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A literature survey over the transmission of the monetary policy and its shocks

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Abstract:
This paper aims to conduct a survey over the literature related to the transmission mechanism of monetary policy and the monetary policy shocks, as well as to update the state of knowledge of the aforementioned subjects in the academic literature. The first part of the paper focuses on identifying the main models used to analyze the process of monetary policy transmission, while the second part focuses on the models used in order to analyze the transmission of the monetary policy shocks. At first, the paper is highlighting the main models used worldwide, then it continues with a literature analysis regarding the Central and East European countries and it ends with the main models used for the Romanian economy.

Keywords: *monetary policy; central bank; transmission mechanism; monetary policy shocks.*

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Introduction

Monetary policy refers to the decisions taken by the monetary authorities in order to ensure the objectives of central banks, by using different monetary policy instruments. Unlike monetary policy, the monetary policy transmission mechanism addresses the effects that these decisions have on the economic activity and inflation, by using a series of transmission channels.

The wide range of monetary and prudential policy instruments influences the economy and the financial system through a wide range of transmission mechanisms characterized by variable and uncertain time intervals. Changes in economic and financial conditions also lead to changes in target-variables policies in terms of price developments or economic stability.

Ireland, P.N. (2005) described the monetary policy transmission mechanism as "how policy-induced changes in the nominal money stock or the short-term nominal interest rate impact real variables such as aggregate output and employment". Schasfoort J. et. al. (2017) considers that the monetary policy transmission mechanism describes how the monetary policy interest rate used by central banks influences inflation, output and employment.

The European Central Bank considers that "the transmission mechanism is characterized by long, variable and uncertain time lags. Thus, it is difficult to predict the precise effect of monetary policy actions on the economy and price level".

According to Beyer, A., et. al. (2017) "underlying the transmission process is the financial market infrastructure that connects the central bank with credit institutions for the settlement of central bank liquidity and securities, namely TARGET2 and T2S, which are integral to safe and efficient transactions. Moreover, financial market infrastructures interlink market participants and thus allow them to exchange financial assets in a harmonised, safe and efficient manner."

In view of the above, we can say that the transmission mechanism of monetary policy consists in a series of channels, which are not mutually exclusive, through which the evolution of monetary policy decisions affects the behavior of other economic variables. This mechanism is the one that aims at the effects that certain decisions have on the economic activity and inflation, through the transmission channels used.

Early studies on the monetary policy transmission were often based on the Autoregressive Vector (VAR) and it continues to be widely used, especially in empirical studies involving a modeling of the monetary policy transmission.

The autoregressive vector is a type of econometric analysis of multivariate time series in which all variables are treated symmetrically. In this way, the current values of each variable, as well as the past ones, can affect the time sequence of all the other variables, creating feedback loops between the variables as each time series evolves. This model highlights the interdependence of dynamic variables, without requiring an exact knowledge of how the included variables interact, only that, theoretically, they should affect each other. VAR analyzes can provide a coherent approach for elucidating interactions between variables over a linear time frame and they can be reliably used for forecasting, structural inference, and policy analysis.

In recent years, the DSGE model (dynamic stochastic general equilibrium) has come to play an increasingly important role in central bank analyzes as a support in monetary policy formulation (and increasingly after the global financial crisis of 2007-2008, in order to maintain financial stability). Today, more and more central banks are actively involved in the construction of DSEG models. Theses models, compared to

other widespread econometric models, are less theoretical and with reliable macro-foundations based on the optimized behavior of rational economic agents. In addition to being "structural", these models play a key role in determining the expectations and, as a general equilibrium, they can help the decision-maker by explicitly designing macroeconomic scenarios in response to the various policy outcomes envisaged.

Literature review of the monetary policy transmission and the transmission of monetary policy shocks

Early studies on monetary policy transmission were mostly based on the use of Autoregressive Vector (VAR). This model, introduced in the early 1980s by Sims, C.A. (1980), continues to be widely used. However, according to Spulbăr, C. and Nițoi, M. (2012), this methodology is known for its structural rigidity and the absence of theoretical foundations.

As mentioned, the autoregressive vector is a type of econometric analysis of multivariate time series in which all variables are treated symmetrically. In this way, the current values of each variable, as well as the past ones, can affect the time sequence of all the other variables, creating feedback loops between the variables as each time series evolves. This model highlights the interdependence of dynamic variables, without requiring an exact knowledge of how the included variables interact, only that, theoretically, they should affect each other. VAR analyzes can provide a coherent approach for elucidating interactions between variables over a linear time frame and they can be reliably used for forecasting, structural inference, and policy analysis.

