

BULGARIAN NATIONAL BANK



DISCUSSION PAPERS DP/115/2019

Transmission of ECB's Monetary Policy in Bulgaria: Insights from a Large Macro-econometric Model

Mariella Nenova, Evgeni Ivanov, Neli Ivanova,
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July 2019

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ISBN 978-619-7409-16-1

ISBN 978-619-7409-17-8 (pdf)

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ABSTRACT: The aim of this paper is to examine the transmission channels of European Central Bank's (ECB) monetary policy in Bulgaria, taking into consideration the structural aspects of the Bulgarian economy, including its strong trade and financial integration in the EU at the background of free movement of capital; the conditions of the currency board regime and the prevalence of euro area (EA) based banks on the domestic financial market. The elaborated structural features determine the sizable influence of the ECB's monetary policy on the Bulgarian economy. The large macro-econometric forecasting model of the BNB has been applied to derive a simulation scenario. The special case of a tightening of the ECB's monetary policy is studied by modelling a combination of simultaneous shocks: an increase of the euro area short- and long-term interest rates, an appreciation of the euro against the US dollar and a decline in economic activity in the euro area.

Our results suggest that the effects through the foreign trade channel play a dominant role in explaining the contraction of domestic output relative to the baseline level following a tightening of the ECB's monetary policy. Investment is the GDP component with the strongest reaction to monetary policy tightening. The Bulgarian labour market adjusts to the ECB's contractionary monetary policy through declines in both employment and wages. The downward adjustment of prices compared to the baseline level is relatively weak and we find that throughout the simulation horizon the reaction of real variables is more pronounced than the reaction of prices.

KEYWORDS: Monetary policy transmission, Macro-econometric models, Currency board

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ACKNOWLEDGMENT: We would like to thank our colleagues from the Economic Research and Forecasting Directorate for their valuable contribution and support and in particular Zornitza Vladova, Tania Karamisheva, Svilen Pachedzhiev and Andrey Vassilev for their insightful input and valuable comments on the paper.

1. Introduction

The specifics of the monetary regime in Bulgaria and the country's trade and financial integration with the euro area (EA) determine the high relevance of ECB's monetary policy changes for the domestic economy. Understanding of the specific channels of European Central Bank's (ECB) monetary policy transmission is fundamental for analysing domestic economic developments from historical and forward-looking perspective as well as for assessing the impact of policy changes. Knowledge on the transmission of the monetary conditions in the euro area to the Bulgarian economy has been an important input for policy discussions over recent years and is becoming increasingly relevant for policy analysis in the context of Bulgaria's preparation to join the Exchange Rate Mechanism (ERM II) and eventually the EA. In addition to that, the favourable economic developments in the EA in recent years are a prerequisite for the withdrawal of the ECB's monetary policy accommodation. This makes the transition to policy normalisation in the euro area and its effect on the Bulgarian economy an important topic for investigation. The contraction of EA output and prices, resulting from a tightening of the ECB's monetary policy, is expected to have sizeable negative effects on Bulgaria's foreign trade (trade spill-over channel) given that the euro area is by far the country's largest trading partner. Moreover, under the currency board arrangement a monetary policy induced appreciation of the anchor currency, the euro, will be directly transferred to Bulgaria's export and import prices, which in turn will affect real volumes of foreign trade (the exchange rate channel), adding up to the effect of the trade spill-over channel. The irrevocably fixed exchange rate of the lev with respect to the euro and the very limited instruments that the national authorities have at hand to influence monetary policy conditions under the currency board arrangement suggest that domestic monetary conditions are largely determined by the monetary environment in the EA. An additional prerequisite for a strong pass-through of interest rate change from EA to domestic financial markets is the dominant role of EA-owned banks in the Bulgarian banking sector. Furthermore, as external borrowing and FDI flows from parent companies in the EA constitute a significant source for non-bank debt financing of domestic companies, it could be expected that the cost and availability of non-bank financing for a large share of the domestic companies will also be influenced by monetary conditions in the EA.

In order to fully account for these structural characteristics of the domestic economy and their respective role in hampering or facilitating the specific channels of the transmission of the ECB's monetary policy to the Bulgarian economy we have opted out for an analytical framework that would allow the

inclusion of numerous interrelations between foreign and domestic variables. The current analysis is based on simulations with the BNB's macro-econometric model (BNBQPM), which is the Bank's main toolkit for forecasting and simulation purposes. Despite being subject to the Lucas critique, large-scale econometric models still represent a useful tool for combining detailed econometric estimates related to the functioning of the individual channels and stages of transmission especially in view of the inconclusive results for Bulgaria based on VAR models (see for example Elbourne and de Haan (2006), Minea and Rault (2009), Potjagailo (2016), Moder (2017), Bluwstein et al. (2016) and Horvath and Voslarova (2017)).

This paper contributes to the existing literature by identifying the channels through which the ECB's monetary policy is transmitted to the monetary conditions in Bulgaria. Moreover, it establishes the relative importance of each of these channels based on simulations with the BNBQPM. The macroeconomic simulation exercise includes a simultaneous increase in the EA short-term and long-term interest rates, an appreciation of the euro against the US dollar and a decline in the economic activity in the EA induced by tightening of ECB's monetary policy (simulated in a multi-country framework)¹. The combination of these shocks forms a scenario of a monetary policy tightening by the ECB.

Our results suggest that the foreign trade spill-over channel plays a dominant role in explaining the contraction of domestic output compared to our baseline following a tightening in the ECB's monetary policy. Real exports decline as a result of the simulated lower foreign demand, which then triggers a decline in domestic output with relatively fast negative second-round effects on the labour market, investment, consumption and prices. The contractionary effect from higher interest rates and lower asset prices as a result of higher market interest rates in the EA takes more time to materialise and begins to weigh on the real GDP a year and a half after the introduction of the shocks. Investment is the GDP component with the strongest response to monetary policy tightening. Throughout the simulation horizon, the reaction of real variables is more pronounced than the reaction of prices.

The paper is organised as follows: the next section reviews the most relevant monetary policy transmission channels for a country with a currency board

¹ The expected change in external demand for Bulgarian goods and services (based on the weight of the euro area in Bulgaria's external trade) is simulated with a modelling package developed by the ECB, called Stress-Test Elasticities toolbox (STEs). In line with the design of the STE toolbox (latest version as from 2018, for more information on the toolbox see (ECB, 2013)) the change in the ECB's policy rate is simulated by the change in the 3-month EURIBOR. The same proxy for the tightening of ECB's monetary policy is used throughout the paper.

regime from both theoretical and empirical point of view. Section 3 discusses the structural aspects of the Bulgarian economy that have implications for the transmission of ECB's monetary policy. Section 4 provides details on the macro econometric model used for the empirical assessment of the transmission of the ECB's monetary policy to the Bulgarian economy with a focus on the individual transmission channels at work. Model simulations are provided in Section 5 and Section 6 concludes and suggests avenues for future work.

2. Literature Review

The monetary transmission mechanism (MTM) can be broadly defined as the mechanism through which monetary conditions affect economic activity and prices. Monetary conditions are typically determined by the national central bank's monetary policy actions, but spill-over effects from global and main trading partners' monetary policy conditions have become increasingly relevant. In countries with currency board arrangements, such as Bulgaria, there is no policy-induced change in interest rates or the money supply and the monetary environment is determined to a large extent by the monetary policy of the anchoring country. Given the high trade and financial sector integration, capital and labour mobility in the EU, we might expect significant interactions between domestic and foreign economic developments.

2.1. Channels of the Monetary Transmission Mechanism

A standard way to analyse the monetary transmission mechanism is by considering the individual channels through which monetary policy changes are transmitted to the real economy and prices. In line with the literature on international transmission of monetary policy, the transmission of ECB's monetary policy to the domestic economy takes place through two main channels: **foreign trade channel** and **financial channel** (Canova, 2005 and Potjagailo, 2016).

The **trade channel** is the first main channel of international monetary transmission. It operates mainly through changes in net exports and its functioning can be analysed in a standard Mundell-Fleming model. Following a monetary policy tightening in the center economy, output and prices in this economy will decline and will have a contractionary impact on foreign demand for the periphery countries. The resulting negative impact on domestic output and prices is supposed to be larger for the periphery countries with fixed exchange rates as there will be no domestic currency depreciation to offset the negative impact of lower foreign demand (Potjagailo, 2016). Countries

with fixed exchange rates to the center country's currency will be affected by the functioning of the exchange rate channel in the center country – upon an interest rate increase the currency of the center country is expected to appreciate against all other currencies. As a result, net exports in both the center economy and periphery countries with fixed exchange rates will contract as the goods and services they produce will become less competitive relative to third countries.

Further in the paper, we will analyse the functioning of the trade channel of international monetary transmission by decomposing the spill-over effects on the Bulgarian economy stemming from changes in EA output and prices (trade spill over channel) and from changes in the value of the euro against other currencies (exchange rate channel)². These two channels reinforce each other as they both lead to a contraction in domestic output and prices following a monetary policy tightening in the EA. While a precondition for the functioning of these channels is naturally the effectiveness of the monetary transmission mechanism within the EA, relevant factors specific to the Bulgarian economy are its trade openness, the structure of trade, the share of imported goods, participation in the global value chains and size of the residents' net foreign non-euro liabilities (Kapusinski et al., 2016).

The second main channel of international monetary policy transmission, the **financial channel**, operates through the impact of monetary policy changes in the center country on financial conditions in the periphery country. Spill-overs to various financial indicators in the periphery countries can be defined as different channels of transmission within the financial channel (see for example Bluwstein and Canova (2016), Takas and Vela (2014) and Rey (2016) for alternative classifications). This paper will focus primarily on the interest rate channel, the asset price channel and the credit channel in line with the traditional classification of the monetary transmission channels (Mishkin, 1995), while acknowledging the effects through risk perceptions, uncertainty and expectations might play a very important role in international transmission of monetary policy (Bluwstein and Canova (2016), Rey (2016)).

Due to enhanced financial integration and prevalence of foreign bank ownership, domestic market interest rates will follow closely the dynamics

² Please note, that in this paper the exchange rate channel is defined in terms of the movements between the currency of a periphery country with a fixed exchange rate to the center country and the currencies of third countries, while other authors (Canova, 2015 and Takás and Vela, 2014) use the term to define the effects stemming from bilateral changes in the exchange rate between the periphery and the center country. In the latter definition, the exchange rate channel works in the opposite direction of the trade spill-over channel.

of EA money market interest rates (interest rate channel). Moreover, when the exchange rate in the periphery economy is fixed to the center economy's currency, the uncovered interest rate parity would imply a complete and simultaneous pass-through with regard to domestic money market rates considering that the country risk premium remains unchanged. Deposit and lending rates in the center and periphery countries are also expected to co-move if there are close ties between the banking sectors of the two countries. Stock prices and other asset prices in the periphery country are also expected to react to monetary policy changes in the center country (asset price channel). Last but not least, the functioning of the credit channel is justified by the presence of financial frictions (Boivin et al., 2010) as the increase of domestic interest rates will have negative effects on bank's capital and balance sheets and at the same time it will undermine borrowers' creditworthiness, resulting in lower credit supply. The credit channel would typically enhance the role of the traditional interest rate channel. While the credit channel has been analysed mostly in a closed economy perspective, it might be equally relevant in the international transmission of monetary policy (Rey (2016) and Bech et al. (2018)). The importance of the credit channel is expected to be stronger when the bank lending is the major financing source for domestic economic agents (Kapuscinski et al., 2016).

While the interest rate, credit and asset price channels are usually seen as the main channels of international transmission of conventional monetary policy, with the extensive use of non-standard monetary policy measures in the aftermath of the global financial crisis, a number of additional transmission channels have been identified (Altavilla et al., 2017). Credit easing measures, which are designed to reduce marginal costs, are important for the functioning of a cost relief channel, while quantitative easing measures are expected to activate a portfolio rebalancing channel. Moreover, non-standard measures give rise to a signalling channel, which functions through the signal central banks give on their intentions to keep interest rates low in the future. Somewhat related to the signalling channel is the confidence channel as defined by Bluwstein and Canova (2016) which operates through spill-overs to uncertainty and financial risk perceptions.

The functioning of all of the above mentioned channels of transmission of international monetary policy changes will ultimately have an impact on real activity and prices in the periphery economy. As already mentioned, the trade channel will affect net exports mainly *via* the trade spill-over and the exchange rate channel. Following a change in domestic financial conditions, investment is affected through the change in the user cost of capital (direct interest

rate channel) and the change in the firms' stock prices (asset price channel) through the so-called Tobin's q ratio. Based on the Tobin's q relation between the market value of capital and the replacement cost of capital, an increase in domestic interest rates will result in lower share prices as demand for shares will decline and eventually this would lead to lower investment. Consumption is also affected by interest rate changes through both the direct interest channel and the asset price channel. On the one hand, changes in interest rates trigger intertemporal substitution effects and induce changes in the slope of the consumption profile as could be seen from the standard Euler consumption optimization equation. On the other hand, short-term interest rates have an impact on the prices of shares, real estate and other assets, held by households. When interest rates increase, asset prices fall and affect negatively consumption through the decline in households' wealth. The negative effects from the functioning of the interest rate and asset price channels on consumption and investment will be intensified by the functioning of the credit channel through lower availability of bank credit.

2.2. Relevant Empirical Studies

Empirical research on the functioning of the monetary transmission mechanism is vast. Various approaches have been employed, depending on whether the focus is on all aspects of the transmission mechanism or on individual channels and stages of transmission. This study relates more closely to two streams of empirical literature: studies on the monetary transmission mechanism in large-scale macro-econometric models and studies on individual channels of the transmission mechanism in Bulgaria. While structural vector autoregressive models and New Keynesian DSGE models have been widely used for empirical analysis of the overall monetary transmission mechanism, they are left beyond the focus of this analysis.

2.2.1. Large-scale Macro-econometric Models

Large-scale macro-econometric models have until recently been extensively used by central banks in the EU and worldwide for monetary policy transmission mechanism analysis. Short-run dynamics in these models is predominantly data-driven, while the long-run dynamics is assumed to converge to a theoretical long-run steady state. This would require the estimation of long-run (co-integrating) relationships first, followed by an estimation of the dynamic equations in error-correcting form. Expectations in these models play only a partial role as price and wage formation are typically backward-looking and depend only on their lagged values. Berben, Locarno,

Morgan, and Valles (2004) report that less than half of the models used in the ECB and EA countries have some forward-looking features and Mayes (2004) acknowledges that the expectations channel is not given enough emphasis in the macro-econometric models for the three Baltic countries.

In a comparative study of the MTM in 12 large-scale macro-econometric models, used by central banks, Smets (1995) finds that “the exchange rate and the cost of capital are the most important channels of transmission, with the exchange rate channel being more important in more open economies”. Simulations with the EA Wide Model (McAdam and Morgan, 2001) find evidence for a dominant role of the investment-based channel in the EA as a whole. Fagan, Henry, and Mestre (2005) confirm the importance of the investment channel and find that the exchange rate channel contributes to around one third of the decline in output through its negative effects on net trade and consumption (Fagan et al., 2005).

Simulations with macro-econometric models have also been applied to study the MTM in other currency board countries (see Vetlov (2003) for Lithuania, Kattai (2005) for Estonia and Mayes (2004) for a comparative study on the three Baltic states). The latter study summarises the common features of the macro-econometric models for the Baltic countries: owing to the specifics of the exchange rate regime short-term interest rates are modelled through uncovered interest parity with an adjustment for a downward trending risk premium (exogenous or dependent on forward rates), while money supply is modelled as a function of transactions demand and foreign inflows. The structure of the models suggests a relatively small role for the credit and bank lending channels, which to a certain extent is justified by the high degree of firms’ foreign ownership and the important role of FDI flows for the availability of funding at the industry level. Despite the structural differences between the three models, in all of them the role of the interest rate channel in the MTM was found to be stronger as compared to the exchange rate channel. Similarly to the results from the EA Wide Model, in the case of Lithuania and Latvia investment is the aggregate demand’s component mostly affected by changes in the monetary conditions, while in Estonia there is a stronger impact on consumption.

2.2.2. Studies on the Individual Transmission Channels in Bulgaria

Empirical studies on the foreign trade channel for Bulgaria are focussed exclusively on the functioning of an exchange rate channel. The results from earlier cross-country studies including Bulgaria (Ganev et al., 2002) are largely influenced by the inclusion of data before the introduction of the currency

board and therefore are not comparable with the current study's results. Later on, Beirne and Bijsterbosch (2011) employ a multivariate co-integration approach (VECM) and find conclusive evidence that the exchange rate pass-through to domestic prices is stronger in Bulgaria and the Baltic countries as compared to the Central and Eastern European countries with flexible exchange rates. The BNB (2015a) used a Bayesian vector autoregression model to assess the effects from changes in the nominal effective exchange rate on output and prices in Bulgaria and found that consumer prices increase by 0.1 percent on impact after a one-percent depreciation of the nominal effective exchange rate, while the reaction of GDP materialises only with a lag and is maximised after approximately one year (0.2 per cent).

The transmission of ECB's monetary policy through the financial channel is analysed in a number of empirical studies. Earlier studies offer in many cases inconclusive results. The studies reviewed by Ganey et al. (2002) support the existence of a credit transmission channel in Bulgaria and provide evidence for a regime switch after the currency board establishment, while Elbourne and de Haan (2006) find little evidence of any link between financial structure indicators and monetary policy. In a VAR framework, Minea and Rault (2009) find that domestic interest rates and monetary aggregates react to the ECB interest rate shock with a substantial lag, while output and prices' responses are not significant.

