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Article

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The effectiveness of fiscal policy within business cycle – Ricardians vs. non-Ricardians approach

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ABSTRACT

This study aims to measure the impact of the share of non-Ricardian households on fiscal multipliers. We show that the share of non-Ricardian households in Hungary increased significantly after crisis began and explain why the plausible reason for this increase is the higher level of liquidity constraints during crisis. We also show that after crisis, when the share of non-Ricardians in Hungary was very high, the impact of government spending shocks on GDP was almost twice as strong as before the Great Recession. Thus, the results of the study indicate that there is some trade-off between the effectiveness of fiscal policy as a tool of GDP stabilization and household access to the credit market.

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1. Introduction

The Great Recession has significantly changed attitudes to the role and macroeconomic effects of fiscal policy. Recent literature has indicated that government spending is generally an effective tool of macroeconomic stabilization during recession. The seminal paper of Auerbach and Gorodnichenko (2012) shows that fiscal multipliers are much higher during recessions than during expansions. Similar conclusions can be drawn from later VAR-type models (e.g. Afonso, Baxa, & Slavik, 2018; Baum, Poplawski-Ribeiro, & Weber, 2012; Baum & Koester, 2011).

There are two main theoretical explanations of this phenomenon. The first explanation is based on the zero lower bound (e.g. Christiano, Eichenbaum, & Rebelo, 2011; Eggertson, 2011; Schmidt, 2017). During the Great Recession, ZLB occurred, which translated into accommodative monetary policy and high fiscal multipliers. The second, less investigated explanation is based on the role of varying share of non-Ricardians within the cycle. This phenomenon is a two-step relationship. Firstly, as Galí, López-Salido, and Vallés (2007) have shown, the higher the share of non-Ricardian households, the stronger the impact of fiscal policy on output. Secondly, there is a relationship between the share of non-Ricardians and macroeconomic situation; during recessions, the share of non-Ricardian households usually increases (Furceri & Mourougane, 2010). The potential explanation is that the share of Ricardians depends on liquidity constraints which are usually counter-cyclical. The households face liquidity constraints more often when the macroeconomic situation is

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worsening, which translates into a higher share of non-Ricardians and higher fiscal multipliers during recessions.

The impact of interest rate ZLB on fiscal multipliers is very well explored. New-Keynesian dynamic stochastic general equilibrium models indicate that ZLB generates very high fiscal multipliers (e.g. Eggertsson, 2011; Miyamoto, Nguyen, & Sergeyev, 2017; Woodford, 2011). This phenomenon, of course, only occurs in countries where interest rates are close to zero – mostly well-developed countries. On the other hand, the role of non-Ricardians is not so important in this group of countries.

As Mankiw (2000) indicates, the higher the level of income the lower the share of rule-of-thumb households. This explains why, in explaining the fiscal multipliers in Eurozone countries, the role of non-Ricardians is relatively small (Coenen & Straub, 2005). Furthermore, in non-European high-income countries the role of non-Ricardians is relatively low, especially during expansions (Morita, 2015). Good access to banking sector in high-income countries translates into a low share of non-Ricardians and their almost negligible impact on fiscal multipliers.

In the case of less developed countries, the situation is different. Rule-of-thumb behaviour is typical for lower income households, which do not save and are not able to smooth consumption (Albonico, Paccagnini, & Tirelli, 2016; Coenen et al., 2012; Coenen & Straub, 2005; Galí et al., 2007). It means that in relatively lower income countries, it is of particular importance to take into account rule-of-thumb households in macroeconomic policy analysis.

The aim of the article is to analyse the impact of share of non-Ricardians on fiscal multipliers in one of lower income European countries. Our research is conducted for Hungarian economy. Among lower income European countries, we have decided to analyse Hungary because:

- The role of liquidity constraints in Hungarian economy is much higher than in EMU countries or other CEE countries (see Appendix 1),
- The Great Recession hit the Hungarian economy relatively strongly and in an abrupt way (in comparison with other CEE countries), which enables us to distinguish clearly between the expansion and recession period.

Moreover, the assessment of fiscal multiplier in Hungary is of significant importance in the context of the future potential accession of this country to Eurozone, because in EMU fiscal policy is the main macroeconomic instrument to cope with asymmetric shocks. However, the only similar study for Central and Eastern European countries with derogation was conducted by Krajewski (2017). Our research deepens Krajewski's analysis of (2017) in two aspects:

- Firstly, we estimate the share of non-Ricardians instead of a priori calibration;
- Secondly, we compare the effects of fiscal policy during expansion and recession.