Since the introduction of this model in the early 1980s, the analysis of multivariate data in the context of autoregressive vector models has evolved as a standard tool in econometrics. Given that statistical tests are frequently used in order to determine the interdependencies and dynamic relationships between variables, this methodology was immediately enriched by including a priori non-statistical information. VAR models explain endogenous variables only by their history. However, structural vector models (SVAR) allow explicit modeling of contemporary interdependence between left variables. Therefore, this type of model tries to overcome the shortcomings of VAR models.

Following Sims' approach, Bernanke, B.S. and Blinder, A. (1992) conducted a model of the Autoregressive Vector in order to study the transmission mechanism of monetary policy in the United States of America. This VAR model included: the unemployment rate, loans (deposits), the interest rate and the CPI logarithm. Another study conducted four years later by Christiano, L., Eichenbaum, M. and Evans, M. (1996), also on the US economy, used the VAR model to identify the effects that monetary policy shocks have on the various financial variables. The model used by Christiano, L. et. al. used the following data: GDP deflator, gross domestic product in real prices, commodity prices, total reserves, non-borrowed reserves, net funds and interest rates. The difference between these two studies was that the first study used monthly data, while quarterly data were used for the second one. To overcome the problem of rigidity, Leeper, E.M. et. al. (1996) proposed a multi-variable Bayesian approach to the autoregressive vector to analyze US monetary policy.

In the first half of the twentieth century, studies on the mechanism of monetary policy transmission were limited to developed economies. In recent years there has been a significant increase in empirical studies on the mechanism of monetary policy transmission for Central and Eastern European (CEE) countries, most of which are

motivated by their accession to the European Monetary Union. Even if the number of studies is increasing, their volume is far smaller than the studies conducted on developed countries. To date, more than half of the countries that have joined the European Union since 2004 have joined the European Monetary Union (EMU). However, the other half of these states, which have not met the necessary conditions in order to become members of EMU, will sooner or later have to adopt the single European currency and, in this context, a good knowledge of the monetary policy transmission mechanism of these countries is particularly important.

These types of studies, conducted on developing economies, offer interesting perspectives on the monetary policy used in different environments. According to Simic, V. and Malesevic-Perovic, L. (2012), most often, the results of developed economies show that monetary policy affects the real economy over a period of two to three years and that monetary policy can be basically used in order to counteract shocks. In contrast, the results of developing economies show a much greater diversity, which makes it difficult to draw conclusions about the impact of monetary policy. Creel, J. and Levasseur, S. (2005), by using a structural VAR model with short-term restrictions, studied the relative importance of interest rates, exchange rates and credit channels in the monetary policy transmission in Poland, Czech Republic and Hungary. Following the analysis, they concluded that, for these three countries, a positive shock to the interest rate would cause prices to rise instead of fall, as a result of the immediate depreciation of the exchange rate. In their study, Creel and Levasseur believe that none of the monetary policy transmission channels identified in the three countries have high importance, but for Poland, the exchange rate and interest rate channels are beginning to play an increasingly important role compared to Hungary and Czech Republic.

Among the first researchers to study the issue of monetary policy transmission in Romania were Antohi, D. et. al. (2003). They analyzed the relationship between the financial sector and the real economy, as well as the transmission of monetary policy impulses on financial variables, through an empirical assessment that was based on the vector error correction methodology. The study was not conclusive because the data series available at that time were very small. However, the result shows that, at that time, the Romanian central bank was directly influencing the deposits interest rates, but not the loans interest rates.

Oroș C. and Romocea-Turcu, C. (2009) addressed, through a SVAR model, the monetary policy transmission channels in six Central and Eastern European countries, namely Poland, Czech Republic, Slovakia, Slovenia, Hungary and Romania. According to them, the distinguishing feature of Hungary and Poland was the presence of the price puzzle effect, combined with a high exchange rate influence, which acted both as a transmission mechanism for monetary policy as well as a demand and supply buffer. In Slovakia, Slovenia, Czech Republic and partly in Romania, the biggest influence was the interest rate channel, which made this group of countries more suitable to join the European Monetary Union.

In 2011, Spulbăr, C., Stanciu, C. and Nițoi, M. used a Bayesian VAR model to provide an analysis of the transmission mechanism of Romanian monetary policy. In this regard, the authors used a number of variables that accentuate the evolution of industrial production, namely, inflation, M2 monetary aggregate, exchange rate, real estate price and interest rate. The main conclusion of the study was that the exchange rate continues to be an important mechanism that significantly influences the variables of the real economy and the interest rate channel tends to become more and more consistent.