More recently, Mihaylov (2016) uses symmetric and asymmetric error-correction models to study the effect of money market conditions in the EA on lending interest rates in Bulgaria depending on the sector of the borrower, the currency denomination and the maturity of loans. The analysis shows a complete pass-through from EA market interest rates to all domestic lending rates in the long-term. The short-run pass-through is not complete (at 58 per cent) and statistically significant only for corporate lending rates. There is no evidence for asymmetric reaction of domestic interest rates when money market conditions in the EA are expansionary or contractionary. Recent cross-country studies have also analysed the spill-over effects from EA to domestic monetary conditions (including the impact of the unconventional monetary policy) on non-euro area countries, including Bulgaria. While Potjagailo (2016) finds a complete and immediate pass through from EA short-term rates (with and without accounting for the impact on UMP) to short-term money market rates in Bulgaria, Moder (2017) does not find statistically significant reactions of domestic interest rates to changes in the foreign monetary conditions.

Credit growth dynamics is analysed in Peshev (2015), Karamisheva (2016) and Mihaylov (2017). The studies identify various relevant supply-side factors (such as bank-specific interest rate spreads between lending and deposit rates, the share of bad and restructured loans, bank ownership and so on). Karamisheva (2016) finds demand factors to be relatively more important, while Mihaylov (2017) finds a strong correlation between supply and demand for credit through an estimated credit market disequilibrium model for the period 2000–2016. The author identifies three distinct periods, in which the supply of credit was estimated to be lower than the demand (in the wake of the financial crisis, during the period 2011–2013 and more recently, in 2015–2016), but attributed the shortage of credit supply to various temporary factors.

On the transmission of domestic interest rate changes to asset prices (proxied by house prices) there is a recent study by Kotseva and Yanchev (2017). The authors model house prices in a VECM framework that simulates the dynamic interplay between prices and demand for housing and find that the interest rate on new housing loans is an important determinant of house prices together with external demand (proxied by FDI in real estate) and the dynamics of domestic GDP *per capita*.

The second stage of transmission of ECB's monetary policy to domestic prices and output has also been analysed in a number of studies. Vladova and Yanchev (2015) find evidence for a two-way relationship between money supply and prices in Bulgaria over the period 1998–2012, with the causality in the direction prices → money demand → money supply being justified by the endogeneity of money supply in a currency board framework. More recently, Ivanov et al. (2018) analyse the determinants of business investment dynamics in Bulgaria. The authors employ a BVAR model estimated over the period 2000–2017 and find that changes in real long-term corporate lending rates have a significant impact on investment, even though it materialises with a lag. Foreign demand, uncertainty and FDI flows seem to be of higher importance in the historical decomposition of investment dynamics, thus suggesting a strong role for trade channel, firms' balance sheet channel and expectations channel.

3. Structural Aspects of the Bulgarian Economy

The theoretical grounds delineating the possible channels through which the monetary policy is transmitted to the real economy and to price dynamics can be used as a starting point in the analysis of transmission mechanism in an individual country. Depending on the specific structural features of the economy, however, the strength of a given theoretically defined transmission

channel and the lag in transmission can vary across countries. To identify the possible important channels of monetary policy transmission in Bulgaria we first outline a number of fundamental structural aspects of the economy which provide a focal point of the analysis and preliminary assessment of the potential strength of a channel in the transmission process.

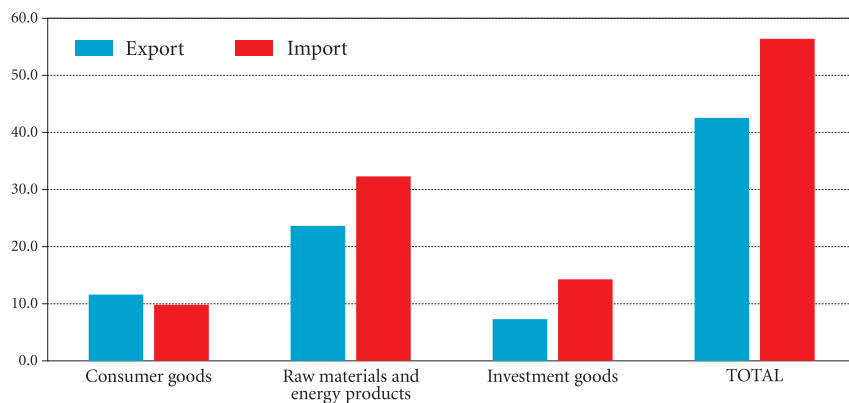
3.1. Small Open Economy Highly Integrated in the Single EU Market

Foreign trade has always played a vital role for the economic development of Bulgaria. The ratio of foreign trade to GDP fluctuated at around 100 per cent for 1995–2017. The dependence of the country's economic progress on imported natural resources like minerals and fuels pre-determines the relatively high share of imports in foreign trade and in turn the crucial role of exports for supplying the economy with the required foreign currency. Imports of basic resources represents more than half of total imports of goods (in some years going up to and above 70 per cent) while the trade deficit in the group of raw materials and energy commodities has usually been the main reason for the overall trade deficit.

In recent years another import group gained prominence – *i.e.* investment goods. Since 2005 (two years before Bulgaria's accession to the EU) the import of investment goods accelerated, linked to and financed by the rising inflow of foreign capital (mainly from EA countries). The trade deficit in investment goods contributed markedly to the overall trade deficit.

Figure 1: Annual Average Exports and Imports in 1999–2017

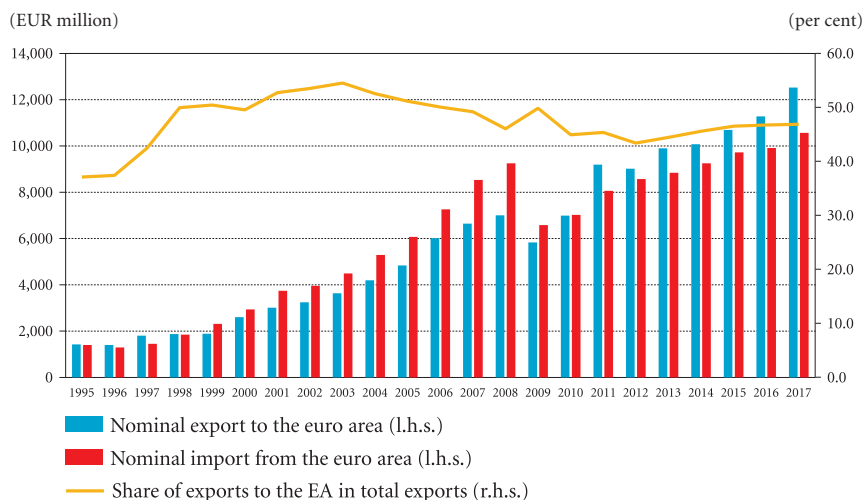
(total and by commodity groups, per cent of GDP)



Source: the BNB.

The integration of Bulgaria in the Single EU Market has secured both stability in foreign trade flows and rising participation rate in EA dominated global value chains. Moreover, the free movement of capital within the EU and the capital transfers from the EU Structural Funds support a rising inflow of foreign capital in Bulgaria, which typically covers the trade deficit more than 100 per cent. Due to Bulgaria's tight links to the EU, the economy is highly sensitive to the cyclical fluctuations of the EU and more specifically of the EA.

Figure 2: Foreign Trade of Bulgaria with the EA



Source: the BNB.

The openness of the Bulgarian economy and its tight economic relations with the EU and the EA in particular suggests that the foreign trade and financial flows channel may have an important role in transmitting the ECB's monetary policy³ to the Bulgarian economy via changes in demand and cost of funding in the EA.

³ The key interest rates for the euro area set by the ECB Governing Council are: 1) the interest rate on the main refinancing operations (MROs), which normally provide the bulk of liquidity to the banking system. The Eurosystem may execute its tenders in the form of fixed rate or variable rate tenders; 2) the rate on the deposit facility, which banks may use to make overnight deposits with the Eurosystem; 3) the rate on the marginal lending facility, which offers overnight credit to banks from the Eurosystem.

3.2. The Currency Board with a Fixed to the Euro Exchange Rate

It has been a topic of intensive research and debate in the academic literature whether a floating exchange rate can support better export performance in small and open developing countries.⁴ There is a trade-off, well studied in the academic literature, between frequent and/or sizable exchange rate adjustments aimed by the national authorities at counteracting negative international environment changes and the target of maintaining macroeconomic stability. The trade-off is normally resolved in favour of macroeconomic stability.⁵

According to the estimations presented in research papers focused on Bulgaria (Barber and Vassilev (2003), Stoevsky (2009), BNB (2009)) the elasticities of exports and imports to foreign and domestic demand respectively are much higher than the export and import elasticities to the real exchange rate. The interpretation of the size and interrelation of these elasticities is that, other things equal, a depreciation of the national currency can be ineffective for improving the overall trade balance or the export performance in case of a deterioration in foreign demand.

Going back to the early 1990-ies Bulgaria opted for a floating exchange rate and full-fledged monetary policy. At the background of the expansionary fiscal policy of that time the overall macroeconomic policy proved unsuccessful⁶ and drove the economy into a deep economic and banking crisis in 1996 – the beginning of 1997.

To resolve the accumulated imbalances and stabilise the economy in July 1997, a currency board arrangement was introduced with a fixed exchange rate to the German mark (later to the euro at the same exchange rate as the German mark was fixed to the euro) and a stringent rule of money issue. According to the rule, the central bank, upon demand, exchanges lev for euro and euro for lev at the fixed by the BNB law exchange rate. The operation of the currency board was and continues to be safeguarded by prudent fiscal policy and structural reforms.

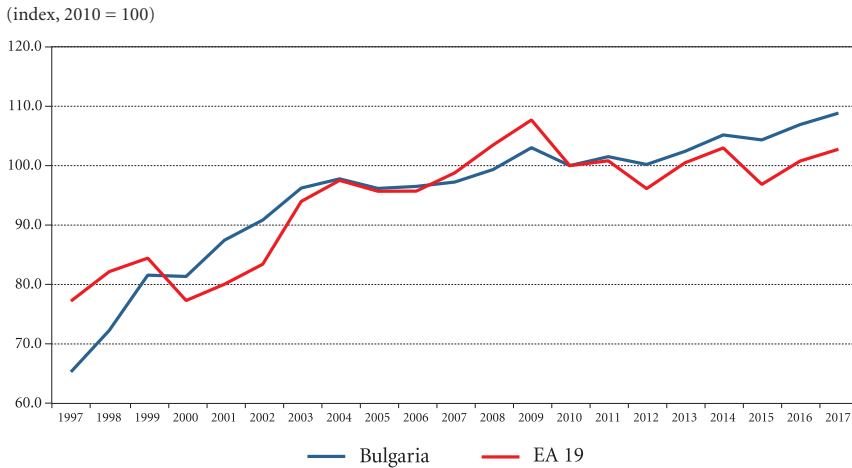
⁴ According to the Marshall-Lerner condition a depreciation of the national currency can improve the trade balance only if the sum of the absolute values of the price elasticities of demand for exports and imports is above 1.

⁵ Although this issue has not found an ultimate agreement in economic literature, the arguments in favour of stable exchange rates are provided in the seminal work of Calvo and Reinhart (2000).

⁶ There are many publications describing the stop and go transition reforms in Bulgaria till 1997 and the overall macroeconomic instability of the economy.

While the lev is fixed to the euro, it fluctuates to all other currencies in a similar way as the euro: the nominal effective exchange rate of the lev moves closely to the dynamics of the nominal effective exchange rate of the euro.

Figure 3: Nominal Effective Exchange Rate of the Lev and the Euro
(*vis-à-vis* the Currencies of 42 Countries)



Note: The NEER or the “trade-weighted currency index”, tracks changes in the value of a given country’s currency relative to the currencies of its principal trading partners. It is calculated as a weighted average of the bilateral exchange rates with those currencies. On the graph the NEER is calculated against the currencies of 42 countries, namely: EU28 + Australia, Canada, Japan, Mexico, New Zealand, Norway, Switzerland, Turkey, USA, Brazil, China, Hong Kong, Korea, Russia. The difference in the dynamics of the presented indices is mainly due to the different weights of the 42 countries in each specific index. An increase in the index would be interpreted as an appreciation of the particular currency against those of the selected 42 trading partners.

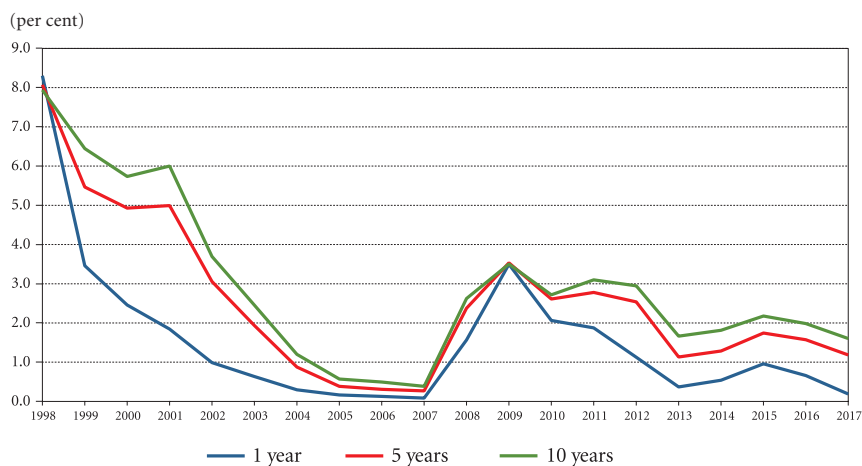
Source: European Commission, Price and Cost Competitiveness Data Section.

The ECB’s monetary policy, while targeting the inflation rate, may have an impact on the free floating euro exchange rate, depending on the degree of synchronisation or diversion between the ECB’s policy and other central banks’ monetary policy. In this respect the ECB’s monetary policy changes may affect the Bulgarian economy through the nominal effective exchange rate channel and its impact on the relative import/export prices.

With the introduction of the currency board the risk premium for Bulgaria has decreased significantly, which facilitated the transmission of the ECB’s monetary policy to the Bulgarian economy. However, differences in monetary conditions between Bulgaria and the EA may arise due to a risk-premium

that varies over time in line with market participants' assessment of economic fundamentals in Bulgaria and in the EA (see Figure 4).

Figure 4: CDS Rates for Bulgaria



Source: JP Morgan.

As the fixed exchange rate of the lev eliminates the exchange rate risk to the euro, the currency board facilitates trade integration with EU member states and the participation of the country in the global value chains (UNCTAD, 2013). In addition, with the free movement of capital, which is an indispensable attribute of the EU, the process of deepening financial interlinkages between Bulgaria and the EA, is made more efficient by the currency board.

The currency board accelerates the transmission of the monetary policy in the EA to the monetary conditions in Bulgaria through the foreign trade and financial channels. As far as the nominal effective exchange rate of the lev co-moves with the nominal effective exchange rate of the euro the exchange rate channel is also open to facilitating the transmission.

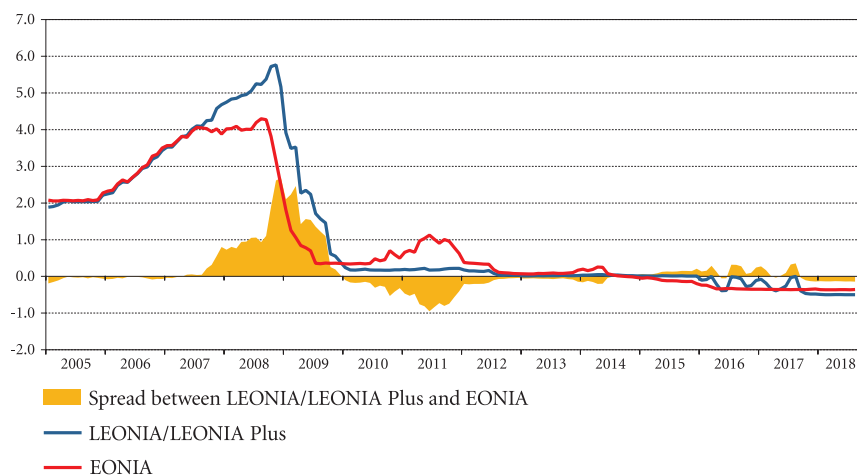
3.3. Prevalence of EA Banks in the Financial Sector

After the introduction of the currency board in 1997 the authorities initiated procedures for privatisation of state-owned banks. Most of the banks on sale became property of international banking groups established in the EA. The subsidiaries of EA based parent banks represent around 60 per cent of total bank assets in 2017.

Though the banks in Bulgaria have no direct access to the ECB financing facilities, the EA banks' subsidiaries, operating in the country, can borrow funds from their parent banks at rates close to the corresponding ECB's policy or at EA money market interest rates. The currency board guarantees the fixed exchange rate of conversion of euro to leva and leva to euro at any time on demand which can explain the co-movement between the overnight money interest rate in leva in Bulgaria and the overnight EA money market.

Figure 5: LEONIA and EONIA

(per cent, percentage points)



Note: With effect from 1 July 2017, LEONIA Plus index replaces LEONIA. LEONIA Plus monthly values are calculated as an arithmetic average for those days when overnight unsecured lending transactions are concluded in the interbank market in leva. For more information about the calculation of LEONIA Plus, see http://www.bnb.bg/PressOffice/POPressReleases/POPRDate/PR_20170316_EN

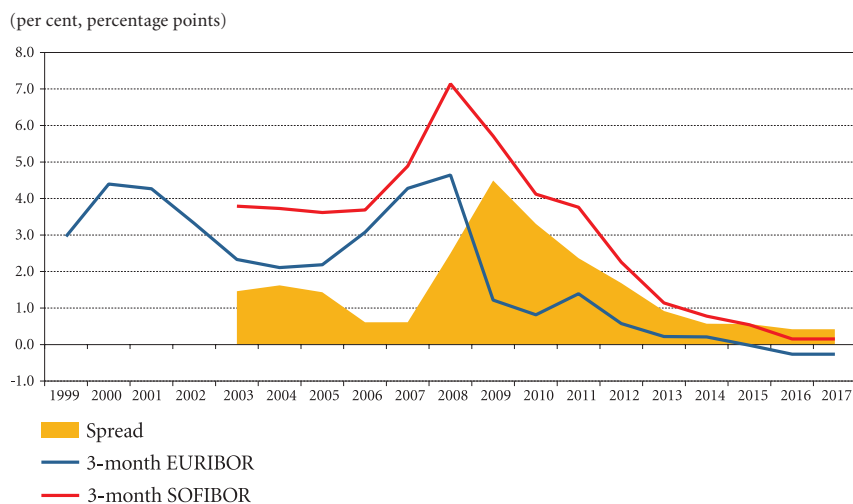
Sources: the BNB, the ECB.

