regarding the effects of the future euro adoption in Bulgaria are raised in Gechev *et al.* (2020), though Durova (2019) states that Czech Republic and Bulgaria are currently the most appropriate countries to join the EMU due to their high business cycle synchronization with the Euro area (EA) among the new member states (NMS) that haven't adopted the euro yet. The recent literature in the field of monetary theory shows the need to supplement the already confirmed effects on aggregate economic and monetary variables in order to seek more appropriate, timely and adequate policies. In this regard, it would be beneficial to monitor the monetary policy transmission at a more disaggregated level and its relation with the consumption pattern, investments, size and financial sustainability of companies, production sectors and regions. Actually, the heterogeneity in response "may be a more important driver of cross-country differences in monetary transmission than country-specific factors" (Pellényi, 2012, p. 19).

The above facts give the aim of the study, which is to analyse the sectoral responses to monetary policy shocks under the currency board arrangement in Bulgaria. The currency board in Bulgaria was introduced in the mid-1997 after a period of hyperinflation, sharp currency depreciation, and financial instability. Since then the Central bank is not able to perform open market operations, the monetary policy was eliminated as the authorities can only determine the minimum reserve requirements and banking regulations. However, the choice of a currency board regime is in itself a kind of monetary policy, which has its consequences as a higher vulnerability to external shocks (see Khan and Nenovsky, 2017). Therefore, the specific tasks that will be covered are to determine the transmission mechanisms through which monetary policy affects individual sectors; to develop appropriate

vector models for impact assessment and to determine whether there is heterogeneity with respect to the response of the individual sectors. Specifically, the study will shed more light on the question of whether there are any significant differences in the reactions of some Bulgarian industries to monetary policy shocks. The results of the analysis may help in solving some questions like how sensitive the individual sectors are to the different transmission channels and whether the pegging of the exchange rate to another currency has an effect on the sectoral structure of the economy.

1. Brief literature review

There are several studies that have already investigated that question for different countries. For example, a study on the economy of Morocco shows that the response to a tightening of monetary policy is uneven across sectors but more surprisingly it is less pronounced in the Agriculture and fishing sectors (see Moussir and Chatri, 2017). For the economy of India Singh and Rao (2018) confirmed the heterogeneity effects of monetary policy on a sectoral level. They showed that mining and quarrying; manufacturing; construction; trade, hotel, transport, and accommodation are among the heavily affected sectors of an interest rate shock. At the same time, the sector of the community, social, and business services benefits from monetary policy shock at least in the short term. Furthermore, each transmission channel has a different effect in terms of depth and duration of the shock. According to Ghosh (2009) those differences seems to be related to the size and capital intensity use of the sector, while Dhal (2011) extend these findings with stating that capital goods and consumer durables are more affected than basic, intermediate and consumer non-durable goods. Also, a transmission lag could be more evidenced for the consumer non-durable goods. Another explanation for the different sectoral sensitivity to the changes of monetary policy is the dependence of firms on bank credits (Bernanke and Blinder, 1988) and the degree of access to loans, which allows the banks to adjust their balance sheets (Kashyap and Stein, 1995). There is also a heterogeneity among the economic sectors in terms of their capital and labour intensiveness and according to Berument *et al.* (2007) the capital-intensive sectors are more vulnerable to interest rate shocks than the labour-intensive ones.

Another type of studies focuses on price rigidity as a source of the sectoral heterogeneity response. Using a structural factor model Pellényi (2012) found that sectors more reliant on short-term external financing achieve higher output growth after a drop in the interest rates. The author also suggests that industries with stronger balance sheets are less inclined to increase prices after the monetary expansion due to the falling financing costs. However, there are evidence that the different activities even within the same sector have a heterogeneous response to a shock in the interest rates, as Hayo and Uhlenbrock (1999) shows in their research of the manufacturing and mining sectors in Germany. With data at the 2-digit level of aggregation, they

identified eight industries that exhibit positive output reaction to a contractionary monetary policy shock. The effect on relative prices is negative in four cases and positive in eleven industries. The use of capital, export orientation, and receipt of subsidies appear to determine these asymmetric effects. The heterogeneity in price rigidity was also pointed as the primary factor that explains the heterogeneity in the responses of sectoral output and inflation to a monetary policy shock for the US economy. Bouakez *et al.* (2014) but also Boivin *et al.* (2009) states that disaggregated prices are flexible in response to sector-specific shocks, but appear sticky in response to monetary disturbances.

The sector's dependence on foreign trade has also been cited as a source of heterogeneity to monetary policy innovations. Some industries are more dependent on exports and / or imports than others, making them vulnerable to changes in external demand and international prices. It is related to the exchange rate policy of the Central Bank, which may increase the export competitiveness of a given sector, at least to some extent. However, some sectors are not tradable or much less tradable, which means we should expect that they are less dependent to exchange rate movements.

Under the currency board arrangement, the Central Bank does not have monetary policy independence and rather must track the policy implemented by the monetary authorities to which the currency is pegged. In fact, Frankel *et al.* (2004) states that only a few developed countries, like Germany and Japan, can have actual monetary independence. They show that regardless of the exchange rate regime, the interest rate in a small economy adjusts to the interest rate of a large and developed country in long-term. The process takes place faster under hard pegs compared with the floating regime but is still valid in all cases. Based on these findings, Golitsis *et al.* (2020) applies a GVAR model to investigate the monetary spill over of the EURIBOR shock on several South-Eastern European Countries. Their analysis shows that a negative shock on Euribor would have a positive and sustainable effect on industrial production in Bulgaria after one year. Similar results were given by Khan and Nenovsky (2017), who added that a shock in the European interest rate have more pronounced and persistent response to output growth and inflation in economies operating under a currency board compared with floating exchange rate regime. Minea and Rault (2011) reach to the conclusion that the Bulgarian economy is more sensitive to monetary shocks from the U.S. Federal Reserve as compared to the European Central Bank interest rate shock. This could be due to the strong trade relations of Bulgaria with countries like Turkey and Russia that are linked to the US dollar.