Using a SVAR model with four variables, Pelinescu, E. (2012) analyzed the transmission mechanism of monetary policy in Romania. Following the study, it was possible to emphasize the importance of the interest rate channel, the complex impact that the foreign exchange channel has, as well as the key role that demand plays and its stimulation through the appropriate economic measures.

In order to evaluate the efficiency of the monetary policy mechanism in Romania, through the interest rate channel, Cocriș, V. and Nucu, A.E. (2013), starting from the VAR approach and taking into account the number of collaborative relationships resulting from the VECM methodology, used a model for correcting vector errors and analyzing impulse responses in order to study the impact of a positive monetary policy shock on macroeconomic variables. Following the analysis, they concluded that in Romania there is an improvement in the efficiency of the transmission of monetary policy impulses through the interest rate channel.

Spulbăr, C. and Nițoi, M. (2013) highlighted through a BVAR model with a Koko Minnesota / Litterman prior, the mechanism of monetary policy transmission and how the main economic and monetary variables in Romania react to various shocks. The model used six variables (monetary aggregate M2, gross domestic product, inflation rate, interest rate, wage index and unemployment rate) from 2001 to 2012. The two authors identified that the effectiveness of the interest rate channel in Romania is high, and the relationship between the inflation rate and the unemployment rate is in line with the Phillips curve.

Cioran, Z. (2015) used a VAR model in order to capture the influence of monetary policy rate and unemployment rate on inflation. Following a system analysis, the author tried to capture the connection between macroeconomic variables. The results show that, under the impact of a positive monetary policy shock promoted by the National Bank of Romania through the interest rate, macroeconomic variables have moved in the desired direction, the unemployment rate reacts moderately and inflation has a slightly downward direction.

The prospect of integration into the European Monetary Union raises the issue for a proper analysis of the impact that the monetary shocks from this area have on the Central and Eastern Europe countries' economies. According to Caraiani, P. (2009), in order to correctly estimate the impact of monetary policy shocks and to compare their impact with the domestic shocks, it is necessary to estimate a dynamic stochastic general equilibrium (DSGE) model.

DSGE models, compared to other widespread econometric models, are less theoretical and with reliable macro-foundations based on the optimized behavior of rational economic agents. Apart from being "structural", these models play an important role in expectations and, by having a general equilibrium nature, they can help the decision-maker by explicitly designing macroeconomic scenarios in response to the different policy outcomes envisaged. In addition, they can be implemented in a very efficient and meaningful way. Spulbăr, C. and Nițoi, M. (2012) believe that DSGE models are tools that can facilitate the identification of sources which are generating variations, it can bring explanations on structural changes, can predict the effects of monetary policy changes and can perform counterfactual tests.

A DSGE model has stochastic implications that can be compared to empirical counterparts. Next will be described briefly, alternative techniques that can serve this purpose. It should be noted, however, that the boundary line between these techniques is

very blurred, as the calibration elements appear in the estimation exercises and vice versa.

Calibration assumes that most of the models` parameters values are chosen from the considerations of other applied fields of economics. The few remaining parameters are selected in order to obtain as close correspondences as possible between the predicted moments of the model and those in the sample data. The matching moment consists in the informal judgment of the second moments approach involved by the calibration model to the analog sampling moments. No formal probability-based metric system is used in this assessment. The motivation for this approach is based on the fact that any model is likely to be rejected by formal statistical inference, given a sufficient amount of data.

The classical estimation of DSGE model parameters involves the deduction of parameter values as a result of minimizing a given objective function, which involves some sample statistics as well as model-based statistics. The estimation, compared to simple calibration, allows the researcher to rely on his inference, on well-defined statistical measures. The most commonly used technique for estimating DSGE models is a Maximum Likelihood Estimation (MLE). MLE is calculated in order to maximize the probability of the observed data of the DSGE model by choosing the appropriate model parameters.

A promising technique is offered by the Bayesian approach. This approach can be seen as taking together some aspects of the calibration tradition with more rigorous estimation techniques. The Bayesian model involves specifying previous data so that the parameters can be estimated. Such prior information could come, for example, from the same sources used in the calibration exercises. The degree of confidence in this is measured by a statistical distribution of the questioned parameter. Then, it is weighted according to the probability of the samples, considering the DSGE model.

A disadvantage of using a DSGE model can be highlighted the limited computational power of the model, which requires a number of trade-offs (for example: the adoption of numerical algorithms that consume plenty of time in order to find the equilibrium of the nonlinear model). A second disadvantage is that DSGE models often suffer from poor identification of the underlying parameters.