One of the key principles of the currency board in Bulgaria is that the central bank does not refinance banks. Only in the case of a threat for a systemic banking crisis the central bank may provide the facility of a lender of last resort but at very stringent requirements to the borrower. Consequently banks manage their liquidity carefully and maintain additional buffers to safeguard their solvency while on its side the central bank assigns a higher level of liquidity and supervisory requirements and standards for the banks, operating in Bulgaria. Higher requirements for banks in Bulgaria increase the costs of funding which may cause the existence of positive interest rate spreads *vis-à-vis* similar products of the EA banking sector.

A clear cut example of a higher requirement is the level of the minimum required reserves. In Bulgaria the effective implicit minimum required reserve rate has averaged 9.4 per cent in the period September 2017 – August 2018⁷ while for the EA banks the rate is 1.0 per cent (lowered by the ECB from 2 per cent since 2012). Moreover, two of the five capital buffers as defined in Directive 2013/36/ EU – the capital conservation buffer and the systemic risk buffer, are set at their maximum so that the minimum capital adequacy ratio for banks in Bulgaria is 13.5 per cent compared to 8 per cent in general.

Based on the elaborated higher requirements and standards to the banking sector of Bulgaria, positive spreads may characterise money market interest rates of higher maturities, as well as deposit and lending rates. In addition, the perception of risk, which may fluctuate over time depending on the expectations about economic developments and policy changes in Bulgaria, may augment the positive interest rate spreads for longer term financial instruments.

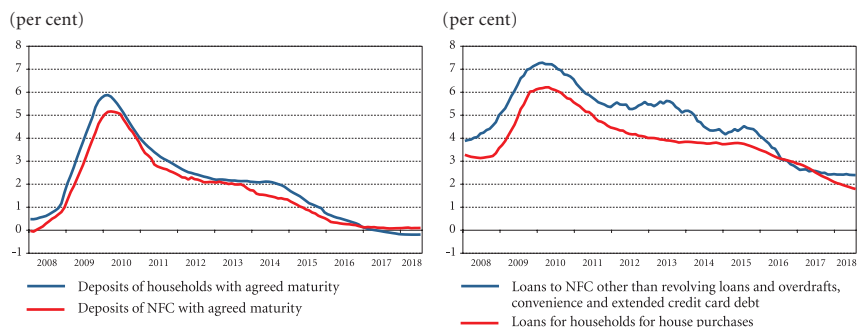
Figure 6: Spread between EURIBOR and SOFIBOR



Sources: the BNB, the ECB.

⁷ According to Article 3 of the new BNB Ordinance No 21 on the Minimum Required Reserves Maintained with the Bulgarian National Bank by Banks, effective as of 4 January 2016, the rate of minimum required reserves on funds attracted from residents remains at 10 per cent of the deposit base, from non-residents 5 per cent and from the state and local government budgets 0 per cent. Those rates of the minimum required reserves were introduced as of 1 January 2009.

Figure 7: Spread between Deposit and Lending Rates

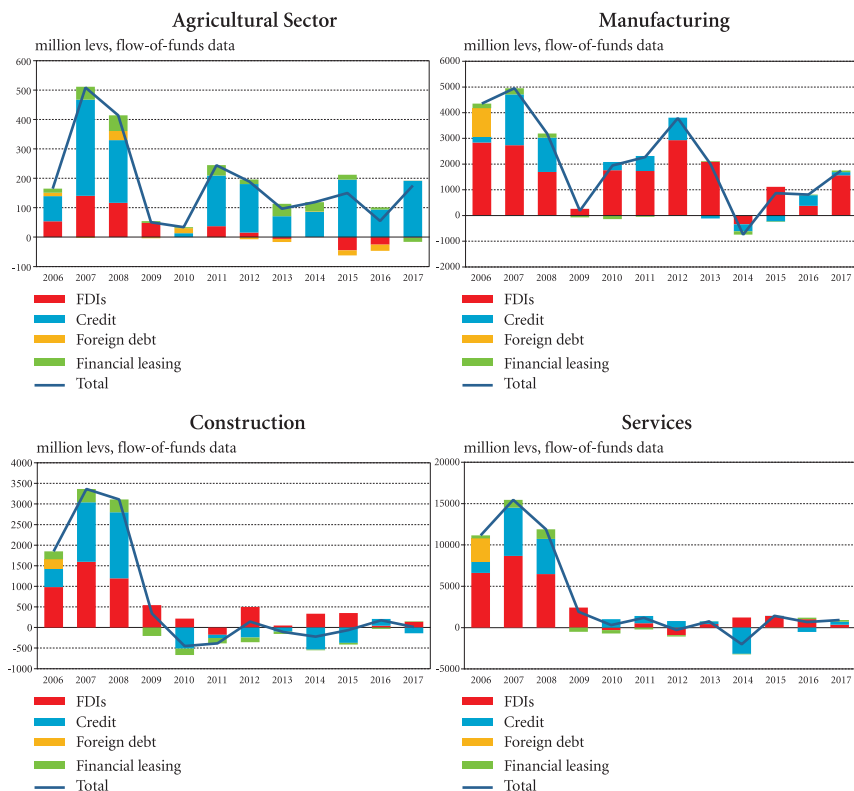


Sources: the BNB, the ECB.

The level of the deposit interest rates in Bulgaria are set by the individual banks in a rather competitive environment and depending on the abundance or scarcity of domestic financial resources, which comprise the bulk of banking sector attracted funds. Bank lending rates for households and corporations are usually calculated by adding a mark-up over a certain money market index, such as the EURIBOR (Mihailov, 2014) or recently adding a mark-up over a selected by the individual banks deposit interest rate. Companies in Bulgaria usually recourse to their gross operating surplus, which occupies the biggest share in their overall financing⁸. In respect to borrowed funds the structure of financing differs by sectors. According to data, agriculture resorts mainly to domestic bank credits while the share of external financing (FDI and debt) dominates in manufacturing, construction and services (excluding financial intermediation services and public services), related to the share of foreign ownership in those sectors.

⁸ The level of the operating surplus by sectors and the structure of borrowed funds of companies are presented in each issue of the BNB quarterly publication "Economic Review".

Figure 8: Sources of Financing



Note: Due to data limitations FDI flows are compiled following BPM 5 methodology for the period prior to 2014 and BPM 6 methodology thereafter. Credit flows are compiled following NCEA-2003 classification of economic activity prior to 2009 and CEA-2008 classification thereafter.

Source: the BNB.

Despite the more stringent macro- and micro-prudential requirements and hence higher costs of banking in Bulgaria, the subsidiaries of EA based parent banks can act as transmitters of the ECB's monetary policy to the monetary conditions in Bulgaria, although the transmission may be only partial depending on the actual circumstances. The financial inflows from the EA – foreign direct investments or external debt, which are not channelled through the domestic banks, but may affect their interest rates, also transmit the monetary conditions in the EA to Bulgaria. All those financial flows bring into being the interest rate channel of transmission of the ECB's monetary policy to the Bulgarian economy.

3.4. Instruments of the Bulgarian Central Bank to Influence the Monetary Conditions in the Country

Under the currency board, the BNB does not set a policy interest rate and does not conduct open market operations. Consequently, it does not avail of the standard monetary policy instruments to change the monetary conditions in the country. But the central bank may use the minimum required reserves to directly influence the liquidity in the economy and within the existing regulatory limits it may apply also macro- and micro-prudential tools to similar effect.

The regulation of the minimum reserve requirements that banks hold at the BNB represents the main instrument through which the central bank can affect the monetary conditions in the country and either accelerate the transmission of the ECB's monetary policy or slow it down. For example, during the economic boom between 2004 and 2007, a series of regulatory changes were adopted by the BNB, one of which was the increase of the minimum reserve requirement rate from 8 per cent to 12 per cent and the imposition of additional reserve requirements on banks that violate an administratively determined credit growth rate⁹. After the global liquidity squeeze that followed the Lehman Brothers bankruptcy in September 2008 the BNB undertook a series of measures to enhance the disposable liquidity of banks, one of the measures being the reduction of the minimum reserve requirement rate.

After the ECB introduced a negative interest rate on its deposit facility in June 2014, the banks operating in Bulgaria started to hoard excess reserves on their accounts with the BNB, the interest rate on these accounts being zero. To cope with this excess accumulation of liquid funds which was costly for the central bank, at the end of 2015 the BNB Governing Council adopted a new Ordinance No 21 on the Minimum Required Reserves maintained by Banks which entered into force on 4 January 2016. The main new provisions in the latter are the introduction of a definition for banks' excess reserves with the BNB and the application of the ECB deposit facility interest rate on the excess reserves when this interest rate is negative¹⁰. The BNB continued to apply a zero interest rate on excess reserves where the ECB deposit facility rate is positive or zero. As

⁹ For details of the BNB measures undertaken in the period 2005–2007 see the BNB Annual Reports for those years.

¹⁰ This was later changed in October 2017. The BNB introduced an extra minus 20 basis points on top of the ECB deposit facility interest rate, with which bank's excess reserves held at the BNB are charged.

regards the minimum required reserves, the BNB retained its policy of not incurring interest.¹¹

An important feature of the currency board in Bulgaria is the coverage of all monetary liabilities of the central bank by foreign reserves apart from reserve money (banknotes and coins in circulation and banks' deposits with the central bank). This wider coverage of monetary liabilities allows for the accumulation of buffers, which through changes in the minimum reserve requirements (set by the BNB), or through the fiscal policy measures, could be used to mitigate the effects of external shocks on Bulgaria's balance of payments flows and the economy as a whole.

3.5. A Summary of the Transmission Channels of the ECB's Monetary Policy to the Monetary Conditions in Bulgaria

The elaborated specific features of the economy have important implications for the transmission of the ECB's monetary policy to the Bulgarian economy. Due to the openness of the economy, its strong trade and financial links with the EA, we may expect that the trade and financial channels are very important. Apart from the impact on the demand for Bulgarian goods and services in the EA, the ECB's monetary policy, by advancing changes in the effective exchange rate of the euro, reflects on the nominal effective rate of the lev and hence influences the relative export and import prices in extra-EA trade of Bulgaria.

Through the financial channel and the prevalence in the Bulgarian banking sector of subsidiaries of EA based banks the ECB's monetary policy has a comparatively rapid effect on the domestic short-term money market rates. In terms of the funds attracted from parent banks, the ECB's monetary policy transmission works through their cost of funding which depends partially on money market rates in the EA. Then it has a secondary effect through bank assets, affecting lending interest rates, excess reserves and foreign assets of banks. Fluctuation of asset prices in Bulgaria (represented in this paper by house prices) has been determined in the past by the inflow of capital (foreign demand) and the growing income *per capita* (domestic demand). The free capital movement in the EU contributed for the important share of EU residents' demand for housing in Bulgaria.

In summary, given the close economic and financial integration of Bulgaria in the EU, the currency board with the exchange rate fixed to the euro and the prevalence of subsidiaries of EA-based banks, it should be expected that

¹¹ For details of the BNB policy see the BNB Annual Report for 2015, 2016 and 2017.

the ECB's monetary policy is transmitted to the Bulgarian economy by the following channels: foreign trade channel, nominal effective exchange rate of the Bulgarian lev and relative export/import prices, asset price channel and last but not the least through the interest rate channel.

4. Channels of Monetary Policy Transmission in the BNB Quarterly Projection Model (BNBQPM)

4.1. Short Overview of the BNBQPM

The transmission channels of the ECB's monetary policy to the economy of Bulgaria are examined within the large quarterly projection macro-econometric model of the Bulgarian National Bank (BNBQPM) which is the main macro-econometric tool used for forecasting and simulation purposes. The model is estimated on quarterly data and covers the main sectors of the economy and the existing interlinkages between them. The functioning of each sector of the economy is modelled in an error-correction framework. As such the model structure is based on the idea that the dynamics of a variable can be explained by the interaction of short-term factors capturing transitory phenomena and long-term ones capturing structural information, as embodied in a standard error-correction model. Some equations defining the short-term variation of each series include as an explanatory variable a lag term of the dependent variable as well¹², with the aim of this being a twofold one. First, there is strong economic reasoning supporting the lag term structure of some variables with a widely popular example of this being sticky prices and adaptive inflation expectations generating persistence in the HICP series. Second, including the lagged dependent variable as an explanatory one is used as a means to ensure that there is no residual autocorrelation if some existed in the initial specification of the equation.

In line with standard practices, the BNBQPM takes a certain number of predefined variables as inputs and makes assumptions about certain characteristics of the future economic and political environment. The assumptions and exogenous variables used are related mainly to the development of the external environment, including ECB's monetary policy decisions. The projected paths of selected variables describing the world economy are based on forecasts prepared by international institutions (ECB, EC, IMF, World Bank, OECD) or represent technical assumptions.

¹² Within the BNBQPM, these equations are the ones defining the unemployment benefits, the HICP and its components, the bank deposits, the total and household credit, and all deposit interest rates.

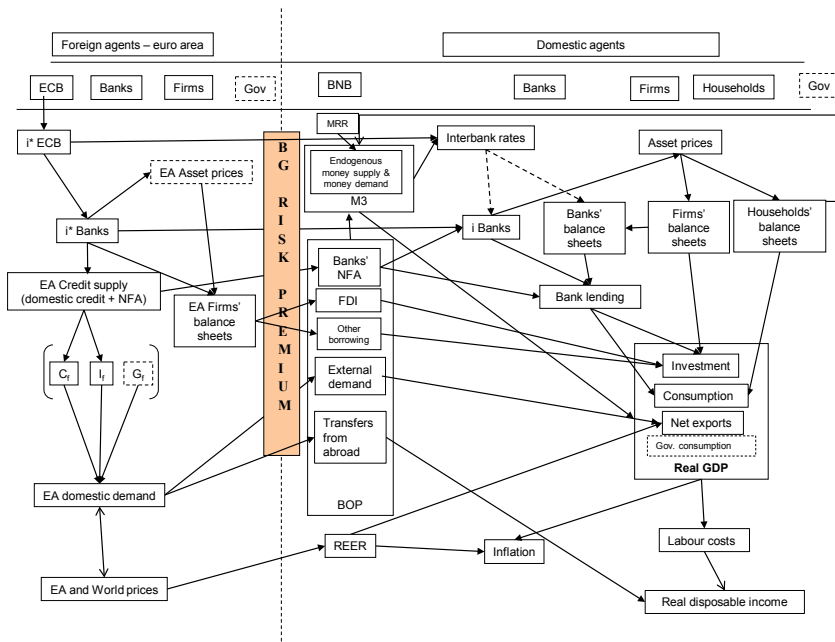
Conceptually, the BNBQPM can be viewed as consisting of six interacting blocks (real sector block, external sector block, price developments block, labour market block, monetary sector block and fiscal sector block), each producing forecasts for a key set of variables describing in a comprehensive way the Bulgarian economy. The separation of the model into these blocks is merely a notional device to delineate typical areas of analytical interest and is not indicative of the structural independence of the blocks. The structure of the BNBQPM with the main interrelations and propagation channels in the model could be found in BNB (2015b).

The rest of this section provides more information on the transmission channels of the ECB's monetary policy within the BNBQPM. The basic scheme of transmission from ECB's policy interest rates to economic activity and inflation is depicted in Figure 9. Once the policy rate is set by the ECB, the corresponding changes in the USD/EUR exchange rate¹³ and the EA interest rates are transmitted to both the EA countries and Bulgaria. The ECB's monetary policy decision then has an impact on prices and imported volumes (through its effects on domestic demand) of all EA countries. These effects are in turn transmitted to the Bulgarian economy via changes in the country's foreign demand and competitors' prices on the export side¹⁴. The BNBQPM captures the following channels through which the shocks are transmitted to the economy: (1) the foreign trade channel (comprising the trade spill-over channel and the exchange rate channel; (2) financial markets channel (comprising the interest rate, credit and the asset price channel). Due to model limitations, the expectations channel of monetary policy transmission is not accounted for.

¹³ In the paper the USD/EUR exchange rate is defined as how many U.S. dollars are needed to purchase one euro. Therefore an increase in the USD/EUR exchange rate should be interpreted as appreciation of the euro against the US dollar.

¹⁴ Competitors' prices on the export side are calculated as a double-weighted average of the export deflators of Bulgaria's competitors. In the first stage of the weighting scheme, the competitors' prices faced by Bulgarian firms in their individual export markets are calculated as a weighted average of competitors' export prices, with the weights reflecting the importance of each competitor with regards to the imports of that individual country. In the second stage, the competitors' prices faced by Bulgarian firms in each of its export markets are weighted according to the share of each market in Bulgaria's total exports, and aggregated. Competitors' prices on the import side are calculated following a similar approach. Further details can be found in Hubrich and Karlsson (2010).

Figure 9: Primary Transmission Channels and Spill-over Effects from the ECB's Monetary Policy



4.2. Transmission through the Foreign Trade Channel

In the context of foreign trade, changes in the ECB's policy rate are passed onto Bulgarian net exports through trade spill-over effects (mainly through the change in EA demand) and effects stemming from changes in the exchange rate.