Overall, the economic literature confirms the existence of sectoral heterogeneity in response to monetary policy shock. Explanations for this phenomenon are the different capital intensity of the sectors, their access to credit, price rigidity, their dependence on foreign trade and the exchange rate regime that was implemented in the country. Although some studies address the issue of different

access to bank loans, the issue of sectoral indebtedness is rather implicit. It is assumed that banks make their own risk assessment on the basis of which they determine the access to credit. At the same time, the heavily indebted sectors may not even seek new loans, trying to repay the old ones and shrinking their investment activity. The stated reasons for the different sensitivity of the sectors to monetary policy innovations are considered separately, as if there is no special connection between them. Finally, far more attention is paid to economies whose exchange rates are free-floating, while fixed-rate countries remain less studied. This report should complement and enrich the literature on monetary policy within the currency board and its effects at sectoral level. Due to the different characteristics of the sectors, it can be assumed that monetary shocks will affect the economic activity in each of them through different transmission channels. This issue will be discussed in the following part of the report.

2. Monetary transmission mechanisms and data

A broad range of theoretical and empirical studies on the monetary transmission mechanism, especially on the aggregate level, have been developed over the years. The choice of variables may vary according to the importance given to interest rates, credits, exchange rates, and asset prices and it broadly depends on the level of financial development and openness of the country (Mishkin, 1995). It was already mentioned that under a fixed exchange rate the interest rate is strongly dependent on one of the countries that are pegged. The transmission of a shock in EURIBOR to the domestic interbank market rate in Bulgaria has already been confirmed by Golitsis *et al.* (2020) and also Koukouritakis *et al.* (2015). Minea and Rault (2011) also point to the differences between LIBOR EUR 3 months' interest rate and Bulgarian interest rate up till the middle of 2003, which is due to the significant reforms implemented in the banking system at that time. These studies show that despite the lack of an independent monetary policy, interest rates in the country can be strongly influenced by the changes in the policy of the European Central Bank. Accordingly, through the channel of the interbank market rate and interest rates on loans for firms, this shock will be transmitted on a sectoral level. Usually, under an inflation-targeting regime, the main instrument of the central bank is to use an overnight repo interest rate. This is done in order to control the overnight interbank market rates and thus the rates of deposits and loans in the banking system (Vargas-Herrera, 2007). This way the central bank can guide the liquidity in the system and inflation. As Bulgaria runs a currency board regime and can't target the interest rate itself, in this study we will use the overnight interbank market rate.

Several studies have already shown that a shock in monetary aggregates like M1 and M2 can impact not only the inflation dynamics but also the overall output (see Audu *et al.*, 2018; Bissoondeeal *et al.*, 2019; Chan *et al.*, 2019; Obradović and Đorđević, 2020;). The monetary authorities in Bulgaria cannot influence neither the

monetary aggregates nor the inflation. However, the above-mentioned analyses, which also include Bulgaria, shows that domestic inflation is sensitive to changes in the external environment. Industries with higher price stickiness respond more strongly to a monetary policy shock (Henkel, 2020). It is worth mentioning the significantly higher price convergence for tradable products compared with the non-tradable (Bozev and Bilyanski, 2021). The price behaviour is a factor influencing the sensitivity of the sector to shocks. The current assessments would benefit from its inclusion as it can provide valuable information about the extent of price absorption.

The exchange rate channel is another important transmission mechanism in open-economy models, especially for small and highly open economies like Bulgaria. Pegging the nominal exchange rate to the euro naturally leads to the expectation that a change in euro area monetary policy will affect the REER. In fact, Koukouritakis *et al.* (2015) shows that one s.e. shock to the EMU 12's interest rate has a negative impact over the RER in Bulgaria. They also show that such a shock will have a negative response to the Harmonized index of consumer price (HICP) and positive to the domestic interest rate and industrial production. On the other hand, one positive s.e. shock to the nominal exchange rate of the EUR against the USD or to the EMU 12's real effective exchange rate will have a negative and persistent response to the RER, HICP, domestic interest rate and industrial production in Bulgaria. The only exception is that the domestic interest rate exhibits a positive response to the EMU 12's real exchange rate. In addition to the above, the country's REER is sensitive to changes in international foreign exchange reserves, but to a lesser extent (Gkolitsis, 2018).

The literature described so far shows the strong dependence of the country to changes in the external environment. Despite the lack of independent monetary policy, innovations in the monetary policy of the euro area, and even of the US Federal Reserve, have almost instantaneous impact on monetary variables and production in Bulgaria. In this case, the response of the economic activity in each sector to a monetary policy shock in practice reflects their sensitivity to changes in the international monetary policy. The domestic monetary variables have only a transmission role. In order to assess the response of the sectoral economic activity to a monetary policy shock we will use the Gross value added of five different sectors – Agriculture (code A by the NACE Rev. 2 classification); Manufacturing (C); Construction (F); Real estate (L), and Wholesale and retail trade, transport, accommodation and food service activities (G-I). The monetary variables included are the overnight interbank market rate on deposits (IR), the consumer price index (CPI), and the real effective exchange rate (REER).

We will use quarterly data over the period 2000Q1 to 2019Q4. The data for the overnight interbank market rate on deposits in leva (BGN) are taken from the Bulgarian national bank, as most of the studies examined so far apply the same interest rate as a policy rate proxy. The monthly consumer price index (CPI) with base year 1995 was brought to quarterly data by averaging and to 2015 base year.

The real effective exchange rate is based on a trade-weighted basket with 42 countries and is deflated by the Consumer price index (CPI). The data for the REER are taken from Eurostat. All the data are seasonally adjusted. The sources of data are the Bulgarian National Bank[1], Eurostat, and the National Statistical Institute of Bulgaria.

3. The transmission mechanism in practice

With the implementation of the currency board in the country the rate of inflation started to decrease and the economic growth bounce back. In the first ten years since 2000, the Current account was running major deficits led mainly by the negative trade balance. However, the major source of financing for the economy was the FDI inflow, directed thoroughly to the Financial, Real estate and Construction sectors. After the Global financial crisis, the development trend has changed significantly. The trade deficit shrank while the FDI inflow deteriorate. The Current account deficit turned into a surplus after 2012 supported by higher surpluses on the Services and Secondary income. The increase of the latter was led by the EU membership of the country in 2007 and the large capital inflows from the EU funds, some of which are also accounted in the Capital account. As a result, for almost the entire period the Foreign reserves were increasing. At the same time, this development cannot explain the whole process of how the foreign exchange is monetized.

