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DOES THE LONG TERM INTEREST RATE DRIVE GDP IN A SMALL OPEN ECONOMY? EVIDENCE FROM POLAND

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A summary of the doctoral dissertation

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In the dissertation "Does the long term interest rate drive GDP in a small open economy? Evidence from Poland" I show that the long term interest rate that includes a time-varying term premium has stabilized GDP in Poland. The dissertation is divided into five parts. In the first part I provide motiavtion for this research and relate it to the existing literature. I discuss the relevance of long term interest rates and time-varying term premia in Poland and other small open economies (SOEs). In the second part I present a tool that I exploit to address my research questions - the dynamic stochastic general equilibrium (DSGE) model of a SOE with one distinguishable feature: the long term interest rate deviates from the Expectations Hypothesis (EH), i.e. from the expected path of short term interest rates due to the presence of the time-varying term premium. In the third part I derive the main results of this dissertation analyzing the role of the term premium in Poland. The fourth part concludes, whereas the fifth part contains appendixes with the full derivation of my model and the dataset used in its estimation. In this document I summarize the dissertation referring to its points.

Introduction

The long term interest rate is an important variable for the dynamics of the business cycle in an SOE since it affects consumption and saving's decisions of households, investment decisions of firms, fiscal policy and the exchange rate. It also impacts the two main channels of the monetary policy transmission mechanism in SOEs: the interest rate and the exchange rate channels. Despite its importance, the long term interest rate is not explicitly included in DSGE models of SOEs (see e.g. Gali and Monacelli, 2005 as a representative example of such models). As a result these models implicitly assume that the EH does hold true, i.e. the long term interest rate equals the expected path of short term rates and it does not contain a time-varying term premium.

Building on the existing literature that has verified the EH (see Gürkay-nak and Wright, 2012 for a review and Sarno et al., 2007; Bekaert et al., 2001; Campbell and Shiller, 1991; Fama and Bliss, 1987 for well-known examples), I formally show in Chapter 2 that this assumption is unwarranted in Poland in the time horizon exceeding 3 years. Thus, at least as far as the Polish economy is concerned, macromodels abstract from the feature of the reality that is possibly important for economic dynamics and economic policies: the time-varying term premium.

Furthermore, in order to motivate my research, I compare the term premium in Poland with the term premium in the United States using one of the empirical macro-finance models (Adrian et al., 2013) and its original estimates for the US[1]. It turns out that in the world of integrated financial markets the term premia in the US and Poland are strongly correlated. Thus, estimated DSGE models of the Polish economy unrecognizing the time-varying term premium may omit a potentially important link between Polish and external economies.

The invalidity of the EH and the high correlation between the term premium in Poland and the US motivate me to investigate whether this variable is important for the dynamic properties of the Polish economy and the conduct of monetary policy. I find the role of long term interest rates and term premia interesting both from the theoretical (better understanding of economic dynamics) and practical (e.g. for the optimal monetary policy) points of view. In case of the importance of this issue for monetary policy, as McCallum (1994) pointed out, if long-term rates were to fall because of an exogenous drop in the term premium, then it seems natural that the central bank ought to "lean against the wind" by tightening the stance of monetary policy to offset the additional stimulus to aggregate demand. The reaction is not that clear, however, in a model with an endogenous term premium

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[1]These estimates are available on the New York Fed web site: http://www.newyorkfed.org/research/data_indicators/term_premia.html

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since it may depend on the underlying shock that impacts the term premium (Rudebusch et al., 2007).

Basing on the above-mentioned motivation I formulate five objectives of this dissertation:

- show that the EH does not hold in Poland. The EH is usually assumed in NK DSGE models of SOEs. Its rejection points to the potentially important variable (the term premium) and mechanisms associated with it that are missing in these models;

- build a DSGE model that takes into account the stylized fact of invalidity of the EH in the SOE. In this way I bridge two research areas: empirical macro-finance and macroeconomics of SOEs since the former lacks the microfounded macroeconomic structure of DSGE models, while the latter usually ignores the term premium;

- estimate structural parameters of the model with Bayesian inference using Polish data, check its fit to the data and robustness of the results. The estimation allows me to parameterize the model in a way that is consistent with the data. Such parameterization is an appropriate starting point for simulations and monetary policy optimization;

- analyze the role of a term premium shock in the estimated model and compare my model with the benchmark model that does not contain the term premium. This analysis allows me to address the main subject of this dissertation: assess the role of the term premium for GDP dynamics and stability;

- assess the role of the term premium for the optimal monetary policy rule in my model. Since the term premium may be an important variable for economic dynamics, it may also be a useful additional variable in the optimal monetary policy rule.