4.2.1. Trade Spill-over Channel

Assuming that changes in the ECB's policy affect the economic activity of the EA, an increase in the main policy rate is expected to have a negative impact on the external demand for Bulgarian goods and services. This direct transmission can be attributed to the fact that the EA is the main trading partner of the country (in 2017 approximately 47 per cent of total exports of goods from Bulgaria are for countries from the EA) and to Bulgaria's high integration in global value chains (Ivanova and Ivanov, 2017). Apart from the direct demand transmission, the trade spill-over channel also includes a price effect. This price effect takes into account that a change in the ECB's policy rate would eventually affect the price level in the EA by altering the EA's domestic demand (despite that in this channel we assume no change in the effective exchange rate). As a result a policy rate increase is likely to lower export prices in the EA countries, which in turn will put pressure on Bulgaria's export price competitiveness provided that Bulgarian exporters do not adjust their export prices accordingly.

Within the BNBQPM the trade spill-over channel will mainly have an effect on real exports of Bulgarian goods. Real imports will react only to the extent to which domestic demand in Bulgaria changes as a result of the tightening of the ECB's monetary policy.

Real exports of goods are modelled as a function of external demand, price and non-price competitiveness¹⁶. External demand in the BNBQPM is taken as an exogenous variable and measures the real weighted imports of Bulgaria's main trading partners. The price competitiveness term represents a ratio of the export prices (export deflator) and a weighted average of the export prices of Bulgaria's competitors (exogenous to the model)¹⁷. Full transmission from a change in the external demand to the real export of goods from Bulgaria is assumed in line with Laxton et al. (1998) and Fagan et al. (2005). Therefore, a one percent decrease in the external demand for Bulgarian export as a result

¹⁶ The non-price competitiveness term accounts for the unobserved driver of exports growth beyond external demand and price competitiveness.

¹⁷ An increase in this price competitiveness term suggests that Bulgarian export prices grow at a higher rate compared to competitors' prices which would imply lower price competitiveness of Bulgarian exporters.

of an increase in the ECB's policy rate would transfer directly into a one percent decrease in export volumes. Given the estimated short-run and long-run equations for real export of goods from Bulgaria, we observe strongest transmission from changes in the ECB's monetary policy through the external demand component, whereas the effect through price competitiveness is of secondary importance. The error-correction term suggests a relatively fast adjustment back to equilibrium (from two to three quarters).

4.2.2. Exchange Rate Channel

Apart from the trade spill-over channel, the ECB's policy rate change will also affect Bulgaria's foreign trade via an exchange rate channel. When the ECB hikes its policy rate, return on EA assets is expected to increase compared to foreign assets and as a result the euro will appreciate in effective terms against other currencies (Bovin, 2010)¹⁸. Assuming similar price developments in Bulgaria and the EA, an appreciation of the euro against the US dollar will have a negative effect on the competitiveness of Bulgarian exports to countries outside the EA (given that their currencies do not appreciate in accordance with the euro). At the same time, as imports become cheaper, imported volumes in Bulgaria will increase and this could have a negative impact on consumption of domestically produced goods and services.

In technical terms, a change in the USD/EUR exchange rate, induced by a change in the ECB's policy rate, is reflected in several steps in the BNBQPM. Initially, we see the effect on export and import prices for Bulgaria, which depends on the characteristics of Bulgaria's foreign trade (product structure, geographical market orientation, currency invoicing). As these characteristics differ between exported and imported flows, we could expect that the terms of trade (measured as the ratio between the export deflator and the import deflator) will change as a result of an exchange rate shock.

The export and import deflators are modelled in the BNBQPM both in the short-run and in the long-run as a combination of domestic prices and external prices. Domestic prices are proxied by the GDP deflator, while external prices both on the import and export side represent a weighted average of prices in euro of five major commodity groups traded on international markets (oil, metals, food, agricultural raw materials and others). The estimation of the external prices on the export and import side takes into account the characteristics of Bulgarian exports and imports respectively (product

¹⁸ Changes in the euro area nominal effective exchange rate historically follow closely the movements of the bilateral USD/EUR exchange rate (see BNB (2015a)).

structure, geographical market orientation, currency invoicing¹⁹). Given this construction changes in the USD/EUR exchange rate impact external prices on the export and import side only to the extent to which trade is invoiced in currencies other than the euro. Considering the fact the share of Bulgarian trade with non-EU countries invoiced in currencies other than the euro is higher in imports than in exports, one would expect that an appreciation of the euro against the US dollar will lead to an improvement in the terms of trade for Bulgaria, assuming no change in domestic prices and in the price of inputs.

The relative importance of external and domestic prices for determining the dynamics of the export and import deflators is comparable as suggested by the estimated coefficients. Moreover, the error-correction term suggests that after a shock is introduced, both deflators return to their long-run equilibrium in approximately four quarters.

Movements in the USD/EUR exchange rate will be passed onto the exported volumes of Bulgarian goods via the price competitiveness term in the BNBQPM (both through the change in the export deflator and through the impact on export prices of Bulgaria's competitors). Additionally, appreciation of the EUR against the US dollar will lower EA's domestic demand which in turn will reduce Bulgarian exports.

Imported volumes to Bulgaria are modelled as dependent on demand for imported goods and a relative prices term (a ratio of the import deflator and the GDP deflator) in the BNBQPM. Therefore, it is the relative prices term through which changes in the exchange rate will be mainly transmitted to the real import of goods (via the import deflator and to a lesser extent via second-round effects on the GDP deflator). Moreover, lower exports as a result of the introduced appreciation of the euro will affect negatively Bulgarian import volumes.²⁰

¹⁹ We introduce the assumption that all trade transactions of Bulgaria with EU countries are invoiced in euro. Regarding the transactions with countries outside of the EU, the currency composition is estimated based on Eurostat data about the invoicing currency structure of export and import transactions of Bulgaria. Data suggests that the most commonly used currency for transactions between Bulgaria and non-EU countries is US dollars.

²⁰ Due to the import content of exports, that is incorporated in the demand for imported goods component.

4.3. Transmission through the Financial Markets Channel

4.3.1. Interest Rate Pass-through

Through the interest rate channel, monetary policy decisions of the ECB affect real economic activity in Bulgaria by changing key domestic interest rates, thus influencing consumption, saving and investment decisions of households and firms. First, changes in key ECB interest rates influence the costs of interbank borrowing on the money market in Bulgaria, to which banks subsequently react by adjusting their deposit interest rates. At the same time, the changes in the cost of bank financing influence the interest rates on loans provided by banks. Interest rates on deposits and loans then enter the decision making process of economic agents and affect key macroeconomic variables, such as the amount of credit extended to the private sector, consumption and investment in the economy.

a. Money market rates²¹

Section 3 outlined the main characteristics of the currency board arrangement in Bulgaria and pointed out that domestic money market developments in the country are expected to follow closely those in the EA. Against the observed tight historical co-movement between domestic and EA money market rates, the former have been modelled in BNBQPM as a linear combination of the contemporaneous 3-month EURIBOR and a country-specific short-term risk premium. This specification would imply a complete and simultaneous pass-through of the ECB's policy changes to domestic money market rates considering that risks perceptions remain unchanged.

b. Deposit rates

The transmission of the ECB's monetary policy changes to the domestic money market subsequently feeds into deposit rates of commercial banks. Deposit rates²² are modelled in an error-correction framework as dependent positively on the spread between three-month money market rates in Bulgaria and the EA and negatively on the ratio of bank deposits to bank loans. The purpose of including the money market spread in the deposit rates equation is to account for the country-specific risk premium relative to the EA market rate. The deposit-to-loans ratio is included to capture liquidity and availability of

²¹ The money market rate used in this simulation exercise is the 3-month SOFIBOR. The calculation and publication of the SOFIBOR index was discontinued by the BNB in July 2018 (for more information see BNB press release from 16 March 2017).

²² In the BNBQPM term deposit interest rates for the private non-bank sector are modelled.

loanable funds in the banking system, and is expected to be inversely related to the deposit interest rate²³.

The short- and long-run equations for deposit interest rates in the BNBQPM point to a higher sensitivity of deposit interest rates to changes in the deposit-to-loans ratio, compared to changes in the money market spread. This may be explained by the significant share of resident deposits in banking sector attracted funds, particularly after the global financial and economic crisis when households increased their savings rate. The estimated error-correction term coefficient suggests that equilibrium is restored within 7 quarters. In the short-run, deposit interest rates exhibit moderate persistence. Under the assumption of unchanged country-specific risk premium, as done in the simulations, the transmission of the ECB's monetary policy changes to deposit interest rates is an indirect one in the model and depends entirely on the adjustment of deposit and credit aggregates.

c. Lending interest rates

Lending rates for households and non-financial corporations are modelled separately in the BNBQPM. This breakdown allows for a more accurate evaluation of the monetary policy transmission mechanism as the pass-through to corporate and consumer lending rates could differ considerably²⁴. The specifications used for modelling these two types of lending rates capture effects associated with the cost of funds, borrower's risk profile, banks' balance sheet considerations and macroeconomic risks.

i. Lending rates for non-financial corporations

The interest rates on loans to non-financial corporations are modelled in an error-correction framework as a function of the three-month EURIBOR, the deposit interest rate, real exports and banks' non-performing loans to non-financial corporations. Deposit interest rates and the three-month EURIBOR approximate domestic and external financing costs, respectively. The inclusion of exports as explanatory variable for corporate lending rates aims to capture changes in borrower-inherent risk related to export-oriented companies. As real exports increase, export-oriented firms are likely to be able to repay more easily their loans and become more profitable and less cash-constrained, and as a result firm-specific credit risk in these companies is reduced. Furthermore, increasing exports indicate positive external environment developments

²³ The deposit-to-loans ratio employs bank-held private deposits and loans issued to the private sector.

²⁴ The rates are weighted across all maturity segments. Household lending rates are aggregated across overdraft, consumption, house purchase and other loans subcomponents.

which contributes to reducing banks' assessment of overall macroeconomic risks in the economy. The inclusion of non-performing loans of non-financial corporations reflects potential lower lending capacity of banks when non-performing loans are increasing, pushing banks to provide higher lending rates to firms.

In the long-run equation, the pass-through from changes in the three-month EURIBOR to domestic corporate lending rates is relatively strong. Probably due to the much higher weight of domestic liabilities in bank's balance sheets, the lending rate for non-financial corporations is estimated to be slightly more sensitive to the change in domestic financing costs compared to the EURIBOR. Changes in real exports and firms' non-performing loans have a less pronounced impact on corporate lending rates. The estimated value for the error-correction coefficient indicates that adjustment to equilibrium occurs in approximately two quarters. According to the short-run econometric specification, corporate lending rate dynamics is driven predominantly by changes in EA money market rates and to a lower extent by changes in the cost of domestic financing. In the short-run equation, corporate lending rate is also more sensitive to changes in exports as compared to changes in non-performing loans.

ii. Lending rates for households

Household lending rates are modelled in an error-correction framework that includes the Bulgaria – EA money market spread²⁵, the deposit interest rate for households²⁶, the residential property price²⁷ index and the average monthly wage in nominal terms. Again, deposit rates are meant to reflect cost-of-funds pricing effects, while the money market spread reveals information about the country-specific risk premium. Changes in EA monetary policy would transmit through their impact on domestic deposit rates, and possibly, via the risk premium if the spread between local money and EA market rates widens. Under the assumption of unchanged country-specific risk premium, the transmission of the ECB's monetary policy changes to the lending rate for households in Bulgaria will take place indirectly through their impact on the dynamics of the deposit interest rate for households, as well as through the

²⁵ Attempts to include the 3-month EURIBOR, as in the case for lending rates for NFC, revealed counterintuitive coefficient estimates, which is why the spread between 3-month money market rate in Bulgaria and the 3-month EURIBOR was chosen in the BNBQPM.

²⁶ The deposit interest rate for households is modelled in the BNBQPM in a similar way to the term deposit interest rate for the private non-bank sector.

²⁷ Residential property prices and house prices are used interchangeably in the text.

effect of the ECB's monetary policy changes on house prices and the labour market in the country.

The inclusion of house prices and wages serves a couple of purposes. House prices capture loan-specific collateral in the case of mortgage and consumption loans, respectively. Wages could be used as an additional proxy for borrowers' risk profile, lower wages implying higher risk on the loan repayment schedule; while house prices capture both collateral constraints and bank balance sheet effects. Lower house prices decrease the value of collateral and make it more difficult for borrowers to negotiate loans, resulting in a higher lending interest rate for households. Furthermore, lower residential property prices lead to a deterioration in the asset position of banks, given the significant amount of property posted as collateral in the banking system.

In the long-run equation, the estimated impact of changes to deposit rates for households is stronger as compared to money market spread changes. Furthermore, household lending rates appear to be slightly more sensitive to changes in house prices than they are to changes in the average monthly wage. The estimated error-correction term coefficient implies a return to equilibrium in a little more than two quarters. In the short-run, household lending rates are less sensitive to changes in deposit interest rates than they are to changes in the money market spread. The estimated importance of wages becomes less relevant in the short-run compared to the long-run equation, while changes in house prices are almost equally important in the short and the long-run.

4.3.2. Asset Prices

Changes in interest rates affect the prices of various types of assets and these changes in the market value of assets affect the decision-making process of households. The asset price channel in the BNBQPM is related to the impact of interest rates on house prices and accounts for the existence of substitution effects between savings, in the form of deposits, and investment in real estate. The direct effect of interest rates on house prices comes through its influence upon the amount that prospective house buyers can borrow from financial institutions. A more indirect effect of the ECB's monetary policy on domestic house prices comes through its influence on the income of households, which is another determinant of housing affordability and demand for housing.

A key determinant of house prices is domestic demand for housing, which is a function of the average housing loan level. Housing loan level is assumed to be a function of the amount that can be borrowed from a financial institution based on current disposable income and the existing mortgage interest rate.

The typical amount lent out by financial institutions to their customers is based on the present value of an annuity, where the annuity is some fraction of current disposable income, which is used for mortgage repayment and is discounted at the current mortgage interest rate for a horizon equal to the term of the mortgage. Thus, according to the financial literature the amount which can be borrowed is proportional to the household disposable income and inversely related to the mortgage interest rate.

Therefore, an upward shift in income or downward movements in the interest rate yields an increase in the average amount of mortgage credit available from banks. In turn, mortgage credit influences house prices. This reasoning is closely related to the notion of a housing affordability index frequently used in assessments of housing market developments and has been embodied in the BNBQPM.

Following the approach proposed by Kotseva and Yanchev (2017), house prices in the BNBQPM have been modelled within a VECM framework that simulates the dynamic interplay between prices and demand for housing. On the demand side, we distinguish between external demand (proxied by FDI in real estate²⁸) and domestic demand for housing. Domestic demand is approximated by an indicator based on GDP *per capita* and the current interest rate on new housing loans.

The short-run equation for house prices suggests that the adjustment to the long-run level takes approximately 5 quarters. The model structure and the magnitude of the estimated coefficients suggest that house prices in the short-run are driven mostly by their adjustment to the long-run equilibrium level. Prior to the global financial and economic crisis, large FDI inflows in real estate activities was another factor that played a key role for the dynamics of house prices in the short-run.

4.3.3. Deposit and Credit Aggregates

a. Credit to households²⁹

Credit aggregates are modelled as a mixture of demand- and supply-side factors: consumption/gross fixed capital formation (respectively in the equations for credit to households and credit to non-financial corporations), a price component, and an interest rate component.

²⁸ We use FDI in Real estate, renting and business activities as a percentage of GDP.

²⁹ The credit to households aggregate excludes loans extended under the National programme for energy efficiency of multi-family residential buildings.

More specifically, loans to households are modelled as being influenced, first, by real consumption, which reflects both a greater demand for credit as consumption goes up and increasing disposable income which allows this consumption and subsequently facilitates credit availability. Furthermore, HICP is added to account for the price component of credit, as the aggregate modelled is a nominal quantity and theory predicts that rising prices would stimulate credit demand. Lastly, the net interest spread (the spread between lending interest rate and deposit interest rate) for households is included to capture lending conditions for households and borrowers' specific credit risks. The intuition for including the spread, rather than only the lending rate for households is that changes in the lending rate alone might not be representative of how loose or tight credit conditions are relative to the overall financial conditions in the country. A widening net interest rate spread signifies less favourable borrowing conditions due to increased credit risks, thus exerting a negative influence on household credit. As evidenced by the relatively low value of the error-correction term coefficient in the econometric specification, speed of adjustment to the long-run level is slow, taking on average about 9 quarters.

b. Credit to non-financial corporations

Credit to non-financial corporations is modelled as a function of gross fixed capital formation, the HICP and the net interest rate spread defined as the difference between lending rates to non-financial corporations and long-term German bonds yields. The spread is used as a proxy for domestic entrepreneurial credit risk. Hence, a widening of the spread should affect adversely credit developments for firms. The inclusion of real gross fixed capital formation is meant to capture rising firm activity and a related pick-up of the demand for loans.

Estimation in an error-correction framework over the historical period shows that developments in credit to corporations are more sensitive to changes in investment prospects and prices than they are to changes in the interest spread in both the long- and the short-run equation. The adjustment to equilibrium takes less than three quarters. In the short-run investment developments seem to have a higher impact on corporate credit, while price and interest spread developments lose much of their explanatory power.

c. Deposit aggregates

The deposit aggregate captured in the model encompasses deposits by the private non-bank sector. Similarly to the stock of credit, in its specification it depends on real and price components as well as an interest rate spread.

Specifically, aggregate private deposits are modelled as a function of real private consumption, private consumption deflator and the spread between deposit interest rates for the private sector and the 3-month SOFIBOR. Aggregate deposits are expected to depend positively on real private consumption. The spread captures the relative attractiveness of deposits to savers, compared to the overall financial conditions in the economy and should also be positively related to the dynamics of deposits. Thus, if deposit rates are relatively higher than the benchmark money market interest rate, economic agents would be more willing to increase deposit savings.