The assets side of the consolidated banks' balance sheet consists of Net foreign assets (NFA) and Net domestic assets (NDA). On the Foreign assets side, the main instruments that the banking sector in Bulgaria is using are the Debt instruments and Deposits. Foreign assets are usually held as secondary reserves, while the deposit part is held outside the country in order to back the denominated accounts in national currency. Their annual growth rate was pretty large in the period 2000-2008 but slows down afterward. Most of the commercial banks in Bulgaria are foreign-owned being a part of international groups established in the EU. The parent banks can provide their local subsidiary with liquidity in the form of foreign liabilities, predominantly deposits in Bulgaria, at a rate close to the money market rates in the EA. The FX is traded for local currency under the currency board at a fixed exchange rate with no limitations. As some of the non-residential deposits are also subject to reserve requirements this process also influences the foreign assets and monetary base (see Gedeon, 2009, p. 108). Over the period 2000-2008 where the average growth of foreign liabilities was about 29.9%. After that, both the foreign liabilities and non-residential deposits started to gradually decrease. In a way, funding the local branches of parent banks from abroad pushes the monetary base

[1] The anual report of The Bulgarian National Bank are available at https://www.bnb.bg.

and monetary supply, which increases the supply of loans and decreases the interest rates.

The role of net domestic assets was more pronounced in the period around the global financial crisis and its aftermath. The share of claims on the private sector to total assets reach its peak at 84.7% in 2008, later on, they gradually decrease to 52.1% of total assets in 2019. In the period 2008-2014, the average share of quasi money in the total liabilities was about 46.9%. After that, their share began to decrease while the share of demand deposits gradually increases.

Under the currency board, the BNB cannot act as a lender of last resort but can determine the minimum reserve requirement and thus influence the monetary base. Since 1 July 2000 the level of required reserves held by banks in the Central bank was lowered to 8% from 11% of the depository base (BNB, 2000, pp. 67-68). This led to an increase of the excess reserves by 47.4% as compared to the previous year. In 2006 the monthly level of excess reserves ranged between 0.5% and 1.2% of the required reserves (BNB, 2006, p. 37). Since 1 of September 2007, in order to curb the lending activity, the BNB has increased the minimum reserve requirements from 8% to 12% which led to a decrease in the excess reserves to below 1% of the minimum requirement (BNB, 2007, p. 32). In the following year, the national bank reduced the minimum required reserves on all funds attracted by banks to 10% from 1 December 2008 and from 10 to 5% on funds from abroad starting from 1 January 2009. The reserve requirements on funds attracted from state and local government budgets were removed (BNB, 2008, p. 34). As a result of the amendments about BGN 1.8 bn of bank funds were released by the end of 2008, while the average effective minimum reserves fell to 7%. Over the period 2009-2012, the effective rate of the minimum required reserves increases to 8.9% while the exceeding minima reached 8.7%. The upward trend in banks' excess reserves continued, ending up at 127.8% of excess reserves above the minimum required under Ordinance No. 21 in December 2015, mainly due to ECB monetary policy.[2] The high level of excess reserves was driven by the significant inflow of deposits into the banking system from abroad and the low credit demand (BNB, 2015, p. 46). Since 4 January 2016 a new amendment to Ordinance no. 21 came into force. It stipulates that BNB will apply the ECB deposit facility rate of -0.3% over the excess reserves hold by the commercial banks. In 16 March 2016 the rate was cut to -0.4%. These changes led to a decrease of the excess reserves to 89.8% above requirements by the end of the year (BNB, 2016, p. 46). The interest rate applied to the excess reserves have been cut again in 2017 and in 2019 to -0.7%. As a result, the funds held by banks exceeded minima by 27.2% in 2019 (BNB, 2019, p. 50). The level of excess reserves shows some volatility in the period 2000-2019 and the effect of the ECB monetary policy

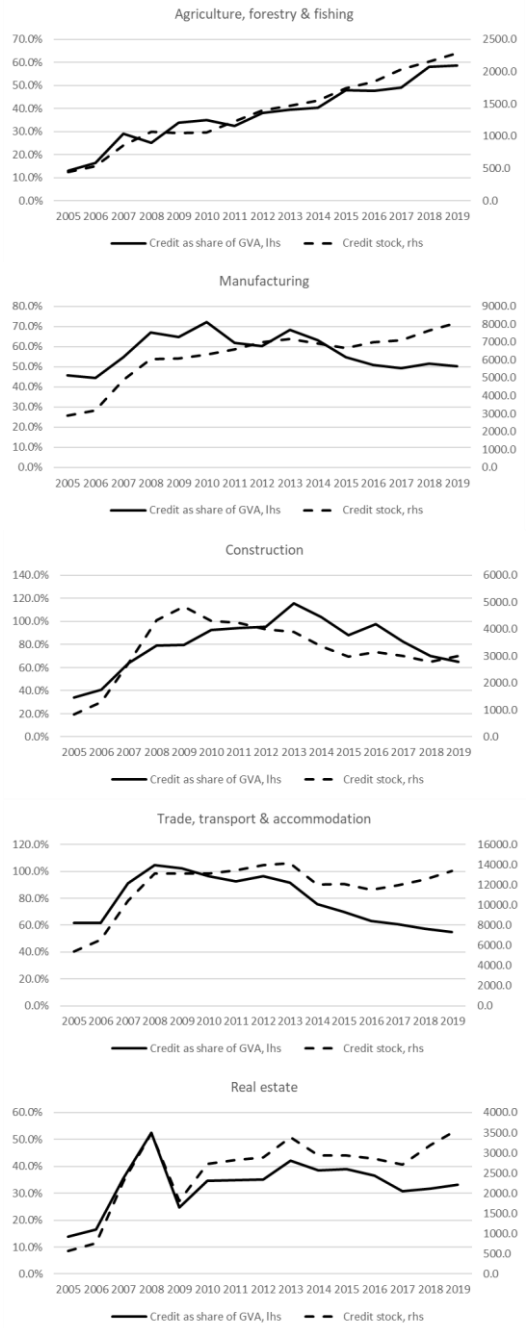
[2] In June 2014 the ECB implemented negative interest rate on the deposit facility which led to significant falls in money market rates, as a result the three-month EURIBOR interbank rates turned negative in the following year.

on the liquidity of the banking system in Bulgaria. Although the reserve requirements are higher compared to those in EA, the high liquidity in the system drove the interest rates on deposits and loans for households and corporations downwards and close to the average in the EA. However, this does not guarantee a direct transmission to the real economy in the form of higher credit growth. In the aftermath of the GFC and due to the increase of the share of non-performing loans to 13.64%[3] of the total gross loans in the system by the end-December 2009, the banking sector in the country became cautious about risk assessment. Thus, not all of the economic sectors in the country benefit equally from the low-interest rates on loans.