Based on the above-mentioned objectives I formulate the following dissertation thesis: The long term interest rate that includes the time-varying term premium has stabilized GDP fluctuations in Poland.

I address this thesis with the following three research questions:

- Does the term premium significantly affect the shock propagation mechanism in the SOE?

- Does the term premium significantly impact the volatility of GDP in Poland?

- What are the consequences of the term premium for the optimal monetary policy in the estimated model of the Polish economy?

My contribution to the existing literature is to address these questions that - to the best of my knowledge - have not been investigated yet. Furthermore, my contribution is to explicitly account for the time-varying term premium in an estimated structural economic model of an SOE.

Literature overview

There are various approaches to modeling the long term interest rate present in the empirical macro-finance literature. Firstly, one has to mention affine structure models. In these models pricing kernels may be represented by either 1) latent variables that are derived from the statistical decomposition of the yield curve e.g. principle components analysis, the method of simulated moments or Kalman filter (Adrian et al., 2013; Piazzesi, 2010; Rudebusch and Wu, 2007; Kim and Wright, 2005; Duffee, 2002; Dai and Singleton, 2000; Duffie and Kan, 1996; Litterman and Scheinkman, 1991) and/or 2) macroeconomic variables e.g. GDP growth, output gap, inflation, employment gap (Smith and Taylor, 2009; Diebold et al., 2006; Hordahl et al., 2006; Bernanke and Reinhart, 2004; Ang and Piazzesi, 2003). Latent variables are usually assumed to follow a VAR(1) process. In some papers the pricing

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kernel is directly driven by the dynamics of a structural model (Doh, 2011; Bekaert et al., 2010; De Graeve et al., 2009; Rudebusch and Swanson, 2008; Gallmeyer et al., 2005). There are also models that derive pricing kernels from households' utility maximization (in the earlier-mentioned models pricing kernel and maximization that is included in the macroeconomic model may not be consistent with each other). They usually use Epstein and Zin (1989) preferences that break the link between the parameter of risk aversion and the elasticity of intertemporal substitution while allowing an agent to be risk-averse and willing to smooth consumption over time to a different degree. These papers argue that inflation risk is responsible for the term premium (Piazzesi and Schneider, 2006; Bansal and Shaliastovich, 2013; Rudebusch and Swanson, 2008).

As it is straightforward from this literature overview, the concept of the term premium has been only partially investigated in the empirical macro-finance literature. Although macroeconomic variables are utilized to explain long term interest rates, the latter do not impact the former. Such an impact may be possible in general equilibrium models. Indeed, some DSGE models attempt to account for the time-varying risk premium by deriving the model equations as a third-order approximation around the steady state (Fernández-Villaverde et al., 2010; Rudebusch and Swanson, 2008). However, in these models it is difficult to obtain a significant impact of the term premium on consumption and output (Gürkaynak and Wright, 2012). Moreover, the computation of a third order approximation is much more time-consuming than that of standard linearized models and its estimation is currently impossible (Rudebusch et al., 2007; Andreasen and Zabczyk, 2011). Thus, bringing non-linearized DSGE models to the data is much more difficult. Due to these issues other papers attempt to include the time-varying term premium by augmenting DSGE models with imperfect asset substitutability and bond market segmentation (Kiley, 2014; Chen et al., 2012; Falagiarda and Marzo, 2012; Andrés et al., 2004). In this way they include

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the term premium in DSGE models that may be estimated and used e.g. for monetary policy analysis.

The model of a small open economy

I address my research questions with the New Keynesian (NK) DSGE model of an SOE with one distinguishable feature: the long term interest rate deviates from the EH, i.e. from the expected path of short term interest rates due to the presence of the time-varying term premium. I obtain this feature by introducing a financial friction (portfolio adjustment and transaction costs) in the decision problem of households. Otherwise it is a standard NK DSGE model of an SOE characterized by: monopolistic competition of firms, sticky prices and the central bank following the Taylor rule.