In the long-run equation, the econometric specification shows that deposits react stronger to changes in the deposit rate-SOFIBOR spread than to changes in private consumption and price components. In the short-run, the error-correction term suggests adjustment to long-run steady state in just slightly above 3 quarters. Overall, these results incline us to anticipate more pronounced effects from the interest rate spread in the long-run, while the short-run deposit aggregate developments are expected to be dominated by real private consumption and equilibrating factors.

4.3.4. Long-term Government Bond Yields and Impact on Government Debt Interest Expenditure

The long-term yield in the BNBQPM is the long-term interest rate for convergence assessment purposes (LTIR)³⁰. LTIR is modelled in an error-correction form. In the long-run, domestic long-term yields are expected to co-move with the German long-term government bond yields, which are standardly used to represent risk-free rates. To account for local money market conditions, the spread between the 3-month SOFIBOR and the 3-month EURIBOR is also included in both the long- and short-term equations. Non-performing loans (NPLs), as an indicator of risks in the financial system, are also found to be positively related to long-term interest rates in the short- and the long-term. Moreover, as a large share of the Bulgarian government bonds is held by domestic financial institutions, the demand for government bonds is expected to decline if banks' financial resources and profitability are negatively impacted by higher NPLs.

³⁰ The LTIR is defined by the provisions of Article 140 of the Treaty establishing the European Community and Article 4 of The Protocol on the Convergence Criteria. The calculation of the LTIR for Bulgaria is based on secondary market transactions of central government bonds issued in national currency with maturity close to 10 years. LTIR data is available in daily and monthly frequency since 2003. More details on the data complication are available in http://www.bnb.bg/bnbweb/groups/public/documents/bnb_download/st_m_instr_ltir_en.pdf

The estimated coefficients in the long-run equation suggest a complete pass-through of changes in the German yields. In addition, the Bulgarian long-term interest rate reacts strongly to changes in the short-term money market spread. The estimated coefficients in the short-run equation point to a relatively weak reaction to changes in the German long-term rate. As indicated by the estimated error-correction term coefficient, the adjustment towards the long-run equilibrium is relatively fast (around three quarters). In the short-term, long-term interest rates show a relatively low persistency and are also less sensitive to changes in the short-term money market spread and NPLs as compared to the long-run relationship.

Changes in LTIR have an impact on 1) government interest payments; and 2) external debt, particularly that of “other sectors”³¹. Due to the long-term structure of government debt³², government interest payments are modelled as a function of LTIR. However, it should be noted that sensitivity of interest payment to changes in the LTIR is expected to be relatively low as interest payments on the predominant part of existing government debt are fixed and the share of government debt to be rolled over each year in the simulation period is around 1 per cent of GDP.

4.3.5. External Debt Financing and Flows Related to the Primary Income of the BOP

In the BNBQPM, the external debt of Bulgaria is obtained by summing up the external debt of the government, the banking sector, the FDI-related external debt and the external debt of other sectors. An ECB’s monetary policy tightening will affect external debt mainly via the long-term interest differential between Bulgaria and the EA as well as the debt service burden. The more the interest rate differential goes up, the more external debt is expected to increase, induced by the higher return on Bulgarian external debt. Increased interest rates will make it more difficult for economic agents to service their debt which will have implications for the overall stock of debt.

The increase in EA interest rates will also increase the burden of debt servicing which would affect the current account through the primary income balance. The primary income balance in Bulgaria has been negative since 2006, reflecting the high stock of foreign investments in the country and the related to it significant payments of interest on investments to non-residents. In

³¹ External debt excluding government gross external debt, direct investment-related debt and foreign liabilities of the banking sector.

³² The average residual maturity of government debt in 2016 is 7.8 years.

the BNBQPM the primary income balance is modelled in a single-equation framework and includes the stock of gross external debt, gross operating surplus and 3-month EURIBOR as determinants. Gross external debt and 3-month EURIBOR are included in the equation for income paid to non-residents as to account for that portion of primary income that is related to interest payments on external debt. When ECB tightens its monetary policy we could expect that the debt servicing burden for Bulgaria will increase, leading to higher primary income outflows. Gross operating surplus should be positively related to primary income outflows since increasing firms' profitability leads to increases in payment outflows (dividends paid to non-residents' on their foreign direct investments in Bulgaria).

4.4. Impact on Domestic Demand and Prices

This section focuses on how changes in the stance of the ECB's monetary policy feed through the various transmission channels to domestic demand and prices. Movements in the user cost of capital are a key determinant of domestic demand, whether it is investment goods, residential housing, or consumer durables. Consumption and investment decisions of economic agents are further affected by substitution effects between consumption, savings and investment as well as by movements in asset prices (house prices) via wealth effects and the corresponding impact on the value of collateral.

Standard applications of the life-cycle hypothesis of saving and consumption indicate that consumption spending is determined by the lifetime resources of consumers. In line with this reasoning in the BNBQPM private consumption³³ in the long-run is modelled by a number of factors, reflecting the financial resources of households allocated for consumption. In particular, in the long-run household's real private consumption is modelled as a function of bank credit to households³⁴ and a proxy for permanent income. Bank credit to households accounts for the impact of supply-side factors on households' credit (credit channel). Permanent income is approximated by the level of real

³³ In the BNBQPM model we work with private consumption, excluding imputed rent for dwelling services.

³⁴ The variable for bank credit to households refers to banks' claims on households and NPISHs, deflated by the HICP.

disposable income³⁵, the capital stock and real house prices³⁶. The variables about the capital stock and the housing price level capture the impact of the households' wealth on consumption. The use of house prices in real terms suggests that households will tend to increase their spending only in case that house prices grow at a faster pace than consumer prices.

In the spirit of large-scale macro-econometric models, the equation for private consumption is in an error-correction form, thus allowing for short-run variations of consumption from the expected long-run equilibrium path of consumer spending. One source of such short-run variations arises from possible substitution effects between current consumption and savings in the form of deposits. While the amount of bank credit to households accounts for the effects of credit constraints on households' consumption behaviour in the long-run equation, the nominal interest rate on household deposits is included in the short-run equation to account for the impact of monetary conditions on the households' saving rate. In the short-run households decide between consumption and savings on the basis of the interest rates on deposits.

The long-run equation for private consumption implies that the variation of the disposable income leads to higher changes in consumption than the rest of the equation's components' dynamics. The adjustment to the long-run path of consumption is estimated to be relatively slow and to take approximately 6 quarters. The model structure and the magnitude of the estimated coefficients suggest that the error-correction term (*i.e.* adjustment to the long-run path) and wealth effects (proxied by the change of relative housing prices) account for most of the dynamics of household consumption in the short-run period. Changes in real disposable income and nominal interest rates on household deposits also affect consumption spending in the short-run, though to a lesser degree.

According to the above setup, a tightening of the monetary policy in the EA in the form of higher short-term interest rates will have a direct negative impact on private consumption through the resulting limited availability of bank credit. Moreover, higher interest rates raise the discount rate applied to the income and service flows associated with homes, lowering their prices. The

³⁵ Real disposable income is calculated as the sum of nominal components of compensation of employees, net government social transfers, net income and current transfers from abroad deflated with the private consumption deflator.

³⁶ Real house prices measure the changes in the transaction prices of dwellings purchased by households adjusted for the impact of consumer prices. In the BNBQPM we use the deflated house price index which is the ratio between the house price index (HPI) and the national accounts deflator for private final consumption expenditure.

resulting decrease in total wealth will then dampen household consumption and aggregate demand. In the short-run, the increase in interest rates on household deposits will lower further consumption as it encourages consumers to save.

In the BNBQPM real private gross fixed capital formation is modelled within an error-correction form. The ECB's monetary policy affects investment activity in Bulgaria most directly through the change in the user cost of capital (direct interest rate channel), which in the BNBQPM is approximated by the nominal interest rate on corporate loans³⁷. In the long-run private investment is modelled as a function of potential sources of financing like the real gross operating surplus (GOS)³⁸, the stock of foreign direct investments in Bulgaria (measured by their ratio to total capital stock), the stock of external debt³⁹ and the monetary conditions that determine the availability of bank credit, namely lending interest rates on corporate loans. An additional risk premium, approximated by the difference between the lending rate to corporations and the long-term risk-free German rate is added to the user cost of capital in the simulation period. In addition to the above variables, we also include in the co-integration relationship the level of house prices (deflated by the GDP deflator) in order to capture possible balance sheet effects on firms and households. In the case of firms, increasing house prices which are a proxy for asset prices indicate an increase in the net worth of firms that could be used for collateral. Higher net worth and collateral values imply lower costs of financing and thus more investment. Regarding households, increasing house prices are associated with an easier access to mortgage credit (through the higher value of the collateral) and thus stronger demand for houses.

In addition to the error-correction term, changes in investment in the short-run are modelled as a function of changes in gross operating surplus, corporate lending interest rates and house prices. The short-run equation suggests that the adjustment to the long-run level takes approximately 4 quarters. Regarding the importance of the identified factors for investment, the magnitudes of the coefficients suggest that the variation of gross fixed capital formation in the short-run is determined mostly by the adjustment of investment to the long-

³⁷ We use corporate lending rates on new loans weighted by the relevant volumes for all maturities and currencies. Most of the new corporate loans tend to be with medium- to long-term maturity.

³⁸ The real gross operating surplus (obtained as a quotient of nominal gross operating surplus and the GDP deflator) is a proxy for firms' profits and its increase is expected to have a positive impact on investment.

³⁹ We use the stock of external debt other than FDI and external debt of financial institutions.

run path and by changes in gross operating surplus, followed by changes in asset prices and interest rates on corporate loans.

According to the above setup, a tightening of the ECB's monetary policy in the form of higher short-term interest rates will discourage directly private investment in Bulgaria through the bank lending channel and the balance sheet channel. Higher lending rates and more difficult access to bank financing (due to lower asset prices and the associated lower collateral value) will constrain firms' demand for bank credit, discouraging private gross fixed capital formation. ECB's monetary policy transmits indirectly to domestic investment activity through its impact on foreign trade (trade spill-over effects). Higher ECB policy rates will dampen the external demand for Bulgarian exports (see section 4.2), which will lead to a decrease in economic activity, profits (gross operating surplus) and hence the demand for investment.

In the BNBQPM inflation is measured by the Harmonized Index of Consumer Prices (HICP)⁴⁰. The HICP is modelled as a weighted average of four components: core inflation (services and non-energy industrial goods prices), food prices, energy prices (excluding administered prices) and administered prices. The ECB's monetary policy is transmitted to consumer prices through the trade channel and through its impact on domestic demand. Changes in the ECB's policy rates induce changes in the USD/EUR exchange rate and import prices of food and energy products, which are then passed through along the supply chain to consumer prices.

According to the model structure, import prices have a direct impact on domestic energy and food prices but they also influence core inflation through firms' production costs. In the long-run equation the modelling of core inflation is based on the concept of cost-push inflation. According to this setup, explanatory variables are the costs of production, namely unit labour costs and external prices on the import side. In the short-run the price level of core components is also influenced by demand-side factors (measured by private consumption) and inertia (lagged value of core inflation⁴¹). Clearly, a contractionary monetary policy of the ECB in the form of higher short-term interest rates will lower core inflation through the appreciation of the euro against the US dollar (foreign trade channel through changes in the exchange rate). Furthermore, as tighter monetary conditions in the EA are transmitted to

⁴⁰ HICP is used to construct other price indices in the BNBQPM, such as the private consumption deflator equation. Core prices are also used to construct the government consumption deflator and gross fixed capital formation deflator.

⁴¹ The lagged value of core inflation is a proxy for adaptive inflation expectations.

domestic interest rates, they will discourage private consumption and decrease production costs of domestically produced goods and services (through wage decreases). Lower demand and production costs are associated with lower core inflation.

In the long-run the food and energy price indices are modelled to follow the path of import prices of food and oil products, respectively. Unit labour costs are also included in order to account for domestic cost factors along the supply chain. The short-run equation for food prices represents the adjustment of food prices to their long-run equilibrium level. The short-run equation with an error-correction term includes as explanatory variables lagged food inflation and dummy variables to account for specific harvesting conditions in the past. The short-run specification of the energy price equation determines the quarterly rate of change of energy prices conditional on: the deviation of energy prices from the long-run equilibrium level, lagged inflation and import prices of oil products. A contractionary monetary policy of the ECB in the form of higher short-term interest rates will lead to similar effects as in the case of core prices, with differences stemming from the degree of the exchange rate pass-through.

5. Model Simulations⁴²

5.1. Design of the Simulations

In the design of the simulation we employ a two-step approach. First off, we select the exogenous to the BNBQPM variables through which the change in the ECB's monetary policy will be transmitted (as described in section 4.1.) and estimate the magnitude of the respective exogenous shocks. As a second step we introduce these exogenous shocks to the BNBQPM in order to quantify the impact of the ECB's monetary policy change on the domestic economy. Overall, we identify and apply four shocks to the BNBQPM that would correspond to a scenario of a monetary policy tightening by the ECB: namely, these are changes compared to the baseline in the EA short- and long-term interest rates, in the nominal effective exchange rate (proxied by the USD/EUR exchange rate), and in the trade spill-over (represented by a combined change in external demand and competitors' prices on the export side).

The shock in EA short-term rates is defined as a temporary increase of the 3-month EURIBOR by 100 basis points as implemented in similar policy experiments for the EA and the Baltics (see for example Smets (1995), van Els

⁴² All changes in the macroeconomic variables discussed in this section as a result of ECB monetary policy tightening represent percentage deviation from baseline levels.

et al. (2001), McAdam and Morgan (2001), Vetlov (2004) and Kattai (2005)⁴³. In the aforementioned studies, the shock is implemented as an eight-quarter level shift of the EURIBOR by 100 basis points. In similar fashion we apply an increase of the same size for the first four quarters, but however assume gradual convergence towards baseline values for the consequent eight quarters of the simulation.

Following van Els et al. (2001) and Fagan et al. (2005) long-term interest rates are expected to react to the monetary shock in line with the expectations hypothesis and are assumed to initially increase by 20 basis points compared to the baseline before gradually returning to baseline values in the course of two years. While acknowledging that this assumption is subject to the Lucas critique and does not incorporate any changes in the term structure of interest rates induced by the widely used by the ECB over the last decade unconventional monetary policies, we still believe that the current design of the simulation is informative for analysing the role of individual channels of transmission.

To simulate the appreciation of the euro against other currencies as a result of higher interest rates, we follow McAdam and Morgan (2001). The authors rely on a modified uncovered interest parity to simulate the expected appreciation of the euro after a monetary shock with the Area Wide Model (AWM). During the first year of the simulation the euro appreciates against all currencies that are not fixed to the euro by 0.88 per cent, while in the second year it returns to slightly below baseline values (-0.05 per cent). This response of the exchange rate to changes in the short-term interest rates is somewhat weaker than what would be expected under the standard uncovered interest rate parity condition (see Els et al. (2001) and Fagan et al. (2005)). The applied modification is motivated by the increasingly high correlation between interest rate policies across the world and especially in Europe.

The assumed changes in short- and long-term interest rates in the EA compared to the baseline as well as the exchange rate are then used in simulations with the STE toolbox⁴⁴ to arrive at the combined change in foreign demand and

⁴³ In some of these studies it is acknowledged that the assumption for exogenous movement of short-term interest rate is not very realistic as in reality short-term rate are endogenously determined on the basis of a Taylor rule type of relationship. The assumption for truly exogenous shocks in short-term interest rates, long-term interest rates and the exchange rate is also imbedded in the STE tool. Given our reliance on the STE tool for assessing the induced-by-monetary-policy change in foreign demand and competitors prices relevant for Bulgaria, we are left with no other option but to follow the same approach.

⁴⁴ The STE platform combines National Central Banks' models into a multi-country EU-wide simulation tool, which allows simulating exogenous shocks (to real economic variables and some financial asset prices) to derive responses for a wide range of endogenous model variables covering each of the 28 EU countries.

competitors' prices, relevant for the Bulgarian economy. As a result of the introduced tightening of the monetary conditions in the EA, trade spill-over effects have a contractionary impact on the Bulgarian economy as both foreign demand for Bulgarian goods and services and competitors' prices decrease relative to the baseline⁴⁵.

In all simulations with the BNBQPM, we assume unchanged domestic fiscal policy. Nominal government spending (with the notable exclusion of social payments) and non-tax revenues remain at their baseline levels. The expected worsening of the budget balance compared to the baseline as a result of both lower tax revenues and higher interest and social payments is financed through the fiscal reserve, while the level of government debt remains unchanged and the debt ratio is only affected through the denominator. The monetary policy instrumentarium, available to a central bank, is constrained in Bulgaria given the currency board arrangement. Possible measures at the disposal of the Bulgarian National Bank, including changes in the minimum reserves ratio, and the macro-prudential policy tools are assumed to remain unchanged throughout the simulation horizon as well.

The change in the ECB's monetary policy is expected to affect the user cost of capital to an extent exceeding the simulated impact on corporate lending rates due to an assumed increase of the non-bank financing costs. This stronger reaction of the user cost of capital in the BNBQPM is introduced by allowing changes in the spread between the lending rate to corporations and the long-term risk-free German government bond yield rates⁴⁶ to affect firms' investment decision making in the long-run. The elasticity of private investment to changes in the spread is assumed to be equal in amount to the historically observed elasticity of private investment to domestic lending interest rate. This stems from the presumption that this elasticity coefficient captures changes in investment with respect to risk as the latter is a component of the interest rate. It has to be noted that the change of the risk premium depends adversely on the assumed response of long-term rates in the EA and

⁴⁵ The assumption that developments in the home economy do not influence developments in the euro area is also standard in VAR-based studies on the monetary transmission mechanism in Baltic countries (see for example Stakenas, J., & Stasiukynaitė, R. (2016). Monetary policy transmission: the case of Lithuania. *Baltic Journal of Economics*, 17(1), 1. and Errit, G., & Uuskula, L. (2014). Euro area monetary policy transmission in Estonia. *Baltic Journal of Economics*, 14 (1–2), 55–77.