Figure 1 shows the amount of credit obtained by each of the sectors under consideration in this article and their share as a percentage of the nominal GVA. The data for the amount of credit per sector are taken from the BNB statistics expressed in mln. leva/BGN in the last quarter of each year. Due to the data limitations, the starting year is 2005.[4] The nominal GVA is obtained by Eurostat in national currency with annual frequency. The observation shows high credit demand from each sector prior to 2008. The demand for credit increase not only in absolute terms but also as a share of the nominal GVA, which point to increasing indebtedness in the economic sectors. In fact, the high credit activity is in line with the comparatively low level of excess reserves held by banks in this period. The average growth rate of the monetary aggregate M2 is 22.8%. In the following years up to 2017 the amount of credit borrowed from the Manufacturing, Wholesale and retail trade, transport, accommodation and food service activities, and Real estate sectors just slightly change. Meanwhile, the claims on Agriculture are rising and those of the Construction sector is falling. The net amount of credit to both sectors however is around zero. It was mentioned that the banking sector in the country was filled with funds from abroad and the levels of excess reserves reached a record high. However, the low growth rates of both external and internal demand made new private investments and expansion of companies less profitable while the demand for borrowed funds less attractive. In addition, the high rate of nonperforming loans made banks more cautious and risk-averse. The average growth rate of the monetary aggregate M2 was just 7.3% in the period 2009-2017. The last two years are characterized by new credit expansion and higher growth of the aggregate M2 by 9.4% on average.

[3] BNB, Press release: Condition of the Banking System as of December 2009, https://www.bnb.bg/bnbweb/groups/public/documents/bnb_download/bs_200912_a6_en.pdf.
[4] The compilation of data for the period 2005-2008 apply the NCEA-2003 methodology used by the BNB and National statistical institute (NSI), which corresponds to NACE Rev. 2 methodology used by Eurostat. For the period 2009-2019 the BNB and NSI apply NCEA-2008 methodology, which corresponds to NACE Rev. 3 methodology of Eurostat.

Figure 1. Credit in stock and as a share of GVA, in % and mln. leva/BGN



Source: Authors' representation based on BNB and Eurostat data

This part of the article explained how the ECB's monetary policy is transferred to a country with a currency board such as Bulgaria. The described developments support and to some extent confirm the validity of the theory of endogeneity of money supply in the presence of a currency board. However, the ECB's highly supportive monetary policy is not able to fully offset the effects of stifled external and domestic demand.

4. Construction of the model and estimation approach

In order to assess the response of economic activity to a monetary policy innovation for each of the five sectors we will apply a standard Vector autoregressive model (VAR). For each particular sector, we will estimate a separate Vector autoregressive model (VAR). The VAR technique is not purely theoretical but mostly econometric approach that takes all the variables within the model as endogenous. Most studies use VAR models to assess the effects of monetary policy at the sectoral level (see Berument *et al.*, 2007; Dhal, 2011; Hayo and Uhlenbrock, 1999; Ghosh, 2009; Moussir and Chatri, 2017; Singh and Rao, 2018). However, the presence of cointegrating relation is highly possible, meaning that there is a common stochastic trend or long-run relation between some of the variables. In such case, it would be more appropriate to estimate a VECM instead of VAR. Estimating a VECM have several shortcomings in our case. First, the cointegration tests, like the Johansen cointegration test (Johansen, 1988), are sensitive to the number of lags in the VAR model. In this case, we may end up with different lag-length in each model. Second, the test is also depended on the assumptions for the type of the deterministic trend and the intercept. Third, in some of the VARs there could be only one cointegration vector while in other there could be more than one (see Lütkepohl and Krätzig, 2004; and also, Ivanov and Ovchinnikov, 2018). Thus, in order to identify the appropriate cointegration relationship for each model we may have several VECMs with very different specifications. In this case, each model will converge to a different type of equilibrium, which will make the results of the impulse response function (IRF) incomparable. Therefore, the compilation of several VAR models was considered as a better solution.

A main issue with the reduced form VAR is the ordering of the variables, as it may impact the structural inferences of the impulse responses. In order to make sure that the ordering is not an issue we follow Pesaran and Shin (1998) who constructs an orthogonal set of innovations that do not depend on the VAR ordering. The generalized impulse responses from innovation to the j-th variable are derived by applying a variable-specific Cholesky factor computed with the j-th variable at the top of the Cholesky ordering.

Another peculiar feature of the time series models such as VARs is the lag length selection. Usually, researchers apply different criteria like Schwartz Information Criteria (SIC), Akaike Information Criteria (AIC), or Hannan and Quinn

(HQ) to assess the appropriate lag length. In our case, this could lead to a different lag length for each VAR model which may cause distortions of the conclusions. The choice of an appropriate number of lags is of great importance. If the lag length is too short, it may happen that the residuals are not free from serial correlation problem, as the first-order autocorrelation is a common issue of most economic time series data. In addition, a lower lag length could be inadequate to capture the dynamic interactions among the variables (Brüggemann *et al.*, 2006). At the same time, a higher number of lags will solve the issue with the autocorrelation, and will adequately capture the dynamics but "may be problematic owing to its impact on the overall error probability of a sequential procedure" (Lütkepohl and Krätzig, 2004, p. 110). In this case, we choose a common lag length of 5 that minimizes the autocorrelation problem. (see Table 3)

In this particular study we are about to estimate five VAR models that will give us indication about the monetary policy effects over the sectors of Agriculture, forestry and fishing; Manufacturing; Construction; Wholesale and retail trade, transport, accommodation and food service activities; and Real estate activities. The reason for their choice is given by Minassian (2017) but also in Kolev (2020) and Peykov (2021), who shows that these are key sectors for the economic development of Bulgaria. In the VAR models all the variables are endogenous. Their ordering starts with the GVA, which is different in each model, followed by the overnight interbank market rate (IR), the consumer price index (CPI), and the real effective exchange rate (REER).