We analyse the impact of share of non-Ricardians on fiscal multipliers in Hungary on the basis of the new-Keynesian dynamic stochastic general equilibrium model with heterogeneous households. The model is similar to that of Galí et al. (2007). However, we compare the effects of government spending on GDP for different shares of non-

Ricardians period using Bayesian estimation. Our analysis is based on Hungarian data for two subsamples: pre-crisis (1999q1–2008q3) and crisis and post-crisis sub-sample (2008q4–2016q4).

The paper proceeds as follows. In Section 2, we provide a general overview of the literature. Section 3 presents the stylized facts about the pre-crisis and post-crisis Hungarian economy, concerning GDP fluctuations, banking sector indicators and the effectiveness of fiscal policy. On the basis of the selected macroeconomic and financial variables and simple SVAR model, we show that the relatively large value of the fiscal multiplier in Hungary during economic slowdown was closely linked to the situation in the financial sector that influenced the behaviour of households. In Section 4, we present the assumption of new-Keynesian model, which gives a theoretical explanation of the relationship between the non-Ricardians and the effects of fiscal policy. In Section 5, we show the Bayesian estimation of the parameters and simulations results on pre-crisis and post-crisis effects of fiscal policy. Section 6 concludes our study.

2. Literature review

The growing interest in the effects of fiscal policy shocks has resulted in many studies and methodological approaches to measure fiscal multipliers. The literature on the effects of fiscal policy shocks has exploded in the context of the recent economic and financial crisis because of a large fiscal stimulus initiated by governments to counter the negative consequences of the impact of crisis on the real economy. However, the results suggest that the effects of fiscal policy shocks depend on special circumstances under which estimates are provided, especially whether these analyses include regime-dependence and heterogeneity of households.

The pre-crisis analyses were mainly provided by linear empirical vector autoregressive models (VAR) or linearized dynamic stochastic general equilibrium (DSGE) models. As a consequence, applied approaches did not identify the influence of fiscal policy as dependent on the state of the economy and, as a result, the short-run multipliers obtained were generally lower than 1 (e.g. Blanchard & Leigh, 2012, 2013; Hall, 2009).

The empirical investigations to measure fiscal multipliers are dominated by VAR models. The crucial element of these models is to impose a set of assumptions in form of identification scheme. The prominent example here is an identification proposed by Blanchard and Perotti (2002), event study approach (e.g. Caldara & Kamps, 2008, 2012; Perotti, 2004) and the sign restriction (Mountford & Uhlig, 2009). The (S)VAR models or panel VAR models are often used for fiscal multiplier estimation for developing and low-income countries, as well as CEE countries (Baranowski, Krajewski, Mackiewicz, & Szymańska, 2016; Grdović Gnip, 2014; Ilzetzi, Mendoza, & Végh, 2013; Kraay, 2013; Mirdala, 2009). The post-crisis VAR models have been modified to the smooth transition vector autoregressive models (STVAR) (see Auerbach & Gorodnichenko, 2012 for US, Hernández de Cos & Moral-Benito, 2016 for Spain or Benčík, 2014 for CEE countries) or to nonlinear TVAR (threshold VAR) models (Batini, Callegari, & Melina, 2012; Baum et al., 2012; Baum & Koester, 2011; Mitnik & Semmler, 2012). In general, the results demonstrate that effects of fiscal expansion are much higher in a regime of low economic activity than in a regime of high activity. However, some papers show different evidence. Ramey and Zubairy (2014) indicate that the multipliers may be negative in the high unemployment

rate regime and they point out that state-dependent estimates of fiscal policy effects are not reliable.

The pre-crisis linearized DSGE models were based on Ricardian equivalence and predicted a decline in consumption in response to positive government spending shock (Baxter & King, 1993; Linnemann & Schabert, 2003). In the standard DSGE models, government spending shocks, financed by lump-sum taxes, provide that households work more and consume less due to the negative wealth effect. The overview of the pre-crisis literature shows that the fiscal multipliers obtained in DSGE models are sensitive to special assumptions including, for instance, the substitution between public and private consumption (Bouakez & Rebei, 2007) or the existence of habit persistence in utility function of households (Ravn, Schmitt-Grohe, & Uribe, 2006). The results are also very sensitive to the presence of heterogeneous agents.