⁴⁶ For the purposes of the simulation in the scenario of a monetary tightening by the ECB, the 10-year German government bond yield rates are assumed to react in the same way as the shock in the 10-year EA government bond yield rates – namely, an initial increase by 20 basis points, followed by a gradual return to baseline values in the course of two years.

Germany. The weaker the assumed pass-through to long-term rates in the EA, the stronger will be the increase of domestic entrepreneurial risk premium.

Table 1. Calibration of the Simultaneous Shocks to EA Short- and Long-term Interest Rates, Competitors' Prices, Foreign Demand and the USD/EUR Exchange Rate

	Year I	Year II	Year III	Year I				Year II				Year III			
				Q I	Q II	Q III	Q IV	Q I	Q II	Q III	Q IV	Q I	Q II	Q III	Q IV
EURIBOR (percentage points)	1.00	0.69	0.19	1.00	1.00	1.00	1.00	0.88	0.75	0.63	0.50	0.38	0.25	0.13	0.00
USD/EURO (per cent)	0.88	0.30	0.00	0.88	0.88	0.88	0.88	0.65	0.42	0.18	-0.05	0.00	0.00	0.00	0.00
Trade spillover via:															
(1) Foreign demand (per cent)	-0.09	-0.24	-0.22	-0.02	-0.06	-0.11	-0.16	-0.20	-0.24	-0.26	-0.27	-0.27	-0.25	-0.21	-0.17
(2) Competitors' export prices (per cent)	-0.10	-0.11	-0.09	-0.07	-0.10	-0.12	-0.13	-0.13	-0.11	-0.10	-0.08	-0.08	-0.09	-0.09	-0.09
EA 10Y BONDS (percentage points)	0.18	0.10	0.02	0.20	0.19	0.17	0.16	0.14	0.11	0.09	0.06	0.05	0.03	0.02	0.00

5.2. Simulated Impact on the Domestic Economy

As previously discussed, in order to study the reactions of domestic output and prices after a monetary policy change in the EA, we simulate simultaneous changes to EA short- and long-term interest rates, trade spill-overs and the USD/EUR exchange rate.⁴⁷ A short overview of the cumulative responses of selected key macroeconomic variables to the scenario of the ECB's monetary policy tightening is presented in Table 2.

Overall, real GDP's deviation from the baseline level equals -0.16 per cent at the end of the simulation horizon. The monetary conditions tightening causes consumers and firms to reduce their spending, while at the same time exports of goods and services contract mainly due to the reduced external demand. Consequently imports of goods and services remain at levels below baseline, following the observed decline in all domestic demand components, as well as exports. The assumed EURIBOR hike is fully transmitted to the domestic money market rate, and partly to the lending rate for households. Subsequently other domestic interest rates follow, which in turn, and against the background of decreasing aggregate demand, leads to a drop of both asset prices and credit to the non-government sector compared to the baseline level. Price and labor developments, granted being at levels under their baseline values at the end of the simulation horizon, show relatively weak elasticity to the ECB's monetary policy changes. The path of the impacts of all variables considered points to a

⁴⁷ The appendix includes detailed tables with the responses of the key macroeconomic variables in the BNBQPM to each of the abovementioned shocks, with the size of the individual shocks normalised to 1 per cent.

Table 2. Simulation Results

Percentage deviations from baseline*	Year I	Year II	Year III	Year I				Year II				Year III			
				Q I	Q II	Q III	Q IV	Q I	Q II	Q III	Q IV	Q I	Q II	Q III	Q IV
Real output															
GDP	-0.07	-0.23	-0.20	-0.02	-0.05	-0.08	-0.13	-0.19	-0.23	-0.25	-0.25	-0.24	-0.22	-0.19	-0.16
Private consumption	-0.02	-0.15	-0.19	0.00	-0.01	-0.02	-0.05	-0.09	-0.14	-0.17	-0.19	-0.20	-0.20	-0.18	-0.16
Investment	-0.19	-1.29	-0.89	-0.01	-0.09	-0.25	-0.41	-0.93	-1.48	-1.43	-1.35	-1.19	-1.00	-0.80	-0.58
Exports (goods and services)	-0.09	-0.25	-0.24	-0.02	-0.06	-0.11	-0.16	-0.21	-0.24	-0.27	-0.28	-0.27	-0.26	-0.23	-0.19
Imports (goods and services)	-0.06	-0.40	-0.36	0.00	-0.03	-0.08	-0.14	-0.28	-0.42	-0.44	-0.45	-0.43	-0.39	-0.33	-0.22
Price developments															
HICP	-0.04	-0.06	-0.06	-0.02	-0.03	-0.04	-0.05	-0.06	-0.07	-0.07	-0.06	-0.06	-0.06	-0.06	-0.05
Export deflator	-0.06	-0.06	-0.04	-0.05	-0.06	-0.07	-0.07	-0.07	-0.07	-0.06	-0.04	-0.04	-0.04	-0.03	-0.03
UIC	-0.03	-0.08	-0.06	-0.01	-0.02	-0.03	-0.05	-0.07	-0.09	-0.08	-0.08	-0.07	-0.06	-0.05	-0.04
Labour market															
Employment	-0.01	-0.04	-0.04	0.00	-0.01	-0.01	-0.02	-0.03	-0.04	-0.05	-0.05	-0.05	-0.04	-0.04	-0.03
Unemployment rate	0.01	0.04	0.04	0.00	0.01	0.01	0.02	0.03	0.04	0.05	0.05	0.05	0.04	0.04	0.03
External developments (per cent of GDP)															
Balance on goods and services	0.00	0.11	0.08	0.00	0.00	0.00	0.01	0.07	0.13	0.13	0.12	0.10	0.09	0.07	0.05
Current account plus capital account	-0.29	-0.07	0.03	-0.30	-0.29	-0.28	-0.28	-0.18	-0.07	-0.04	-0.01	0.01	0.03	0.04	0.06
Fiscal developments (per cent of GDP)															
Government primary budget balance	0.00	-0.02	-0.03	0.00	0.00	0.00	0.00	0.00	-0.01	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Interest spending	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Financial market and asset price developments															
Money market rate	1.00	0.69	0.19	1.00	1.00	1.00	1.00	0.87	0.75	0.63	0.50	0.38	0.25	0.13	0.00
Lending rate to non-financial corporations	0.51	0.54	0.27	0.39	0.49	0.55	0.60	0.59	0.57	0.52	0.47	0.40	0.32	0.23	0.14
Lending rate to households	0.03	0.12	0.13	0.00	0.01	0.03	0.06	0.09	0.12	0.13	0.14	0.14	0.14	0.12	0.11
Long-term interest rate	0.14	0.16	0.06	0.00	0.13	0.20	0.21	0.20	0.18	0.15	0.12	0.09	0.07	0.05	0.04
House price index	-0.07	-0.47	-0.61	0.00	-0.02	-0.07	-0.17	-0.29	-0.42	-0.54	-0.61	-0.65	-0.65	-0.61	-0.55
Credit to non-government sector	-0.91	-1.41	-1.03	-0.15	-0.40	-0.66	-0.91	-1.09	-1.23	-1.36	-1.41	-1.40	-1.32	-1.20	-1.03

* The real output and price developments variables, employment, house price index and credit to non-government sector are all expressed as a percentage deviation from baseline. The remaining variables represent an absolute difference from baseline.

smooth decay of the policy change effect. Whereas the variables do not return to their respective baseline levels within the simulation horizon, the gradual decrease of the contractionary effect still signals that the ECB's policy change should have only a temporary effect on the economy.

Apart from the summarised results in Table 2, the paper also discusses in more details the extent to which the transmission of the ECB's monetary policy change on certain macroeconomic variables for Bulgaria is caused by trade spill-overs, changes in the exchange rate or changes in the EA's interest rates. To that aim the analysis decomposes the cumulative impulse responses of the selected variables into the contributions of the outlined exogenous shocks that represent the ECB's monetary policy tightening scenario. The lines in the graphs below correspond to the impulse reactions in the simulation with a simultaneous change in all exogenous variables⁴⁸, while the bars represent the contribution of each of the exogenous assumptions to the overall change in the respective variable as compared to the baseline⁴⁹. In order to estimate the contribution of each exogenous shock, we run four consecutive simulations, each time adding up a new shock to the ones already introduced. The first simulation incorporates only the short-term EA interest rate. We then introduce an additional shock each round and the difference in the results between the current and the previous round's cumulative response represents the contribution of the newly introduced shock. Apart from the short-term interest rate the other shocks that appear in the simulation are trade spill-over (combined effect on external demand and competitors' prices on the export side), the USD/EUR exchange rate and EA long-term interest rates.

We first discuss one of the channels where the transmission of the ECB's monetary policy tightening is observed to be most direct and significant for the overall change in the Bulgarian economic activity, namely the foreign trade channel. The rapid response of real exports and thereafter domestic output to changes in economic developments in the EA can be explained by Bulgaria's high degree of trade openness and integration in global value chains (Ivanova and Ivanov, 2017). Lower exports compared to the assumed in the baseline, as a result of the ECB's monetary policy tightening, will in turn trigger second-round effects such as lower companies' profits, labour demand and wages. The respective decline in gross operating surplus and disposable income will likely result in a decline in private investment and consumption, leading to a

⁴⁸ This approach is considered to be superior to simply adding the responses from four different simulations with only one assumption changing at a time.

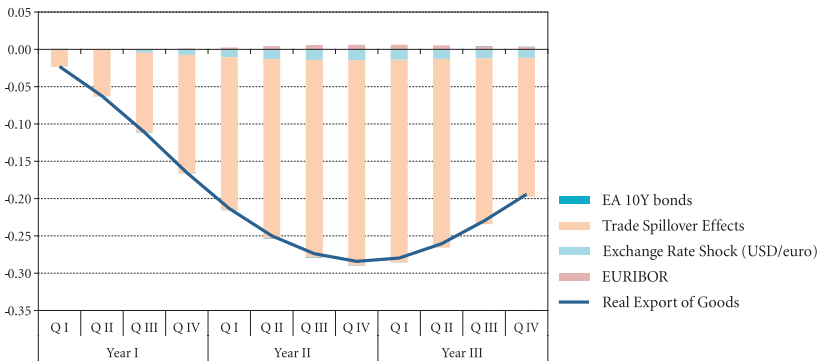
⁴⁹ Please note that the change in foreign demand and competitors' prices are combined in one simulation, named "trade spill-over effects".

contraction of real GDP, which is partially offset by the induced contraction in real imports.

5.2.1. Impact from the Functioning of the Foreign Trade Channel

The foreign trade channel is dominated mainly by the impact on exports of goods, which represents the GDP component to contract most significantly compared to its baseline level in the first quarter of the simulation (-0.03 per cent). This is due to the immediate and combined negative impact from the trade spill-over effect and the exchange rate effect which result in lower foreign demand and deteriorating price competitiveness. The decline of exports as a result of the simulated scenario relative to baseline is maximised in the last two quarters of the second year (-0.28 per cent). Given the design of the simulation, the impulse response function of real exports is expectedly humped-shaped. At the end of the three-year simulation horizon, exports remain 0.19 per cent below their baseline level. Throughout the simulation horizon, the impact of contractionary trade spill-over effects explains most of the decline in exports, while the contribution of the negative effects stemming from the appreciation of the USD/EUR exchange rate is significantly less pronounced. The interest rate channel has an insignificant role for the simulated reaction of real exports.

Figure 10: Response of Real Exports of Goods*

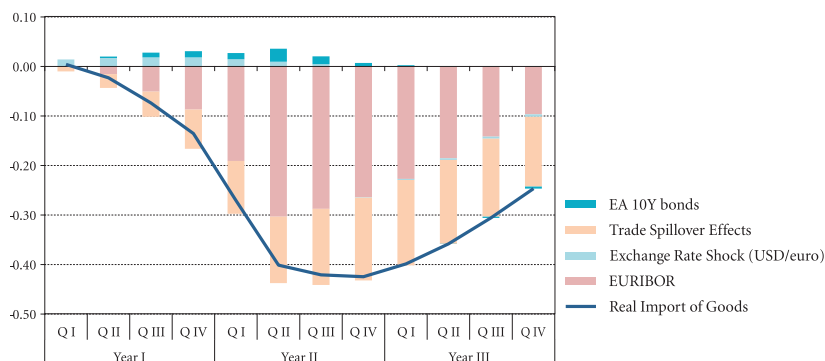


* Deviations from baseline in per cent, percentage points.

As a result of the ECB’s monetary policy tightening, real imports are expected to adjust downwards relative to the baseline. The maximum decline of imports of goods (0.42 per cent deviation from the baseline path) is reached a year and a half after the beginning of the simulation. The main channel through which the transmission flows is the induced change in Bulgaria’s domestic demand

components and exports. Due to its highest import content, investment is more important in determining import dynamics, compared to exports and consumption.⁵⁰ The negative impacts stemming from both the interest rate and the trade spill-over channel follow a gradually increasing and then decaying path, the former reaching its maximum negative contribution in the sixth quarter of the simulation, and the latter in the beginning of the last year. The contractionary interest rate induced effect however fades away at a faster pace compared to the trade spill-over one, and in turn over the last two quarters reduced exports appear to be the main dampening factor to imports. The negative effect on real imports compared to the baseline as a result of the ECB's monetary policy tightening is partly offset by the positive contribution of relative prices of imported to domestically produced products – as the exchange rate appreciates in effective terms, imports become cheaper which stimulates an increase in imported volumes. However, after the first seven quarters of the simulation the decline in domestic prices relative to their baseline levels is more substantial than the decline in import prices (due to the slowdown of the domestic economy) which contributes to the observed decline in imports.

Figure 11: **Response of Imports of Goods***



* Deviations from baseline in per cent, percentage points.

The tightening of the ECB's monetary policy and the following appreciation of the euro against the US dollar results in relatively small declines in both the export and import deflators in the first two years of the simulation. The highest decline in the export and import prices relative to the baseline is reached four quarters after the beginning of the simulation at -0.07 per cent

⁵⁰ Changes in the Bulgarian domestic demand components as a result of the ECB's monetary policy tightening are explained in details in section 5.2.3.

and -0.1 per cent, respectively. As expected, the terms of trade improve due to the appreciation of the euro against the US dollar as the decline of the import deflator is somewhat larger as compared to the reaction of the export deflator.

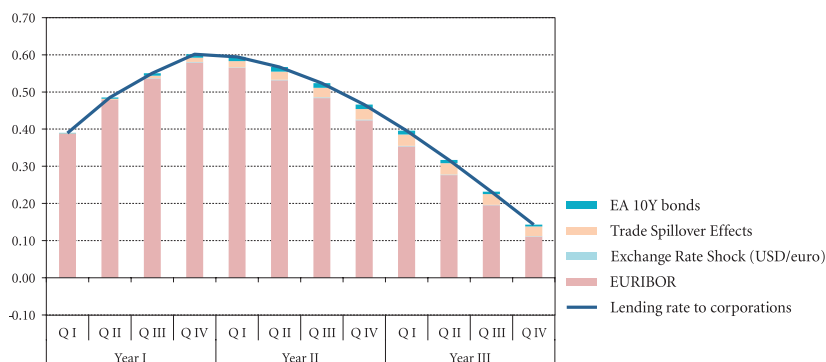
Having discussed the reaction of the real and price components of the foreign trade variables, we can analyse the resulting effect on the balance of goods and services. As a result of the simulation, this balance in ratio to GDP deteriorates marginally relative to the baseline scenario only in the first year of the simulation as the speed of decline of nominal exports is somewhat higher than that of imports. For the rest of the projection horizon, however, the decline of real imports exceeds that of real exports and the balance increases as compared to the baseline. The maximum improvement in the overall balance of goods and services is reached in the second year of the simulation (0.13 per cent of GDP). The improvement in the balance as per cent of GDP after the first year is driven almost entirely by the change in the real volumes of exports and imports.

5.2.2. Impact from the Functioning of the Financial Channel

Changes in the 3-month EURIBOR affect directly domestic money market rates and lending rates for corporations, while the channel of transmission to deposit rates is less direct and is triggered mainly by changes in the loan-to-deposit ratio. Following the increase of deposit interest rates compared to the baseline, the reduced value of real-estate type of collateral and the subsequent decline of wage earnings, lending rates for households also increase. Last but not least, the adjustment of long-term government bonds yields is driven mainly by the simulated increase of long-term rates in the EA.

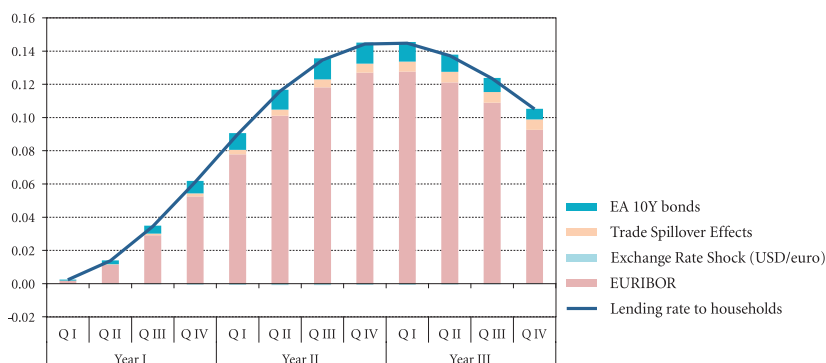
The speed and the degree of adjustment of the different interest rates modelled in BNBQPM, however, vary significantly. Domestic money markets rate increases relative to the baseline with the same amount as the induced hike in the EURIBOR, a result of the assumed full pass-through from the latter to the former. The rise in short-term interest rates in the EA is transmitted relatively quickly to lending interest rates for non-financial enterprises in Bulgaria as well. The maximum increase as compared to baseline (60 basis points) is reached in the fourth and fifth quarter after the beginning of the simulation.