The basic form of the VAR is as follows Y_t = f(Total GVA, IR, CPI, REER) and in matrix form:

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + u_t \quad (1)$$

Where A_i is n x n coefficient matrix and u_t is an error term, which is assumed to be time-invariant white noise process with zero mean. All variables are used in their logarithmic forms, except for the interest rate. In this current form the model assumes no contemporaneous interaction between the Total GVA and the rest of the variables. On the other hand, the interest rate responds simultaneously to the changes in the GVA. The price index (CPI) is contemporaneously affected by the sectoral GVA and overnight interbank market rate, while the CPI deflated real exchange rate is influenced by all other variables.

Our first step is to determine the degree of stationarity of the variables. We have applied the Phillips-Perron test (PP) unit root test (Phillips and Perron, 1988). The test in levels includes constant, constant, and linear trend included and neither of them. The results of the test are present in Table 1.

Table 1. Unit root tests for assessing the degree of stationarity of the variables, N=79

Variable	Phillips-Perron test (PP) Level of significance (p-value), (Adj. t-stat in brackets)		
	No Constant	Only Constant	Constant and trend
Agriculture	0,2333 (-1,297)	0,2167 (-2,176)	0,1889 (-2,837)
Manufacturing	0,9848 (1,723)	0,6908 (-1,153)	0,4459 (-2,268)
Construction	0,7931 (0,386)	0,3822 (-1,791)	0,8242 (-1,492)
Real estate	0,9972 (2,540)	0,9801 (0,363)	0,7493 (-1,684)
Trade, transport and accommodation	1,000 (4,483)	0,7043 (-1,120)	0,0020 (-4,607)
Interest rate (IR)	0,0949 (-1,641)	0,4139 (-1,727)	0,1510 (-2,957)
Consumer price index (CPI)	0,9998 (3,399)	0,3650 (-1,827)	0,9390 (-0,991)
REER	0,9839 (1,848)	0,2055 (-2,207)	0,9253 (-1,081)

Source: Authors' calculations based on Bulgarian National Bank, Eurostat and National Statistical Institute data.

The results show that neither of the variables is stationary or integrated of order zero I(0). The only exception is the data of the Wholesale and retail trade, transport, accommodation and food service activities after the unit root test is performed with a constant and linear trend. This is a bit surprising as visually they look like integrated series. The next step is to differentiate the series in order to obtain stationary ones and to check again for the presence of a unit root. The results of the evaluated test in first differences are presented in Table 2.

The examination of the first differences of the time series shows that the null hypothesis for presence of a unit root cannot be accepted. This means that the selected variables are stationary of order one I(1). As the data are non-stationary, a Johansen cointegration test was performed, which confirmed the presence of cointegration in all cases, and in some cases more than one cointegration vector was confirmed. In this case, we should move on with the estimation of several VECM models, but the reasons for refraining from this approach have already been clarified. VAR in differences, on the other hand, could suffer from a loss of significant information about the long-term relations between the variables (Ivanov and Ovchinnikov, 2018, p. 211).

Table 2. Unit root tests for assessing the degree of stationarity of the variables in first differences, N=78

Variable	Phillips-Perron test (PP) Level of significance (p-value), (Adj. t-stat in brackets)		
	No Constant	Only Constant	Constant and trend
Agriculture	0,0000 (-10,695)	0,0001 (-13,555)	0,0001 (-15,590)
Manufacturing	0,0000 (-9,379)	0,0000 (-9,765)	0,0000 (-9,974)
Construction	0,0000 (-10,556)	0,0001 (-10,599)	0,0001 (-10,567)
Real estate	0,0000 (-9,399)	0,0000 (-9,988)	0,0000 (-10,054)
Trade, transport and accommodation	0,0000 (-11,989)	0,0001 (-21,772)	0,0001 (-25,885)
Interest rate (IR)	0,0000 (-11,566)	0,0001 (-11,570)	0,0001 (-11,504)
Consumer price index (CPI)	0,0004 (-3,625)	0,0000 (-5,286)	0,0001 (-5,578)
REER	0,0000 (-7,974)	0,0000 (-8,431)	0,0000 (-8,974)

Source: Authors' calculations based on Bulgarian National Bank, Eurostat and National Statistical Institute data.

Table 3. VAR residual serial correlation LM test

Null hypothesis: No serial correlation at lag h										
Results for the VAR model with first variable:										
	Agriculture		Manufacturing		Construction		Trade; hotels and restaurants		Real Estate	
Lag	LRE* stat	Prob.	LRE* stat	Prob.	LRE* stat	Prob.	LRE* stat	Prob.	LRE* stat	Prob.
1	10.74027	0.8257	13.40322	0.6444	22.7266	0.1219	8.786171	0.9222	11.17514	0.7991
2	22.09494	0.1409	11.0152	0.8094	20.23714	0.2106	22.05257	0.1422	22.94483	0.1159
3	12.87463	0.6826	19.82486	0.2297	13.64425	0.626	14.22437	0.5829	30.18326	0.0173
4	18.12536	0.3176	18.66572	0.2879	22.86975	0.1179	21.49308	0.1611	23.40724	0.1039
5	16.08869	0.4478	13.90463	0.6072	30.71405	0.0148	19.56157	0.2415	23.56231	0.1001
6	15.3017	0.5036	16.56231	0.4161	11.30663	0.7907	24.89167	0.0723	8.7205	0.9247

Source: Authors' calculations based on Bulgarian National Bank, Eurostat and National Statistical Institute data.

If there is cointegration relationship between the variables, the coefficient estimates are consistent in the case of VAR in levels (Fanchon and Wendel, 1992, p. 211). The unconstrained Least Squares (LS) estimator of the VAR will have the same asymptotic properties as a Maximum Likelihood (ML) estimator which observes the cointegration restriction (see Lütkepohl, 1993, p. 369). The equation for calculating

the impulse response functions for the VAR will be equivalent to the case with is a stationary process, while the responses will not necessarily converge to zero over time (see Lütkepohl, 1993, p. 376). After estimating the VAR models Breusch-Godfrey Serial Correlation LM Test was applied to all of them. The results of the tests are available in the Table 3. The stability condition of the VAR indicated that all the eigenvalues were inside the unit circle.[5]