As mentioned previously, the Ricardian equivalence holds in the standard DSGE models. Thus, the consumption is a function of permanent disposable income of households, not their current disposable income. It is a result of ability of households to smooth their consumption in time, e.g. by access to the financial market. However, as presented by Mankiw (2000), it is important to distinguish between savers and spenders – two types of households to reflect the realistic economic assumptions. He assumes heterogeneity between the agents and argues that the explanation of consumption smoothing is limited to some agents due to their liquidity constraints, lack of access to the financial market or their myopia. These insights are included and developed in the Galí et al. (2007) study in which consumption behaviour depends on changes in government spending. In Galí et al. (2007) paper, the higher share of non-Ricardian households, the higher value of spending multipliers. Also Coenen and Straub (2005) in their model for the euro area emphasize that the occurrence of heterogeneous agents raises the consumption in response to spending shocks more than in model without non-Ricardian households. However, they point out that the estimated share of non-Ricardian households may be relatively low to generate the sufficient (for prevailing negative wealth effect) crowd-in effect in consumption. The importance of heterogeneous agents for analysing the effects of fiscal policy in the Euro area present among others Ratto, Roeger, and in't Veld (2009); Marto (2014); Fève and Sahuc (2017) and Zeman (2017).

The post-crisis DSGE models were aimed to capture the impact of the business cycle fluctuations on the effects of fiscal policy. The 'bad times' are often expressed by special assumptions related to monetary policy (e.g. zero lower bound, liquidity trap, highly accommodative monetary policy – see: Christiano et al., 2011; Coenen, Straub, & Trabandt, 2012; Cogan, Cwik, Taylor, & Wieland, 2010; Cwik & Wieland, 2011; Erceg & Lindé, 2014; Schmidt, 2017; Woodford, 2011 and Olivier & Takongmo, 2017), or constraints in agents' behaviour (liquidity-constrained households or non-Ricardian credit-constrained consumers – e.g. Anderson, Inoue, & Rossi, 2016; Kara & Sin, 2018; Parker, Souleles, Johnson, & McClelland, 2013). According to the obtained results, fiscal multipliers are usually strongly state-dependent, and, as a consequence, fiscal expansions during recessions produce higher effects than during periods of economic boom (see e.g. Canzoneri, Collard, Dellas, & Diba, 2016).

The role of financial cycle has been much exploited after 2008, especially in the context of the credit availability (see eg. Alessi & Detken, 2018; Blanchard & Summers, 2017; Bordo & Landon-Lane, 2013; Borio, 2014; Gelain, Lansing, & Natvik, 2017; Juselius, Borio, Disyatat,

& Drehmann, 2016). The effects of government spending shocks under different financial regimes show among others Pragmaidis, Tsintzos, and Plakandaras (2018) and Afonso et al. (2018). The attempt to explain the role of deleveraging shock in the ZLB environment and the presence of patient and impatient households is analysed by Eggertsson and Krugman (2012). According to these authors, the deleveraging shock reduces the debtors' spending and may lead the economy into the liquidity trap and into a world of topsy-turvy. Under that circumstances, the deficit-financed government spending may stimulate economy and enable debtors to improve their balance-sheets. The interactions between deleveraging and credit market conditions, as well as behaviour of credit-constrained agents are also investigated among others by Cuerpo, Drumond, Lendvai, Pontuch, and Raciborski (2015) and Jones, Midrigan, and Philippon (2018). The impact of private debt overhang on larger government spending multipliers is confirmed by Bernardini and Peersman (2018).

The behaviour of households in the context of the financial crisis is also analysed for CEE countries, including Hungary. The households' consumption smoothing behaviour in a group of 10 Central, Eastern and Southeastern European countries is investigated by Corti and Scheiber (2014). They analyse the OeNB Euro Survey data and conclude that during the crisis period (from 2008 to 2013), a part of households had only limited scope for consumption smoothing, as well as the limited ability to save out of current income.

3. Hungarian economy – stylized facts

In this section, we analyse stylized facts about Hungarian economy that may potentially point to liquidity constraints and compare them with stylized facts about fiscal multipliers drawn from simple SVAR model.