Basing on the literature overview I find this modeling approach to be the most suitable to achieve the dissertation objectives as it allows for estimating structural parameters that are robust to policy changes. Moreover, the intuitive economic interpretation of structural shocks is an important advantage of DSGE over standard time series models. Nevertheless, I am also aware of the limitations of my modeling approach. Firstly, DSGE models are subject to critique about assumptions, they are based on e.g.: rational agents that optimize they behavior or infinite time horizon of their decisions. Furthermore, my model does not include two important channels through which the term premium may impact the economy: the investment and the government spending channels. I leave these issues for further research since in this dissertation I do not intend to quantify the whole impact of the term premium on economic dynamics of the SOE. The value added of the dissertation is more humble, but - in my opinion - still challenging.

The model consists of 5 types of agents: 2 types of households, firms, the central bank and the government. The presence of heterogenous households is crucial to obtain the time-varying term premium in the model. I argue

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that the term premium may be driven by both endogenous and exogenous factors from the point of view of an SOE. Following Gros (2011) I relate the former to external imbalances. Investors worried about the sustainability of external debt require a compensation for the risk they take in the form of the term premium. Indeed, data suggests that countries with higher external net debt are characterized by higher yields in long term bonds and higher term premia. Exogenous factors, in turn, may be related to the general risk aversion of global investors or changes in the monetary policy stance of the major central banks (to the extent they do not respond to other variables that influence both foreign and domestic economies).

Estimation results

In order to estimate the model I log-linearize it around the steady state. I use the Polish and the euro area quarterly data to estimate the model that span the period 1Q2004-2Q2014. The estimation provided a series of interesting insights in the role of the term premium shock in the Polish economy. As the variance decomposition of main variables reveals, this shock has a negligible impact on GDP and inflation volatilities. At the same time it is the main driver of the long term interest rate. This observation is supported by the evidence from the historical shock decompositions of GDP and the long term interest rate. In particular, the negative term premium shock that was observed in 2014 might have been caused by an increased global liquidity and investors' risk appetite associated with the Quantitative Easing (QE) programs conducted by the major central banks. This shock translated into lower long term interest rates in this period that had a noticeable, but very moderate in magnitude, positive impact on consumption, inflation and GDP in Poland.

The small impact of the term premium shock on GDP and consumption also influences how long-term interest rates translate into GDP changes. Ac-

cording to the estimation results, the 10-year interest rate has to decrease by 0.58% in order to cause the same cumulated GDP increase over 3 years as a drop in short term interest rates by 0.11%. This means that the NBP short-term interest rate has a 5.1-fold stronger impact on output in Poland than the 10-year long term interest rate.

The very moderate impact of the term premium shock on GDP and inflation volatilities may suggest a limited role played by the term premium in Poland in my baseline estimation. Such conclusion may not be correct, however, since in my model the term premium consists not only of the exogenous part but it also includes an endogenous part. In order to verify whether the inclusion of the endogenous part is supported by the data, I construct a model in which the term premium is an exogenous autoregressive process (the alternative model). I estimate the alternative model with the same data set as my baseline model and I show that the baseline model explains the data much better than the alternative one (assuming that a priori I do not prefer one model over another). Thus, if one attempts to include the term premium into DSGE SOE model, one should prefer the specification with the net external debt in the term premium to the one in which it is completely exogenous.

Next, I assess whether my estimation results depend on potentially important modeling choices I make. I divide these decisions into two categories: choices on observables and priors for the estimated parameters. In order to check whether my results are robust I repeat my estimation changing one of these assumptions. Finally, I successfully conduct a number of estimations using alternative observable variables or prior assumptions for parameters in order to confirm the robustness of my results.

The importance of the term premium in the estimated DSGE SOE model

In order to analyze the role of the term premium I construct a benchmark model of the SOE in which I switch off the friction that gives rise to the endogenous and exogenous parts of the term premium which I interpret as removing the term premium itself. Furthermore, I compare my baseline (estimated) model with the benchmark one looking at the volatility of main variables and model dynamics (represented by impulse response functions, IRFs).