5. Results of the impulse response function

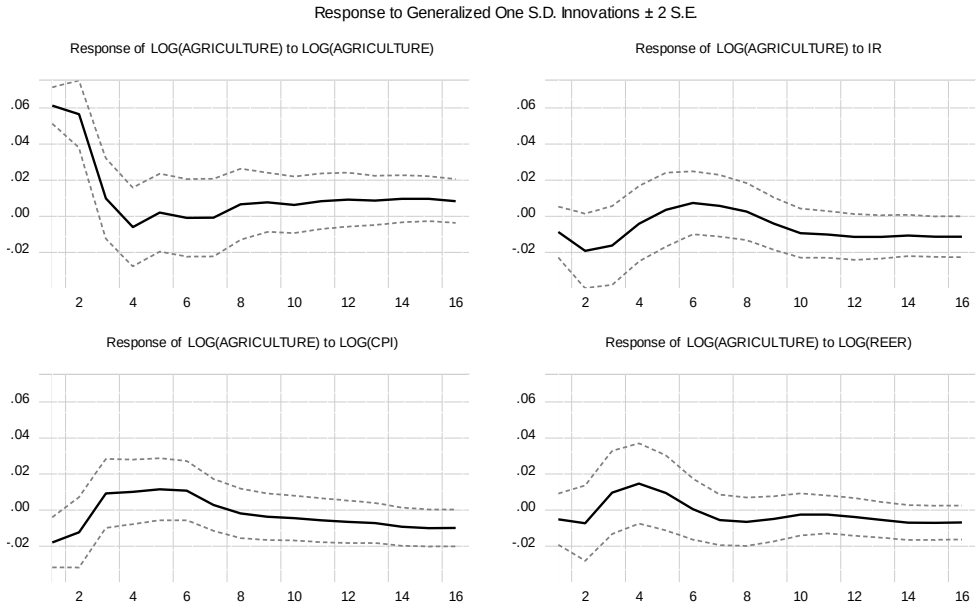
The impulse response function shows how the dependent variable responds in the event of a shock at a given point in time to a particular exogenous variable (Enders, 2008). Actually, the impulse response function can be interpreted with a vector moving average, while the dependent variable is covariance stationary. The vector moving averages are created with the conversion of the equations in the vector autoregressive model specified. The interpretation of the responses to the shock should not include shocks from the other variables. Therefore, we have implemented the procedure of Pesaran and Shin (1998), which suggests that the ordering of the variables is irrelevant.

The starting point of the analysis will discuss the responses of each sector to one standard deviation shock in the monetary variables. The results of the impulse responses over the next 16 quarters for each sector are shown in Figures 2 to 6. For the impulse responses, bootstrapping method is used to generate confidence intervals. However, we use data with unit-root which are also cointegrated, thus the variance may not be accurately estimated and the t-, χ^2 and F-tests for inference of the VAR parameters may not be valid (see Lütkepohl and Krätzig, 2004, p. 94). Therefore, in some cases we check the accuracy of standard errors by reassessing with Monte Carlo methods at one hundred repetitions.[6]

A positive shock in the IR causes the Agricultural sector to contract in the first four quarters followed by a positive effect between the fifth and the eight quarters (see Figure 2). Following the decrease of IR since the last quarter of 2008, the amount of credit obtained by the sector increased which makes the results plausible (see Figure 1). The increase in prices should force household consumption to shrink in short and long term with some adjustment in the medium term. This makes the sectors' response to a shock in CPI also robust. The REER shock response shows similar effects, although the positive effect is less pronounced than the impact of a CPI innovation. Usually, appreciation of the REER would hamper competitiveness and lead to a decline in exports and an increase in imports. However, the impact is comparatively small while the export of agricultural products is more dependent on the demand in the EU than the price competitiveness.

[5] The data that support the findings of this study are available from author, upon request.
[6] Idem.

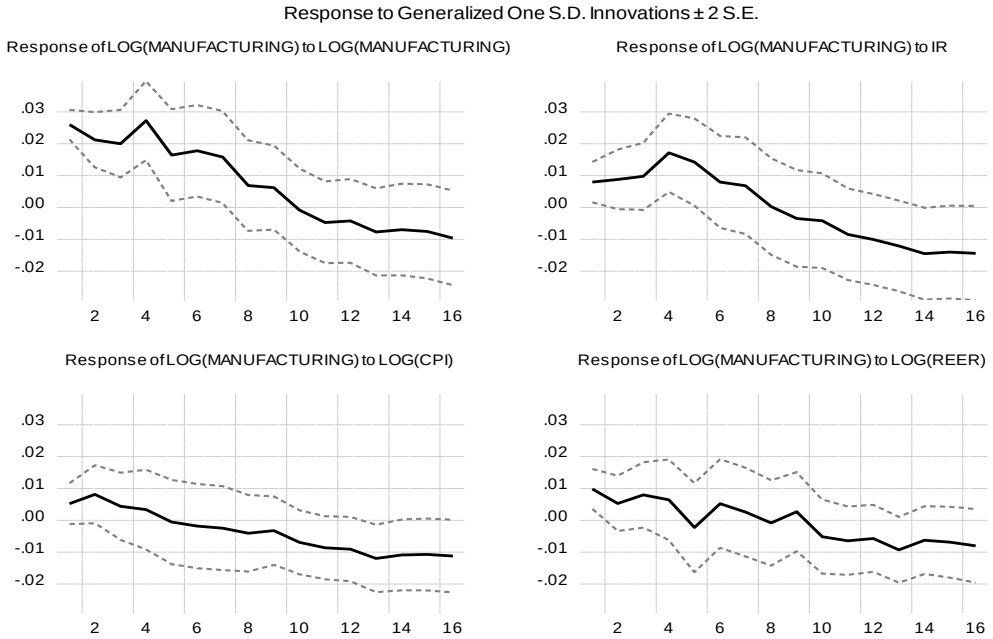
Figure 2. Responses of the GVA in Agriculture to monetary policy shocks



Source: Authors' calculations based on Bulgarian National Bank, Eurostat and National Statistical Institute data.

The Manufacturing sector exhibits a positive response after a contractionary monetary policy via an increase in interest rate, after which it gradually dies (see Figure 3). A similar but less pronounced pattern can be observed after a shock in CPI or REER. The positive effect increases until the fourth quarter. The results are in line with the finding of Dhal (2011) as the dominant part of the sectors' production consists of capital goods and consumer durables. Thus, in the long term, the effects of the shocks should be more prominent compared to the response in the other sectors, which is the case. Additional factors are the higher price stickiness, export dependence, and price convergence with the EU average which also presume a high and negative rate of response in the medium to long term.