Before 2008, the Hungarian economy experienced a positive growth rate, including an increasing path of private consumption. The situation completely changed in 4th quarter of 2008, when the global economy (including Hungarian economy) started to suffer from the Great Recession. What is interesting is that the decrease in Hungarian household consumption was generally higher than the decrease in GDP growth rate. This may point to liquidity constraints in Hungarian economy because in case of free access to the credit market optimizing households smooth consumption and consequently consumption fluctuations are much smaller than GDP fluctuations.

We compared the macroeconomic variables with financial variables. Before the crisis, as presented in Figure 1, the positive economic growth rate was associated with rapid credit expansion of households. At the beginning of 2009, this expansion abruptly collapsed. Similar to the case of consumption behaviour, the potential explanation of this collapse is liquidity-constrained households' behaviour after crisis, because in case of free access to banking sector the increase in growth rate of loans should be observed during recession.

It is worth noting, that important feature of Hungarian banking sector before Great Recession was that the most of loans were denominated in foreign currency – mainly in CHF and Euro. Before crisis, the boom of CHF lending was observed in some CEE countries – for example, at the end of 2007 Hungary displayed the largest share of CHF loans in total private sector loans (34.77%) in that region (Andrieş & Nistor, 2018). The threats of

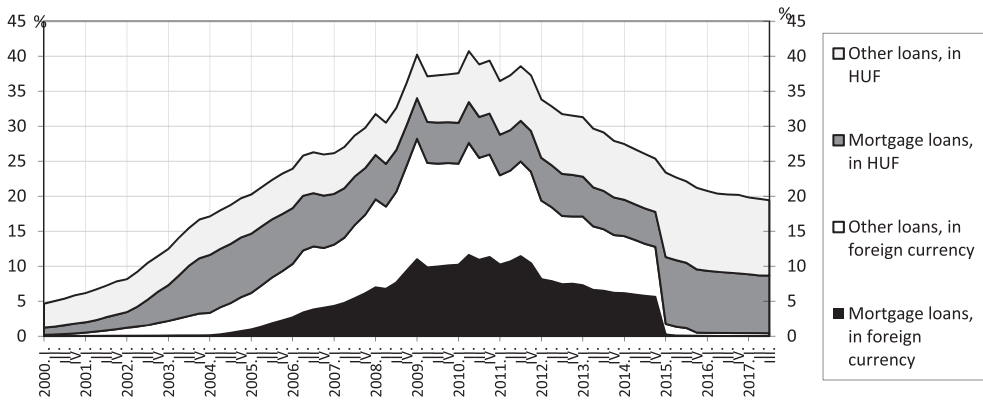


Figure 1. Loans of households as a % of GDP (stocks). Source: Magyar Nemzeti Bank (<https://www.mnb.hu/en/statistics/statistical-data-and-information/statistical-time-series/xii-financial-accounts-financial-assets-and-liabilities-of-institutional-sectors/comprehensive-information>)

excessive credit growth were investigated by Laidroo and Männasoo (2014), among others. The authors analysed situation in 11 new EU countries (including Hungary) and observed the existence of a negative association between loan loss reserves and real GDP growth. When the Great Recession began, forint depreciated significantly (see Figure 2), which significantly worsened the financial situation of households with mortgage loans denominated in CHF or EUR.

As mentioned above, the potential explanation of the significant decrease in consumption and the collapse of credit expansion is the liquidity-constrained behaviour of households. According to Eggertsson and Krugman (2012) in case of high debt, the liquidity-constrained behaviour may lead to significant deleverage – during crisis liquidity-constrained debtors are forced into rapid deleveraging. In similar vein, Cuerpo et al. (2015) show that the deleveraging is a consequence of shocks that force credit-constrained households to reduce their debt stock.

However, another potential explanation of deleverage in Hungary is an endogenous reaction of households to high indebtedness. Thus, we also analysed survey data on