More and more central banks have begun to use these neo-Keynesian DSGE models (US Federal Reserve, Bank of Canada, Bank of England, European Central Bank, etc.). DSGE models were built on the neoclassical growth model, with stochastic ingredients added from real business cycle models and real / nominal frictions, such as the cost of capital adjustment, nominal wage and price rigidity, or monopolistic competition. According to Dou, W.W. et. al. (2020), a common approach used by central banks is to start from a reference model and then incorporate additional elements such as: financial market frictions, including, frictions based on moral hazard, collateral restrictions, friction based on information or limited commitment; exogenous shocks, including global shocks, marginal efficiency shocks, preference shocks, etc.; financially constrained intermediaries (see Christiano, L. et. al, 2010, and He, Z. and Krishnamurthy, A., 2013); international trade (see Lombardo, G. and Ravenna, F., 2014, and Leibovici, F. and Santacreu, A.M., 2015); agent heterogeneity and the effects of monetary policy redistribution (see Gornemann, M. et. al, 2012, and Auclert, A., 2016).

The use of shadow policy rates has become increasingly popular when it comes to summarizing the position that monetary policy has on the correlation it maintains with macroeconomic variables. Claus, E. et. al. (2014) believe that in the USA, a shadow rate

is a reasonable approximation of both conventional monetary policy shocks and unconventional shocks. Also, Francis, N. et. al. (2014) found that in the United States, when using a data set spanning both pre-ZLB (zero lower bound) and ZLB periods, this type of rate can serve as a good substitute for monetary policy.

In 2019, Mouabbi, S. and Sahuc, J.G. integrated a set of shadow policy rates into a dynamic model of general stochastic equilibrium, to reveal the macroeconomic effects of unconventional measures implemented by the European Central Bank. The analysis concluded that, if the ECB had not resorted to use unconventional monetary policies, the Eurozone would have suffered a substantial decline in output and deflated from mid-2015 to the beginning of 2017. However, the most important aspect highlighted by this paper is that the standard DSEG models can still be used (even when negative interest rates are recorded), as long as we use a monetary policy replacement which is not constrained, such as monetary policy shadow rates.

Out of the thirteen states that joined the European Union in 2004-2013, more than half of them have already joined the European Monetary Union. Among the states that have not yet joined the EMU are: Czech Republic, Poland, Croatia, Hungary, Romania and Bulgaria. Two of these states, the largest ones (Romania and Poland), even though they have registered considerable economic growth in the recent years, they are facing strong economic difficulties, as well as serious demographic and population migration problems. From a monetary point of view, Bulgaria and Croatia have decided to stay close to the policies promoted by the European Central Bank, giving up all or a part of their monetary independence and adopting either a monetary council or crawling peg exchange rates. Hungary also chose the crawling peg exchange rate regime, but with a wider range of variation, while Poland, Czech Republic and Romania have chosen the inflation targeting strategy. It should be noted that the integration into the Monetary Union should not become a leitmotif for these countries, but the adoption of the single European currency should be seen as a transitional stage, part of the growth process.

The successful integration of Central and Eastern Europe (CEE) into Western Europe within the European Union has led to a significant increase in outsourcing between regions. This interaction was generally beneficial for both sides but also it increased the vulnerability of each region to the shocks of the other region.

Strong growth bonds complicate macroeconomic ECB policy-making due to the fact that non-euro area economies affected by distant shocks are more likely to respond less efficiently to traditional monetary policy instruments. An example of this situation is the financial crisis which occurred in the United States of America in 2007. The United States Federal Reserve and the European Central Bank have adopted a series of policies in order to ease economic tensions, but their effect has been rather limited. The crises impact on Western European banks was quickly felt by the Central and Eastern European countries, quickly turning into a loop of negative reactions to the financial and real sectors of the European economy.

European Monetary Union countries cannot set their own monetary policy adjustments. This meant that member countries and even other European Union Member states (which have not joined the Monetary Union yet), had to adopt the global monetary adjustment policies set used by the European Central Bank and integrate them with their own fiscal policies, generating a wide range of policy mixes, even for Euro Area countries.

Adjusting interest rates in the European Monetary Union should also have an effect on the economies outside the Union. In the case of non-euro area countries,

adjusting interest rates also means adjusting the cost of external borrowing, which determines the domestic interest rates and their factors related to trading decisions, such as financing trade credit to support imports and exports.

Strong financial and trade ties between EU and CEE countries are the channels through which monetary policy shocks from the euro area are transferred to small economies, open economies and the economies of CEE countries. Studying this transmission (how fast it works and to what extent) is of great relevance to the CEE countries in the light of their European agreements and for their accession to the European Monetary Union. In addition, it is important to determine whether the transmission of monetary policy works differently in CEE countries, given that there is a gap in the development of the financial sector between regions and that the ECB is homogeneous by nature, leading to very different effects in each region which puts the Bank in difficulty.