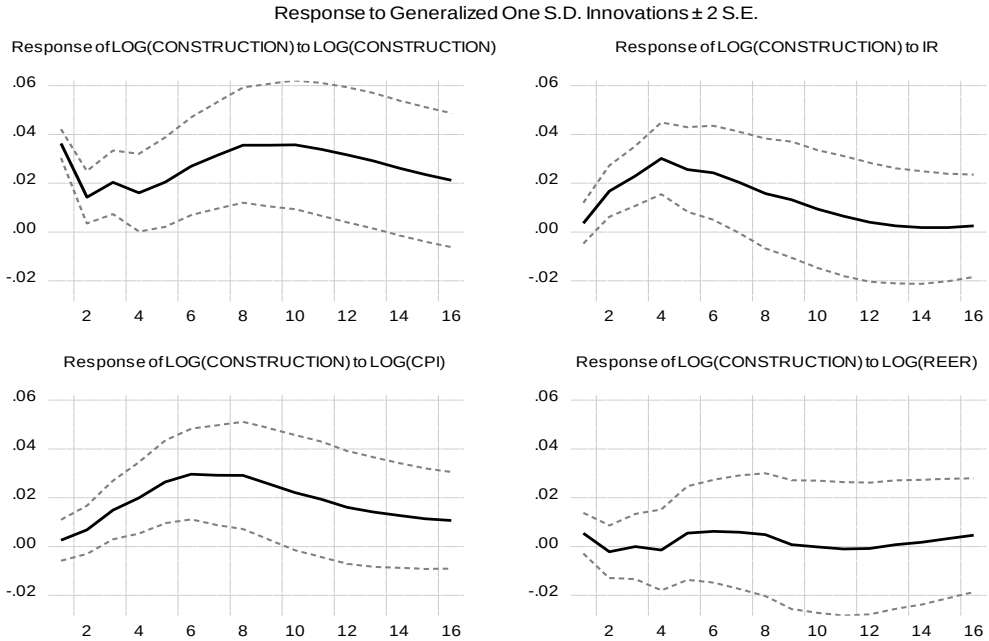
Figure 3. Responses of the GVA in Manufacturing to monetary policy shocks



Source: Authors' representation based on Bulgarian National Bank, Eurostat and National Statistical Institute data.

The impulse response function shows that an increase in the interest rate or CPI should boost the Construction activity after which it gradually begins to subside (see Figure 4). In general, the cyclicality in the Construction activity (respectively the peak and the bottom) lags behind most other sectors (Dell'Ariccia *et al.*, 2020). The sector operates mainly via long-term contracts so it can be expected that the effect will be much smaller in the long term. The Construction sector in Bulgaria is highly dependent on FDI inflows and borrowed funds. This should imply a negative correlation between the IR and the activity in the sector as the higher interest will increase the costs of funding. In practice, an increase in the IR is usually due to a high inflation rate and/or overall output growth. In order to satisfy the demand or to take advantage of the higher prices, the companies take action to extend their facilities which has a positive effect on Construction. However, this chain of actions is part of the boom-bust cycle, and it's usually unsustainable.

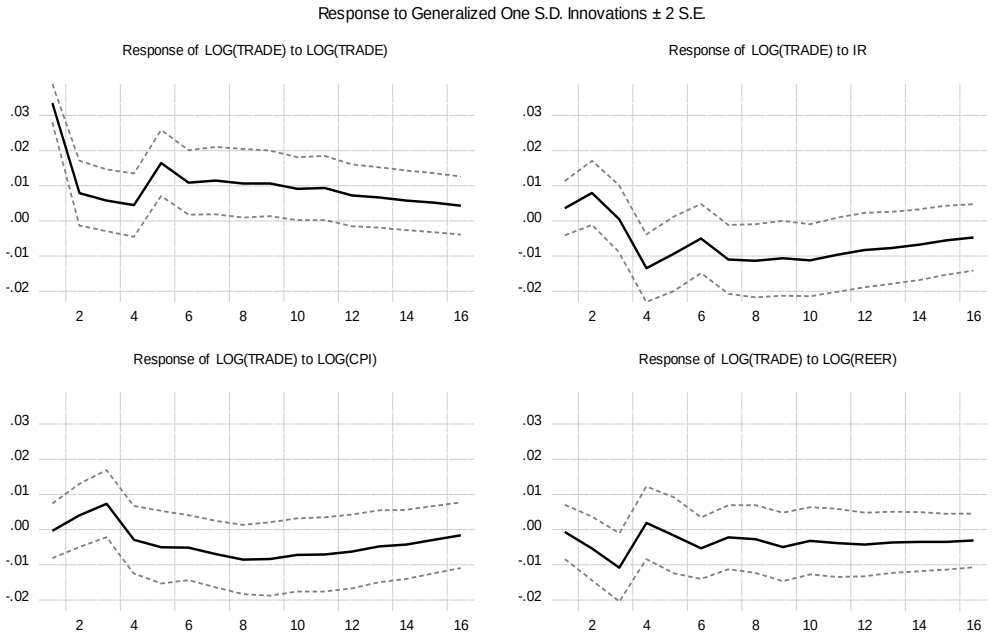
Figure 4. Responses of the GVA in Construction to monetary policy shocks



Source: Authors' representation based on Bulgarian National Bank, Eurostat and National Statistical Institute data.

The Wholesale and retail trade, transport, accommodation and food service activities appears to have a significant negative response to a change in the interest rate, after one year (see Figure 5). A higher price level, increases the turnover in trade and the added value in the sector at least in a short-term. The effect becomes negative after a year. The sector is also highly dependent on FDI inflows and bank credits. An increase in the IR implies higher borrowing costs which make the expansion less likely. At the same time, an increase in the IR or CPI lowers private consumption. In general, the sector serves consumption and is directly related to it, which makes the results logical. A similar logic is applicable in the event of a positive shock on the REER, which will reduce the competitiveness of the sector.