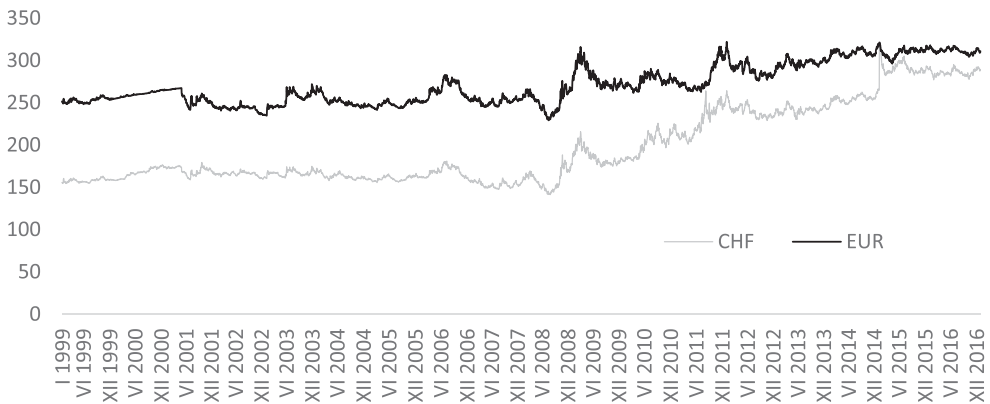


Figure 2. HUF exchange rate (MNB data).

liquidity constraints in Hungary to check whether Hungarian households are liquidity-constrained and whether the role of liquidity constraints increased after crisis. We compared the statistical macroeconomic and financial data with survey data showing the share of households unable to face unexpected financial expenses because this measure is a proxy of liquidity constraints (Krajewski, 2017). As shown in Figure 3, the percentage of households aware of their liquidity constraints increased significantly in 2009.

On the basis of simple SVAR, we also analysed the stylized facts on fiscal multipliers in Hungary. We compared ‘average’ multipliers for the period 1999q1–2016q4 with subsamples before crisis and after crisis began (that is until 2008q3 and since 2008q4, respectively). We used the SVAR methodology with Blanchard and Perotti (2002) identification scheme, that is:

$$A\mathbf{x}_t = \alpha_0 + \sum_{i=1}^4 \Gamma_i \mathbf{x}_{t-i} + B\mathbf{v}_t \tag{1}$$

where $\mathbf{x}_t = [G_t T_t Y_t]^T$, G_t – government spending, T_t – net taxes, Y_t – GDP, \mathbf{v}_t – vector of structural innovations, $\mathbf{v}_t = [v_t^G v_t^T v_t^Y]^T$, $A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & -a_3 \\ -a_1 & -a_2 & 1 \end{bmatrix}$, $B = \begin{bmatrix} \beta_1 & 0 & 0 \\ 0 & \beta_2 & 0 \\ 0 & 0 & \beta_3 \end{bmatrix}$.

All data comes from Eurostat. We use log-transformed data, seasonally adjusted with TRAMO/SEATS, and detrended with HP filter. The parameter a_3 , which represents elasticity of revenues to GDP, was calibrated at 1.43, on the basis of estimates of Baranowski et al. (2016) for the Hungarian economy. Next, we analyse the lag structure of our models based on the Akaike information criterion (see Appendix 2). We got two lags in the case of full sample and one lag in model for pre-crisis sub-sample. The AIC for post-crisis sub-sample suggests to use maximum lag. However, taking into account the relatively short sub-sample and additional lag length criteria (SIC and HQ), we decided to use one lag for both subsamples. The use of one lag in both subsamples allows us to compare effects of government spending shock in pre- and post-crisis periods.

Estimates for full sample and defined subsamples are presented in Appendix 3. The impulse-response functions for government spending shocks are presented in Figure 4.

Estimated IRFs allowed us to calculate government spending multipliers, presented in Table 1.

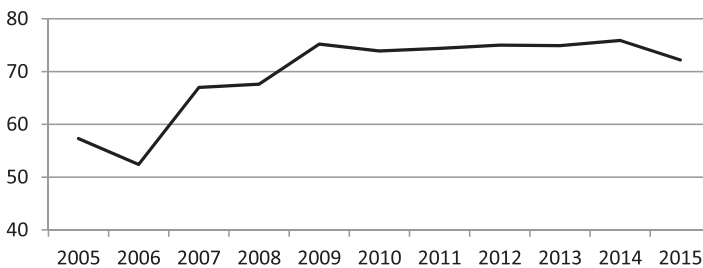


Figure 3. Percentage of households unable to face unexpected financial expenses in Hungary (Eurostat data).