It turns out that the volatility of GDP is significantly higher in the benchmark model. On the other hand, the real exchange rate and the long term interest rate volatilities are lower in the benchmark model which means that the term premium stabilizes the output at the cost of destabilizing some asset prices.

The analysis of IRFs indicates that the stabilization effects of the term premium for the domestic GDP come mainly from the risk premium and the export preference shocks, i.e. shocks that are primarily propagated through changes in exchange rate and net exports. When these shocks hit the economy the term premium reduces external debt volatility by reacting endogenously to its changes. Consequently, it also stabilizes net exports and consumption leading to a lower volatility of GDP. On the other hand, when a time preference shock, i.e. a typical domestic demand shock, hits the economy, the change in the term premium has too weak stabilization effect on consumption leading to an increased GDP volatility as compared with the case of the absence of the term premium.

Next, I perform a counterfactual simulation of the Polish economy in the estimation period in order to analyze what my model and its estimation imply for the role of the term premium for the volatility of main macroeconomic aggregates in the past. I show that without the term premium, GDP volatil-

ity would have been much higher especially directly before and during the global financial crisis. This may constitute the explanation of the stabilizing function of the flexible exchange rate found in Brzoza-Brzezina et al. (2014) since switching off the term premium, in this particular period, would have reduced the exchange rate volatility and as a consequence increased GDP volatility. Furthermore, the counterfactual simulation reveals that also in 2013-2014 the term premium stabilized GDP in Poland. In this period the negative term premium was conducive to the exchange rate appreciation acting contractionary and outweighing the favorable impact of lower long term interest rates on GDP that worked via an increase in consumption. Both examples lead to the conclusion that even tough the endogenous part of the term premium affects both the long term interest rate and the exchange rate, the latter channel is much stronger.

The above-mentioned conclusions refer directly to the Polish economy, however, some of them may be also relevant for other SOEs. First of all, since the term premium stabilizes GDP for shocks that affect the exchange rate and net exports, while it increases GDP volatility for the domestic time preference shock, the relative importance of these two types of shocks should influence the net impact of the term premium on GDP volatility in an SOE. In this context the model estimation for other SOEs would be very interesting. Furthermore, since the term premium stabilizes the consumption volatility when the impact on GDP of the first type of shocks prevails, the term premium should also increase welfare in this case. The veryfication of such a hypothesis requires a second-order approximation of the model with the term premium that would allow for welfare analysis. I leave these issues for further research.

Long term interest rates and the optimal monetary policy rule

Since the long term interest rate affects two main channels of the monetary policy transmission mechanism it may be an important variable for the central bank that attempts to optimize monetary policy. Therefore, having estimated and analyzed the dynamic properties of the NK DSGE SOE model that includes the time-varying term premium, I investigate the implications of my model for the optimal monetary policy of the Taylor rule-type. To this end I compare the performance of two optimal Taylor rules: one that has a standard form (central bank's interest rate responds to its past values, output gap and inflation) and one that allows additionally for a direct response to the term premium. This allows me to assess whether the term premium bears an additionally important information for monetary policy over the output gap and the inflation rate.

I show that the optimality of the monetary policy rule does not significantly depend on the inclusion of the term premium. This result is robust to changes in parameter λ that depicts the relative weight that the central bank attaches to output gap stabilization. The reason for this result seems to be a little additional information on the state of the economy contained in the term premium that would help the central bank to stabilize the economy.

Conclusions

In this dissertation I show that the long term interest rate that includes a time-varying term premium stabilizes GDP in Poland. I prove that historically the term premium reduced the output volatility in Poland, while it did not affect significantly the inflation rate volatility. This conclusion refers especially to the recent global financial crisis period: if the term premium had been switched off at that time, the GDP volatility would have been much higher at that time. On the other hand, the term premium shock had a mi-

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nor impact on GDP and inflation volatilities which suggests, among others, that the QE programs conducted by the major central banks did not have a substantial impact on the Polish economy even though they significantly lowered long-term interest rates in Poland. According to my estimation, the central bank short-term interest rate has a 5.1-fold stronger impact on the output gap in Poland than the 10-year long term interest rate. Finally, I show that the optimal monetary policy rule of Taylor type in the estimated model does not depend on the inclusion of the term premium. This indicates that the term premium brings little additional information on the state of the economy as compared with the output gap and inflation.

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