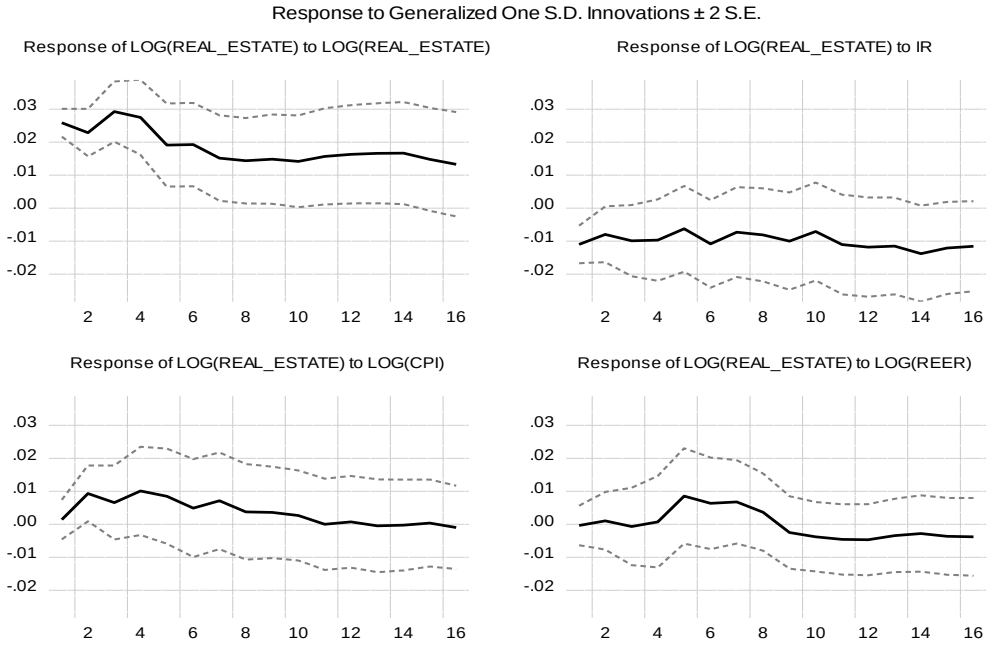
Figure 5. Responses of the GVA in Wholesale and retail trade, transport, accommodation and food service activities to monetary policy shocks



Source: Authors' representation based on Bulgarian National Bank, Eurostat and National Statistical Institute data.

An increase in interest rate exhibits a negative and persistent effect on Real estate activities (see Figure 6). The results are logical in light of the high sectoral dependence on inward FDIs. This, along with the relatively low property prices, was the basis of the investment boom in the period up to 2008 (Tsoklinova, 2016). An increase in the IR in the interbank market in Bulgaria should also reflect an increase in the overnight interbank market rate in the EA. The higher cost will make foreign investments less profitable. At the same time, both domestic and foreign demand will diminish. The Real estate sector operates under a high rate of operational surplus. Thus, a positive price shock increases the revenue and profit, and accordingly the GVA of the sector. Here, the advantages that the fixed exchange rate offers as risk insurance should also be taken into account.

Figure 6. Responses of the GVA in Real Estate to monetary policy shocks



Source: Authors' representation based on Bulgarian National Bank, Eurostat and National Statistical Institute data.

Obviously, the effects of monetary policy are quite heterogeneous, both in terms of the amplitude, the duration of the shock and the transmission channel. In the Agricultural sector, monetary policy innovation has a negative initial impact in all cases, followed by a short period of positive effects. On the other hand, the response of the Manufacturing sector gradually changes from positive to negative, with the interest rate channel seems to be the most impactful. The interest rate and the price level have a sustainable positive effect on Construction, unlike the other sectors considered. It seems that the effect of innovation in any of the monetary variables is relatively small over the GVA in the Wholesale and retail trade, transport, accommodation and food service activities, at the same time it is negative after the third or fourth quarter. In the Real estate sector, the effect of interest rates and prices seems to counterbalance each other much of the time. Overall, the interest rate shock has a positive effect on Construction and Manufacturing (at least during the first two years), while it is rather negative for the rest of the sectors. The consumer price index has a rather positive effect in the short term, but in the medium term is negative for the Agriculture sector, Manufacturing and Wholesale and retail trade, transport, accommodation and food service activities. The impact of the REER on the sectoral activity in Agriculture and Manufacturing is quite similar to that of

the CPI, but somewhat slightly weaker and short-lived. It is interesting to note that the correlation between the impact of the interest rate and the prices is high in the Manufacturing sector (correlation of 0.89); Wholesale and retail trade, transport, accommodation and food service activities (0.81) and Real estate (0.70). This in a way shows the degree of price stickiness of the individual sectors and confirms its importance for the sectoral responses.

Conclusion

The aim of the paper was to investigate the impulse reaction of several economic sectors to different monetary policy shocks. For that purpose, we have estimated five reduced form VAR models each with three monetary transmission channels, in particular, those are the overnight interbank market rate, the consumer price index, and the real effective exchange rate. The results suggest that there is strong heterogeneity between sectors to the different monetary policy shocks even if the national currency operates under a currency board. The differences in the reaction are both in terms of depth, in terms of direction, and duration. The results show that monetary policy has a strong positive effect on Construction, even in the long run. The impact on Manufacturing is negative in the long run. At the same time, the impact on the Agriculture and Wholesale and retail trade, transport, accommodation and food service activities is predominantly negative, although there are short periods with a positive effect. The differences in sectoral responses to a monetary policy shock can be explained by the specific characteristics of each economic sector. More important examples are the sectoral dependence on external demand and capital flows, dependence on borrowed funds, price stickiness, capital-labor intensiveness, and the type of output produced.

The currency board in Bulgaria implies a full and almost immediate transmission of the ECB's monetary innovations. Under these conditions, the Bulgarian National Bank is unable to ensure a smooth transition from one monetary policy to another, although it can still influence the monetary base via the required reserves. A poorly coordinated, towards the Bulgarian economy, monetary policy could cause a significant negative response of some of the economic sectors given their heterogeneous response. On the other hand, an appropriate choice of monetary policy by the Central bank can accelerate the current development of a given sector and of the aggregate output. Depending on the production structure and the level of economic development, an appropriate monetary policy strategy could be to maintain a fixed or managed floating exchange rate at the beginning, which will pass into inflation targeting after reaching a higher stage of development or a production structure that is less dependent of the REER dynamics. From a structural development point of view, maintaining a fixed exchange rate in Bulgaria seems rather appropriate policy at the moment.

From the monetary policy-making point of view, this study can be useful in showing that monetary transmission channels exhibit heterogeneous impacts over the different economic sectors under the currency board regime. It also shows that the objectives and instruments of monetary policy require more comprehensive and in-depth assessment not only at the aggregate level but also at the meso and microeconomic levels. The issues raised here need further analysis, certainly setting the direction for future research in this area to enrich the theory and practice of monetary policy.

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