Japan was the first state to use unconventional monetary policy strategies by launching a policy of quantitative easing in 2001. This type of monetary policy became more and more popular after the recent global financial crisis (2007-2008), when conventional monetary policies could no longer cope and the large industrialized states were forced to resort to unconventional monetary policies. In order to assess the effects and effectiveness of unconventional monetary policies, several approaches have been identified which we will be presented below.

A first approach is based on the use of the VAR model with restrictions on the simultaneous relationships that are established between the variables, and the effects of the policy and transmission mechanisms are evaluated on the basis of the impulse response analysis.

Using a DSGE model for calibration, in order to examine the separate effects of short and long-term interest rates on the real economy, is the second approach. Structural analyzes using such structural models depend entirely on the specified structure, which must be examined very carefully.

A third approach is the plug-in approach, which uses estimations of the impact of unconventional monetary policy measures on asset prices in order to connect them with the standard macroeconomic models. This type of approach uses estimations of financial market reactions as a monetary policy shock associated with unconventional policy actions.

In 2007, Anzuini, A. and Levy, A. provided empirical evidence on the effects of monetary policy shocks in three of the EU Member States, which are not part of the European Monetary Union (Poland, Czech Republic and Hungary). Using a VAR analysis, they discover that, despite the low financial development of these states, the composition of macroeconomic variables, conditioned by a monetary policy shock, is similar for these three states, but differs substantially from the situation in advanced European countries.

Jannsen, N. and Klein, M. (2011) analyzed the effects of the transmission of monetary policy shocks from the Eurozone to a number of Western European countries (Sweden, Denmark, Norway, the United Kingdom and Switzerland). Using a structural VAR model for the Eurozone and increasing it consecutively through foreign interest variables, they identified that a monetary policy shock in the Monetary Union leads to a somewhat similar change in interest rates and gross domestic product in Western European countries which are not part of the Union.

Kimura, T. and Nakajima, J. (2013), using the TVP-VAR techniques and the latent threshold model (LTM), proposed an estimation framework for identifying monetary policy shocks for both conventional and unconventional policy strategies. The study was conducted on the monetary policies promoted by the Bank of Japan, and its results suggest that the impact of unconventional shocks on the real economy and inflation has been positive but slow, due to inflationary volatility and output shocks which have significantly increase after the crisis and made it difficult to accurately quantify the transmission of these changing effects in terms of financial conditions on the real economy and inflation.

A very interesting study is the one conducted by Andrade, P. and Ferroni, F. (2018). They studied the shocks of Delphic and Odyssey monetary policy over the Eurozone. Through their study, the two authors propose an approach for the separate identification of shocks and measure the impact that they have on macroeconomic aggregates in the studied area. The Delphic shock corresponds to a situation in which the central bank provides a prediction on a macroeconomic perspective, while an Odyssey shock corresponds to a situation in which the central bank commits itself to the interest rate plan announced and is following it. The survey made by Andrade and Ferroni is based on the study of the United States by D'Amico, S. and King, T.B. (2015), which considered a VAR model with slow-moving quarterly variables and survey data on interest rate, inflation and output expectations. In order to identify the Dolphic and Odyssean shocks, the two authors impose different signal restrictions, on one hand, on the model of short-term and long-term rates and, on the other hand, on inflation and gross domestic product expected.

Benecka, S. et. al. (2018), in their paper entitled Spillovers from Euro Area monetary policy: A focus on emerging Europe, analyzed the international effects of Eurozone monetary policy shocks on Central, Eastern and South-Eastern Europe (CESEE). The model used was a global autoregressive vector model (GVAR) with shadow rates for monetary policy in times of ZBL, and the results show that in most Eurozone and CESEE countries, prices are adjusting and production tends to fall as a response to the monetary policy tightening promoted in the Eurozone, but with a substantial degree of heterogeneity.

Conclusions

As a result of the analysis we made on the literature, we can say that, in general, studies on the transmission of monetary policy are often based on the use of the Autoregressive Vector, while for the analysis of the impact that monetary policy shocks have on the main macroeconomic variables, the general equilibrium stochastic dynamic model is used. The autoregressive vector is a type of econometric analysis of multivariate time series in which all variables are treated symmetrically. DSGE models, compared to other widespread econometric models, are less theoretical and with reliable macro-foundations based on the optimized behavior of rational economic agents.

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