Figure 12: Response of Lending Rates to Corporations*



* Deviations from baseline in per cent, percentage points.

Figure 13: Response of Lending Rates to Households*



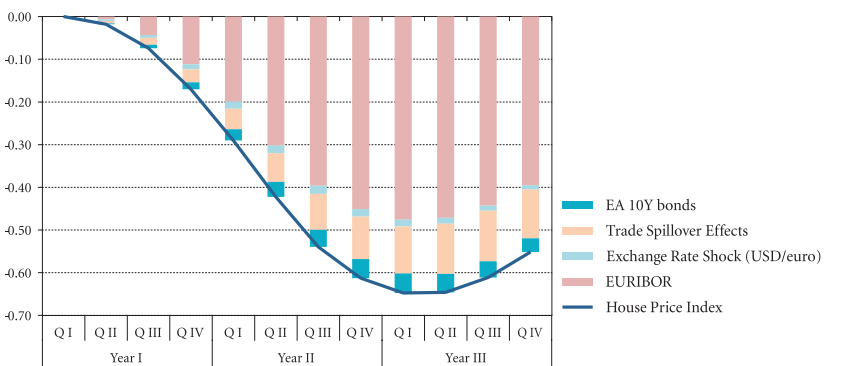
* Deviations from baseline in per cent, percentage points.

The pass-through to deposit rates is weaker (24 basis points at maximum) and is reached a year and a half after the beginning of the simulation. The reaction of lending rates for households is even less pronounced with the maximum increase of 15 basis points relative to the baseline observed almost two years after the initial monetary policy change in the EA. Under the assumption of unchanged short-term country-specific risk premium, the main driver of the simulated increase of domestic long-term government bonds yields is the simulated increase of risk-free German government bonds. The impact of second-round effects from deteriorating loan quality following the increase of lending interest rates and the contraction of domestic output is more

limited. As compared to baseline the maximum increase of long-term rates by 21 basis points is reached relatively fast – already in the fourth quarter after the beginning of the simulation.

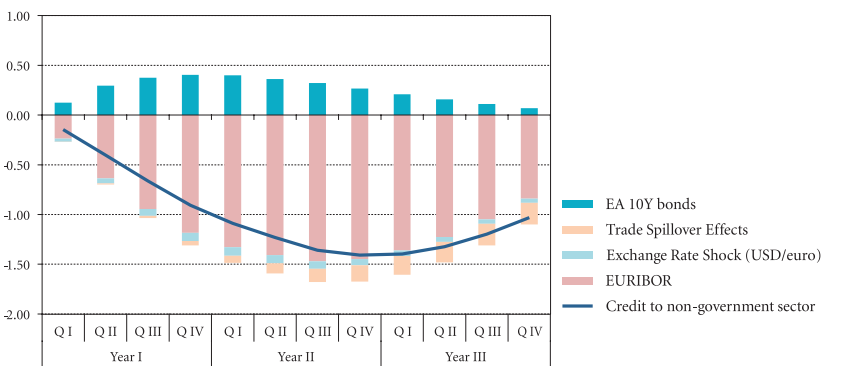
Following largely the increase of domestic interest rates, house prices decline, but their response is somewhat delayed and the maximum decline of -0.65 per cent from the baseline level is reached only in the beginning of the third year of the simulation. Due to the dependence of house prices on GDP *per capita*, they are also negatively affected by the reaction of output to the contractionary trade spill-over impact.

Figure 14: Response of House Prices*



* Deviations from baseline in per cent, percentage points.

Figure 15: Response of Private Sector Credit*



* Deviations from baseline in per cent, percentage points.

As expected, total bank lending to the private sector declines following the simulated monetary policy change in the EA. The maximum decline of credit (by 1.4 per cent as compared to the baseline level) is observed at the end of the second year of the simulation. This observed fall of credit relative to the baseline is almost entirely due to the decrease of lending to non-financial corporations, whereas lending to households falls slightly below baseline values only in the last couple of quarters. In contrast to household lending, corporate lending declines significantly as compared to baseline, reaching its trough eight quarters after the beginning of the simulation, and the negative effect gradually begins to fade away afterwards. The initial drop in non-financial corporations' credit is largely driven by the widening spread between corporate lending rates and the risk-free German long-term rates⁵¹. The hike in EA long-term rates has limited but positive impact on corporate lending. While counterintuitive, this can be explained by the design of the simulation exercise⁵². While the interest rate spread remains the main dampening factor on credit growth, second-round effects stemming from lower private investment and prices have some negative impact as well.

5.2.3. Response of Domestic Demand and the Labour Market

In line with economic theory and with the majority of empirical studies, private investment in our simulation is the domestic demand component that is most negatively affected by the ECB contractionary monetary policy. The combined effects of higher user cost of capital, higher risk premium, lower bank credit and lower value of the collateral (as proxied by house prices), which result from the increase of short-term rates in the EA, have a dominant role for the decline of private investment compared to its baseline level. The contraction of investment reaches its maximum a year and a half after the beginning of the simulation (-1.5 per cent). In terms of the contribution of each shock to the overall change in investment around 70 per cent of the decline is attributable to the shock in EA short-term rate. The trade spill-over effects together with

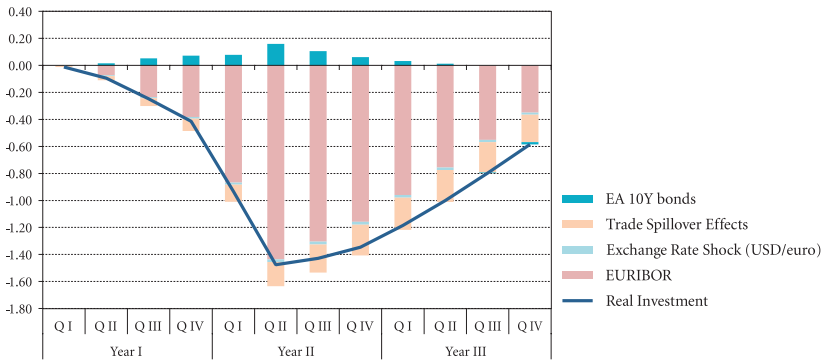
⁵¹ This can be explained with our assumption for the reaction of the German 10-year government bond yields. In the simulation we set the reaction of the German 10-year government bond yields to be equal to that of the EA 10-year government bond yields – namely, an initial increase by 20 basis points, followed by a gradual return to baseline values in the course of two years. At the same time corporate lending rates react stronger to the ECB's monetary policy tightening, leading to a widening of the spread.

⁵² In order to calculate contributions to overall deviation from baseline, shocks are introduced to the BNBQPM one by one. Holding all else constant and assuming no changes in the EURIBOR, a hike in the EA long-term rates leads to an overall increase of lending due to the narrowing of the spread between corporate lending rates and the risk-free German long-term rates. Once the EURIBOR shock is introduced however the spread widens instead and affects lending negatively, due to the strong pass-through of EA short-term rates to domestic corporate lending rates.

the exchange rate change also weigh negatively on investment, albeit to a much lower extent.

The hike in German long-term rates compared to the baseline, as a result of the increase in the EA long-term rates in the simulation, outweighs the initial increase of domestic long-term rates and leads to a decrease of foreign external debt⁵³. Consequently this has a rather limited but positive impact on private investment due to the estimated in the model negative elasticity of investment to changes in external debt. Similarly to the effect on credit for non-financial corporations, the shock in EA long-term rates impacts positively investment through the narrowing spread between corporate lending rates in Bulgaria and Germany’s long-term interest rates.

Figure 16: **Response of Real Investment***



* Deviations from baseline in per cent, percentage points.

Note: The Figure depicts the response of overall real investment activity, which is driven entirely by private investment dynamics as government investment is assumed to remain unchanged in the simulation.

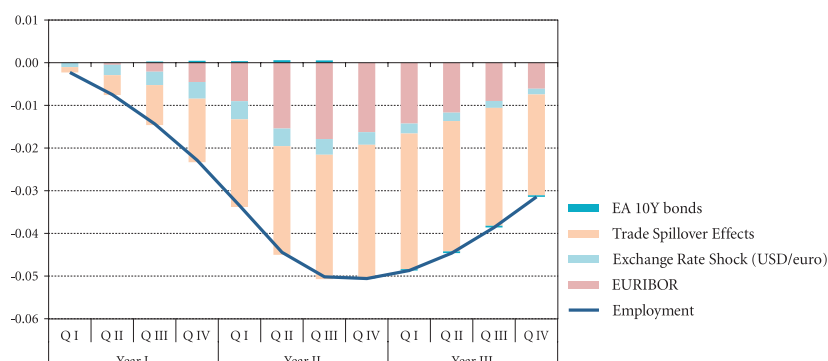
Lower real exports and lower investment, as a result of the monetary policy tightening, lead to a decrease in aggregate demand in the economy relative to the baseline. Consequently this dampens business activity and constrains firms’ demand for labour. The trade spill-over shock, transmitted to labour demand through its impact on real output, has a dominant role in explaining the downward adjustment in employment. The decline, triggered solely by the change in money market rates in the EA is less prominent and materializes with a one-year lag. The maximum decline of employment as compared to the baseline level is reached mid-simulation period (-0.05 per cent as compared to

⁵³ See section 4.3.5. for more details on the transmission channel.

baseline). The decrease of employment is less pronounced than the drop of real output, and in consequence labour productivity decreases as well.

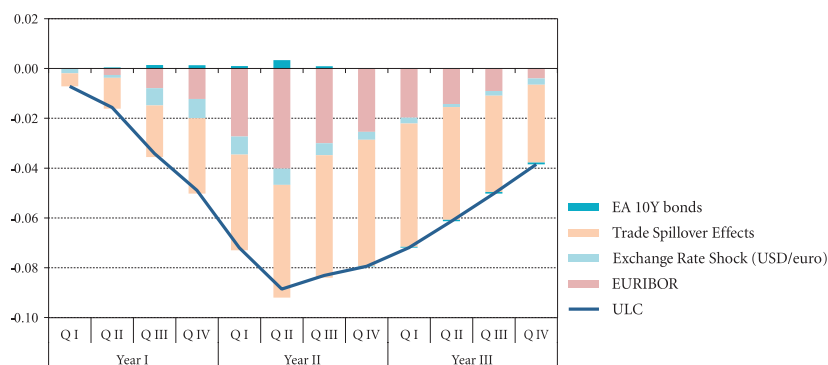
As both demand for goods and services and productivity decline relative to the baseline, firms are pushed to adjust to the monetary policy changes by decreasing wages. The decline of unit labour costs is largely explained by the trade spill-over effects, while the impact of the interest rate channel becomes more visible only in the second and third year of the simulation. The maximum decline of unit labour cost is reached in the sixth quarter of the simulation and comes up to 0.09 per cent as compared to baseline.

Figure 17: Response of Employment*



* Deviations from baseline in per cent, percentage points.

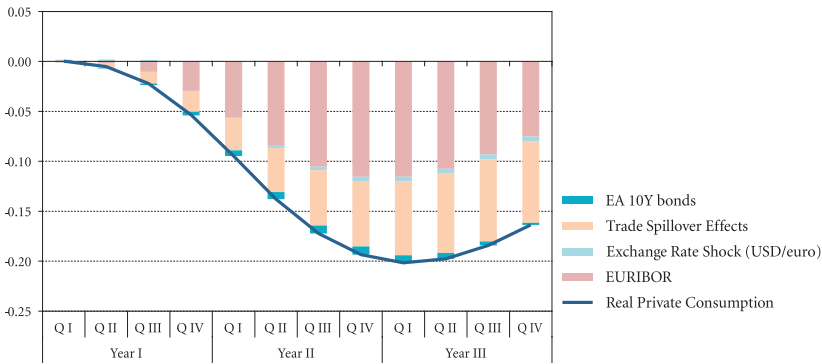
Figure 18: Response of Unit Labour Costs*



* Deviations from baseline in per cent, percentage points.

The decline of both employment and wages compared to their levels in the baseline translate into a downward adjustment of disposable income. This decrease in financing available to households, against the background of also declining house prices, tighter lending conditions and eventually lower household wealth constrain household spending and consequently private consumption declines relative to the baseline. In the simulation exercise the maximum decline of consumption (by 0.20 per cent as compared to the baseline level) is reached in the beginning of the third year, with the interest rate (EURIBOR) channel having the most pronounced negative impact. At the end of the simulation horizon the contractionary effect on consumption begins to gradually fade away, albeit consumption still remaining at a level around 0.16 per cent lower than what the baseline scenario suggests.

Figure 19: **Response of Real Private Consumption***



* Deviations from baseline in per cent, percentage points.

5.2.4. External Debt Financing and Current Account Developments

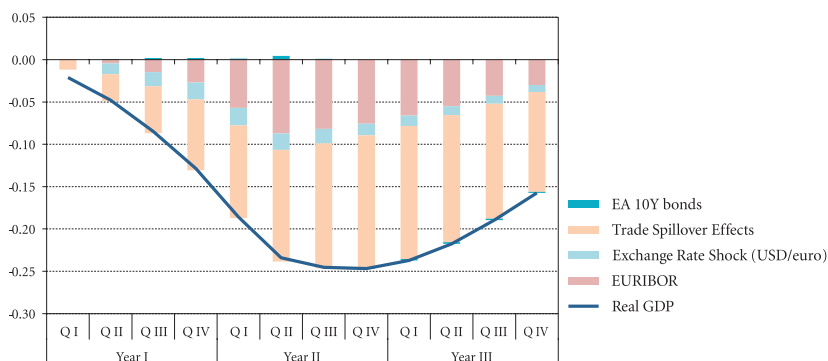
As a result of the changes in the flows on the external sector of the Bulgarian economy, the current account balance deteriorates as per cent of GDP in the simulation scenario. The main components of the current account that are affected by the change in the ECB’s monetary policy are the trade balance and the primary income balance. The simulated deterioration of the primary income deficit dominates over the improvement of the trade balance in the first ten quarters of the simulation and the current account decreases as per cent of GDP compared to the baseline. The maximum decline of the current account is reached in the first quarter of the simulation (-0.3 percentage points of GDP).

The increase in external debt service payments as a result of the increased 3-month EURIBOR leads to higher primary income deficit, despite the offsetting, yet weaker, effect of reduced firms' profitability (proxied in the simulation by the gross operating surplus). The increase in the primary income deficit relative to the baseline as per cent of GDP is maximised in the fourth quarter of the simulation, reaching 0.3 per cent of GDP.

5.2.5. Response of Aggregate Output and Prices

The reaction of real GDP is aggregated across the simulated response of all expenditure components. Following the ECB's monetary policy change real GDP contracts compared to the baseline level with maximum decline of 0.25 per cent as reached in the seventh quarter of the simulation exercise. As expected, given the openness of the economy and trade integration with EA countries, the foreign trade channel plays a dominant role in the response of real output to a change in ECB's monetary policy. The contractionary effect from higher interest rates and lower asset prices takes more time to materialise and begins to weigh on real GDP a year and a half after the beginning of the exercise. Based on the design of the simulation, the impact from the functioning of the exchange-rate channels fades away in the third year after ECB's monetary policy tightening.

Figure 20: Response of Real GDP*

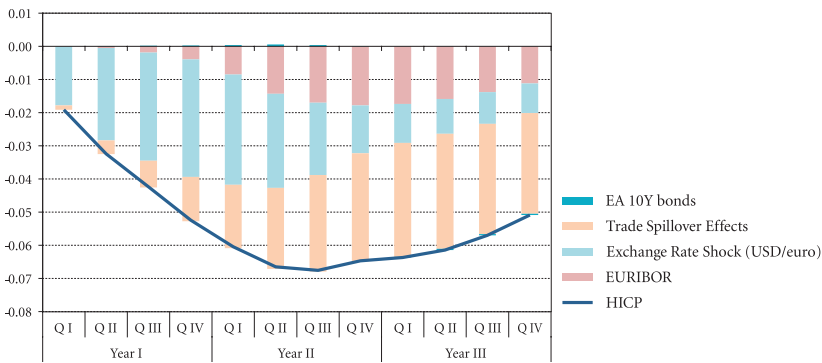


* Deviations from baseline in per cent, percentage points.

Following the ECB's monetary policy change, domestic prices adjust downwards as a result of the combined effects from declining import prices, unit labour costs, and consumer spending. The decline of the HICP core index is very similar to the reaction of import prices and unit labour cost (maximum

decline is 0.09 per cent as compared to baseline). At the same time, given the assumption than administrative prices do not react to the monetary policy change, the resulting decline in the HICP index is somewhat weaker, reaching a maximum of 0.07 per cent in the sixth quarter from the beginning of the simulation. The reaction of prices is quite persistent and HICP is 0.05 per cent lower relative to baseline at the end of the simulation horizon.

Figure 21: **Response of HICP***



* Deviations from baseline in per cent, percentage points.

6. Conclusion

With the expected normalisation of monetary policy in the EA, discussions on the possible spill-over effects on small, open economies with strong trade and financial ties to the EA, such as Bulgaria, are highly relevant.

The study examines the transmission of a tightening in ECB’s monetary policy to the Bulgarian economy through the lens of a large macro-econometric model that allows for the inclusion of numerous interrelations between foreign and domestic variables. The scenario of a tightening in ECB’s monetary policy in the BNBQPM is represented by a combination of shocks to the EA short- and long-term interest rates, an appreciation of the euro against the US dollar and a decline in economic activity in the EA. We identify two broad channels of transmission as particularly important for Bulgaria, given the structural characteristics of the country – namely, the foreign trade and the financial channel.

Our results suggest that the foreign trade channel plays a dominant role in explaining the contraction of domestic output following a tightening of

ECB's monetary policy. This is expected given the high trade openness of the economy and its high trade and financial integration with EA countries. The contractionary effect from higher interest rates and lower asset prices takes more time to materialise and begins to weigh on real GDP a year and a half after the beginning of the simulation exercise.

Following the ECB's monetary policy tightening real GDP contracts, with maximum decline of 0.25 per cent as compared to the baseline level, reached in the seventh quarter of the simulation exercise. Investment is the GDP component with the strongest reaction to monetary policy tightening. The contraction of investment reaches its maximum a year and a half after the beginning of the simulation (-1.5 per cent), with around 70 per cent of this decline attributable to the interest and asset price channel. Exports of goods also react strongly and decline by -0.28 per cent, with the peak of the decline occurring only two quarters after the introduction of the shocks, suggesting a quick transmission. The Bulgarian labour market adjusts to ECB's contractionary monetary policy through declines in both employment and wages. The decline in unit labour costs is somewhat faster and slightly more pronounced as compared to that in employment.

The downward adjustment of prices is relatively weak, reaching a maximum of 0.07 percentage points in six quarters. The maximum decline of house prices (0.8 percentage points) is reached at the beginning of the third year and is largely driven by increasing interest rates. Overall, throughout the simulation horizon, the reaction of real variables is more pronounced than the reaction of prices.

The main limitations of the study are related to short-comings of the chosen econometric approach, used to examine the channels of transmission of ECB's monetary policy on the Bulgarian economy. Expectations in our setup play only a partial role as price and wage formation are backward-looking. As such we see addressing this short-coming as a potential area for future research on the topic. Another interesting topic that can also be explored in future work is how the relative importance of the identified channels of transmission has evolved over time, taking into account the structural and cyclical changes that the economy has gone through.

Table 3. Foreign Demand Shock

Percentage deviations from baseline*	Year I	Year II	Year III	Year I			Year II			Year III					
				Q I	Q II	Q III	Q IV	Q I	Q II	Q III	Q IV	Q I	Q II	Q III	Q IV
Real output															
GDP	-0.52	-0.57	-0.59	-0.49	-0.51	-0.53	-0.54	-0.55	-0.57	-0.57	-0.58	-0.59	-0.59	-0.60	-0.60
Private consumption	-0.14	-0.28	-0.36	-0.05	-0.13	-0.18	-0.21	-0.24	-0.27	-0.30	-0.32	-0.33	-0.35	-0.36	-0.37
Investment	-0.59	-0.91	-0.94	-0.43	-0.58	-0.64	-0.70	-0.78	-0.94	-0.96	-0.96	-0.95	-0.94	-0.93	-0.93
Exports (goods and services)	-0.95	-0.96	-0.96	-0.95	-0.95	-0.95	-0.96	-0.96	-0.96	-0.96	-0.96	-0.96	-0.96	-0.97	-0.97
Imports (goods and services)	-0.51	-0.67	-0.72	-0.42	-0.50	-0.55	-0.59	-0.62	-0.67	-0.69	-0.70	-0.71	-0.72	-0.72	-0.73
Price developments															
HICP	-0.09	-0.13	-0.13	-0.05	-0.08	-0.10	-0.11	-0.12	-0.12	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13
Export deflator	-0.07	-0.10	-0.10	-0.04	-0.07	-0.08	-0.09	-0.09	-0.10	-0.10	-0.10	-0.10	-0.10	-0.11	-0.11
UIC	-0.17	-0.18	-0.18	-0.22	-0.16	-0.16	-0.16	-0.17	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.19
Labour market															
Employment	-0.10	-0.11	-0.11	-0.05	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11
Unemployment rate	0.09	0.11	0.11	0.05	0.10	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.11	0.10
External developments (per cent of GDP)															
Balance on goods and services	-0.32	-0.23	-0.21	-0.37	-0.33	-0.30	-0.28	-0.26	-0.23	-0.22	-0.22	-0.21	-0.21	-0.20	-0.20
Current account plus capital account	-0.31	-0.22	-0.20	-0.36	-0.32	-0.29	-0.27	-0.25	-0.22	-0.22	-0.21	-0.20	-0.20	-0.20	-0.20
Fiscal developments (per cent of GDP)															
Government primary budget balance	0.00	-0.01	-0.02	0.01	0.01	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02
Interest spending	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Financial market and asset price developments															
Money market rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lending rate to non-financial corporations	0.08	0.11	0.11	0.04	0.07	0.09	0.11	0.11	0.11	0.12	0.12	0.11	0.11	0.11	0.11
Lending rate to households	0.01	0.02	0.03	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03
Long-term interest rate	0.03	0.06	0.05	0.00	0.02	0.04	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05
House price index	-0.21	-0.41	-0.48	0.00	-0.23	-0.30	-0.33	-0.37	-0.40	-0.42	-0.44	-0.46	-0.47	-0.48	-0.49
Credit to non-government sector	-0.54	-0.84	-0.94	-0.09	-0.25	-0.40	-0.54	-0.64	-0.71	-0.79	-0.84	-0.88	-0.90	-0.92	-0.94

* The real output and price developments variables, employment, house price index and credit to non-government sector are all expressed as a percentage deviation from baseline. The remaining variables represent an absolute difference from baseline.

The shock is defined as a sustained decline in foreign demand by 1 per cent.

Table 4. Change in Competitors' Prices

Percentage deviations from baseline*	Year I	Year II	Year III			Year I			Year II			Year III		
			Q I	Q II	Q III	Q IV	Q I	Q II	Q III	Q IV	Q I	Q II	Q III	Q IV
Real output														
GDP	-0.11	-0.18	-0.20	-0.05	-0.10	-0.13	-0.16	-0.17	-0.18	-0.19	-0.20	-0.20	-0.21	-0.21
Private consumption	-0.03	-0.08	-0.11	-0.01	-0.02	-0.03	-0.05	-0.06	-0.08	-0.09	-0.10	-0.10	-0.11	-0.12
Investment	-0.11	-0.26	-0.31	-0.04	-0.10	-0.14	-0.18	-0.21	-0.26	-0.28	-0.29	-0.30	-0.31	-0.31
Exports (goods and services)	-0.17	-0.27	-0.28	-0.07	-0.16	-0.21	-0.24	-0.26	-0.27	-0.28	-0.28	-0.28	-0.28	-0.28
Imports (goods and services)	-0.08	-0.16	-0.19	-0.02	-0.06	-0.10	-0.12	-0.14	-0.16	-0.17	-0.17	-0.18	-0.19	-0.19
Price developments														
HICP	-0.02	-0.04	-0.05	-0.01	-0.02	-0.03	-0.03	-0.04	-0.04	-0.05	-0.05	-0.05	-0.05	-0.05
Export deflator	-0.08	-0.08	-0.07	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.07	-0.07	-0.07
UIC	-0.03	-0.03	-0.03	-0.02	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Labour market														
Employment	-0.02	-0.04	-0.04	-0.01	-0.02	-0.03	-0.03	-0.03	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
Unemployment rate	0.02	0.03	0.04	0.00	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04
External developments (per cent of GDP)														
Balance on goods and services	-0.05	-0.05	-0.03	-0.03	-0.05	-0.06	-0.06	-0.06	-0.05	-0.04	-0.04	-0.04	-0.03	-0.03
Current account plus capital account	-0.05	-0.04	-0.03	-0.03	-0.05	-0.06	-0.06	-0.05	-0.05	-0.04	-0.04	-0.03	-0.03	-0.02
Fiscal developments (per cent of GDP)														
Government primary budget balance	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01
Interest spending	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Financial market and asset price developments														
Money market rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lending rate to non-financial corporations	0.01	0.03	0.04	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.04	0.04
Lending rate to households	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Long-term interest rate	0.00	0.02	0.02	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02
House price index	-0.04	-0.13	-0.18	0.00	-0.03	-0.05	-0.08	-0.11	-0.13	-0.14	-0.16	-0.17	-0.18	-0.19
Credit to non-government sector	-0.12	-0.26	-0.32	-0.01	-0.04	-0.08	-0.12	-0.16	-0.20	-0.23	-0.26	-0.30	-0.31	-0.32

* The real output and price developments variables, employment, house price index and credit to non-government sector are all expressed as a percentage deviation from baseline. The remaining variables represent an absolute difference from baseline.

The shock is defined as a sustained decline in competitors' prices by 1 per cent.

Table 5. Change in USD/EUR Exchange Rate

Percentage deviations from baseline*	Year I	Year II	Year III	Year I				Year II				Year III			
				Q I	Q II	Q III	Q IV	Q I	Q II	Q III	Q IV	Q I	Q II	Q III	Q IV
Real output															
GDP	-0.27	-0.41	-0.45	-0.15	-0.25	-0.31	-0.36	-0.39	-0.41	-0.43	-0.44	-0.45	-0.45	-0.46	-0.46
Private consumption	-0.01	-0.08	-0.13	0.01	0.00	-0.02	-0.04	-0.06	-0.08	-0.09	-0.10	-0.11	-0.12	-0.13	-0.14
Investment	-0.20	-0.46	-0.54	-0.07	-0.18	-0.24	-0.30	-0.36	-0.46	-0.50	-0.52	-0.53	-0.54	-0.55	-0.55
Exports (goods and services)	-0.23	-0.36	-0.36	-0.10	-0.22	-0.29	-0.32	-0.34	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36
Imports (goods and services)	0.05	-0.01	-0.02	0.08	0.06	0.03	0.01	0.00	-0.01	-0.02	-0.02	-0.02	-0.02	-0.03	-0.03
Price developments															
HICP	-0.32	-0.46	-0.53	-0.20	-0.31	-0.37	-0.40	-0.43	-0.46	-0.48	-0.49	-0.51	-0.53	-0.54	-0.55
Export deflator	-0.58	-0.62	-0.64	-0.55	-0.56	-0.60	-0.61	-0.62	-0.62	-0.62	-0.63	-0.64	-0.64	-0.64	-0.64
ULC	-0.07	-0.10	-0.10	-0.04	-0.04	-0.10	-0.11	-0.10	-0.10	-0.09	-0.10	-0.10	-0.10	-0.10	-0.11
Labour market															
Employment	-0.05	-0.08	-0.09	-0.02	-0.04	-0.06	-0.07	-0.08	-0.08	-0.08	-0.09	-0.09	-0.09	-0.09	-0.09
Unemployment rate	0.05	0.08	0.08	0.02	0.04	0.06	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08
External developments (per cent of GDP)															
Balance on goods and services	0.03	0.08	0.13	0.04	0.03	0.02	0.04	0.06	0.08	0.10	0.10	0.11	0.12	0.13	0.14
Current account plus capital account	0.04	0.09	0.13	0.04	0.03	0.03	0.05	0.06	0.09	0.10	0.11	0.12	0.13	0.13	0.14
Fiscal developments (per cent of GDP)															
Government primary budget balance	0.00	-0.01	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.01	0.01
Interest spending	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Financial market and asset price developments															
Money market rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lending rate to non-financial corporations	0.02	0.05	0.05	0.00	0.01	0.03	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lending rate to households	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Long-term interest rate	0.02	0.06	0.06	0.00	0.01	0.02	0.04	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06
House price index	-0.10	-0.31	-0.40	0.00	-0.07	-0.13	-0.20	-0.26	-0.30	-0.33	-0.36	-0.38	-0.40	-0.41	-0.42
Credit to non-government sector	-1.00	-1.51	-1.79	-0.32	-0.60	-0.82	-1.00	-1.16	-1.29	-1.41	-1.51	-1.60	-1.67	-1.74	-1.79

* The real output and price developments variables, employment, house price index and credit to non-government sector are all expressed as a percentage deviation from baseline. The remaining variables represent an absolute difference from baseline.

The shock is defined as a sustained appreciation of the euro against the US dollar by 10 per cent.

Table 6. Sustained Increase in Short-term EA Interest Rates

Percentage deviations from baseline*	Year I	Year II	Year III	Year I				Year II				Year III			
				Q I	Q II	Q III	Q IV	Q I	Q II	Q III	Q IV	Q I	Q II	Q III	Q IV
Real output															
GDP	-0.01	-0.08	-0.08	0.00	0.00	-0.01	-0.03	-0.06	-0.09	-0.09	-0.09	-0.09	-0.09	-0.08	-0.08
Private consumption	-0.01	-0.09	-0.13	0.00	0.00	-0.01	-0.03	-0.06	-0.09	-0.11	-0.12	-0.13	-0.13	-0.13	-0.13
Investment	-0.17	-1.33	-1.29	0.00	-0.07	-0.23	-0.38	-0.87	-1.55	-1.49	-1.43	-1.37	-1.31	-1.26	-1.21
Exports (goods and services)	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
Imports (goods and services)	-0.04	-0.30	-0.32	0.00	-0.02	-0.05	-0.09	-0.19	-0.33	-0.34	-0.34	-0.33	-0.32	-0.31	-0.30
Price developments															
HICP	0.00	-0.02	-0.02	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
Export deflator	0.00	-0.02	-0.02	0.00	0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
UIC	-0.01	-0.03	-0.03	0.00	0.00	-0.01	-0.01	-0.03	-0.04	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Labour market															
Employment	0.00	-0.02	-0.02	0.00	0.00	0.00	0.00	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
Unemployment rate	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01
External developments (per cent of GDP)															
Balance on goods and services	0.03	0.21	0.22	0.00	0.01	0.03	0.06	0.13	0.23	0.23	0.23	0.23	0.23	0.22	0.21
Current account plus capital account	-0.26	-0.07	-0.04	-0.30	-0.27	-0.25	-0.23	-0.15	-0.04	-0.04	-0.04	-0.04	-0.03	-0.04	-0.05
Fiscal developments (per cent of GDP)															
Government primary budget balance	0.00	-0.01	-0.03	0.00	0.00	0.00	0.00	0.00	-0.01	-0.02	-0.02	-0.03	-0.03	-0.03	-0.03
Interest spending	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Financial market and asset price developments															
Money market rate	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Lending rate to non-financial corporations	0.50	0.65	0.68	0.39	0.48	0.54	0.58	0.61	0.64	0.66	0.67	0.68	0.68	0.68	0.68
Lending rate to households	0.02	0.11	0.16	0.00	0.01	0.03	0.05	0.08	0.10	0.12	0.14	0.15	0.16	0.16	0.16
Long-term interest rate	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
House price index	-0.04	-0.35	-0.56	0.00	-0.01	-0.04	-0.11	-0.20	-0.30	-0.40	-0.47	-0.52	-0.56	-0.58	-0.59
Credit to non-government sector	-1.18	-1.82	-2.04	-0.24	-0.64	-0.94	-1.18	-1.36	-1.51	-1.69	-1.82	-1.91	-1.97	-2.02	-2.04

* The real output and price developments variables, employment, house price index and credit to non-government sector are all expressed as a percentage deviation from baseline. The remaining variables represent an absolute difference from baseline.

The shock is defined as a sustained increase of 3-month EURIBOR by 100 basis points.

Table 7. Increase in Long-term Interest Rates in the EA

Percentage deviations from baseline*	Year I	Year II	Year III	Year I				Year II				Year III			
				Q I	Q II	Q III	Q IV	Q I	Q II	Q III	Q IV	Q I	Q II	Q III	Q IV
Real output															
GDP	0.01	0.02	0.01	0.00	0.00	0.01	0.01	0.01	0.04	0.03	0.02	0.01	0.01	0.01	0.01
Private consumption	-0.01	-0.04	-0.05	0.00	0.00	-0.01	-0.02	-0.03	-0.04	-0.04	-0.05	-0.05	-0.05	-0.04	-0.04
Investment	0.16	0.93	0.68	0.00	0.04	0.23	0.36	0.42	1.30	1.09	0.92	0.80	0.70	0.64	0.59
Exports (goods and services)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Imports (goods and services)	0.03	0.16	0.11	0.00	0.01	0.04	0.06	0.07	0.23	0.19	0.16	0.14	0.12	0.11	0.10
Price developments															
HICP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00
Export deflator	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00
U.I.C.	0.00	0.02	0.01	0.00	0.00	0.01	0.01	0.01	0.03	0.02	0.01	0.01	0.01	0.01	0.01
Labour market															
Employment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Unemployment rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00
External developments (per cent of GDP)															
Balance on goods and services	-0.02	-0.11	-0.08	0.00	0.00	-0.03	-0.04	-0.05	-0.15	-0.13	-0.11	-0.10	-0.08	-0.08	-0.07
Current account plus capital account	-0.02	-0.11	-0.08	0.00	0.00	-0.03	-0.04	-0.05	-0.15	-0.13	-0.11	-0.10	-0.08	-0.08	-0.07
Fiscal developments (per cent of GDP)															
Government primary budget balance	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01
Interest spending	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Financial market and asset price developments															
Money market rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lending rate to non-financial corporations	0.03	0.08	0.09	0.00	0.02	0.03	0.05	0.07	0.08	0.08	0.09	0.09	0.09	0.09	0.09
Lending rate to households	0.02	0.07	0.09	0.00	0.01	0.03	0.04	0.06	0.07	0.08	0.09	0.09	0.10	0.10	0.10
Long-term interest rate	0.70	1.09	1.04	0.00	0.66	1.01	1.13	1.14	1.10	1.07	1.05	1.04	1.04	1.04	1.05
House price index	-0.03	-0.21	-0.33	0.00	-0.01	-0.04	-0.09	-0.14	-0.20	-0.23	-0.27	-0.31	-0.33	-0.35	-0.35
Credit to non-government sector	2.38	2.78	2.81	0.62	1.55	2.08	2.38	2.56	2.61	2.73	2.78	2.81	2.81	2.81	2.81

* The real output and price developments variables, employment, house price index and credit to non-government sector are all expressed as a percentage deviation from baseline. The remaining variables represent an absolute difference from baseline.

The shock is defined as a sustained increase of 10-year government bond yields in Germany and the EA by 100 basis points.

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ISBN 978-619-7409-17-8

ELEMENTS OF THE 1 LEV BANKNOTE, ISSUE 1999, ARE USED IN COVER DESIGN.