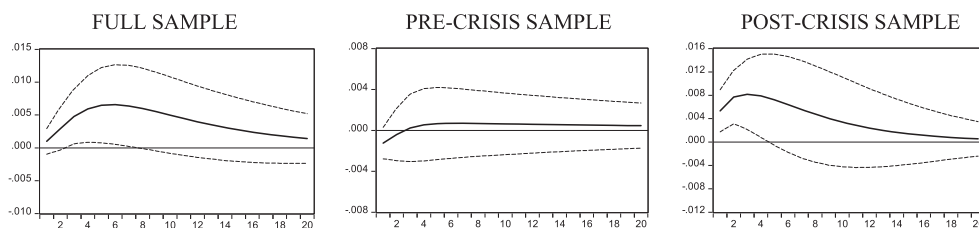


Figure 4. Response of GDP to spending shock (response to one S.D. innovation ± 2 S.E.).

Table 1. Spending multipliers. *Note:* the quarter with the peak multiplier in brackets.

	Full sample	1999Q1–2008Q3	2008Q4–2016Q4
Peak multiplier	0.5994 (6)	0.0588 (6)	0.8776 (3)
Average multiplier (within 20 quarters)	0.3539	0.0358	0.4033
Cumulative (within 20 quarters)	7.0787	0.7171	8.0654

The values of multipliers estimated for pre-crisis sample are lower than those for the full sample whereas multipliers for post-crisis are higher than those for the full sample. The peak, average and cumulative multiplier for 'bad times' are many times higher than multiplier estimated for the pre-crisis period. This suggests that effectiveness of fiscal expansion after the global financial crisis has been stimulated by specific macroeconomic circumstances of the Hungarian economy and, according to our hypothesis, the reason of these results can be bounded up with household behaviour and liquidity constraints. For this reason, in the following sections, we analyse the impact of fiscal expansion within the new-Keynesian model with heterogeneous households; that is, a model taking into account the occurrence of liquidity constraints among part of households.

4. New-Keynesian model

There are two groups of households in the model. The fraction $\varpi \in (0, 1)$ of the continuum of households indexed by $j \in [0, 1]$ faces liquidity constraints. These households follow rule-of-thumb; that is, they make decisions only on the basis of current income. They are called the non-Ricardians, because they do not behave according to Ricardian equivalence. In case of this group of households, the budget constraint takes the form:

$$P_t C_t^{NR} + P_t T_t^{NR} = W_t P_t L_t^{NR}, \quad (2)$$

where C_t^{NR}, L_t^{NR} are the non-Ricardians consumption and labour supply, respectively; T_t^{NR} is the taxes paid by non-Ricardians; W_t is the wages, and P_t is the price.

Non-Ricardians maximize the following utility function:

$$u = \ln C_t^{NR} - \frac{(L_t^{NR})^{1+\varphi}}{1+\varphi}, \quad (3)$$

where $\varphi \geq 0$.

Thus, the labour supply of non-Ricardian households must satisfy the following intra-temporal condition:

$$W_t = C_t^{NR} (L_t^{NR})^\varphi. \quad (4)$$

The second group of households have access to capital market. These households, called Ricardians, optimize consumption according to Ricardian equivalence, as in a seminal Barro (1974) paper. They face the following intertemporal budget constraint:

$$P_t(C_t^R + I_t) + \frac{B_{t+1}}{(1 + r_t)} + P_t T_t^R = W_t P_t N_t^R + (1 + r_t^k) P_t^R K_t^R + B_t + D_t, \tag{5}$$

where C_t^R , I_t , B_t and K_t – Ricardians’ consumption, investment, bonds, capital respectively, T_t^R – taxes paid by Ricardians, D_t – dividends paid to firms owned by Ricardian households, r_t , r_t^k – return on bonds and capital, respectively.¹

Optimizing households maximize the expected value of the sum of discounted utilities given by

$$E_t \left(\sum_{t=0}^{\infty} \beta^t \left(\ln C_t^R - \frac{(L_t^R)^{1+\varphi}}{1 + \varphi} \right) \right), \tag{6}$$

where $\beta \in (0, 1)$.

Only optimizing households accumulate capital. In the case of this group of households, the capital accumulation equation is as follows:

$$K_t = (1 - \delta)K_{t-1} + \left(f \left(\frac{I_t}{K_{t-1}} \right) \right) I_t, \tag{7}$$

where $\delta \in (0, 1)$ and function f fulfils: $f(\delta) = \delta$, $f' > 0$, $f''(\delta) = 1$, $f''' < 0$ (see Galí et al., 2007).

On the basis of the above assumption, we can get the following conditions of discounted utility maximization:

$$E_t \left(\beta \frac{C_t^R}{C_{t+1}^R} \right) = \frac{1}{1 + r_t}, \tag{8}$$

$$\begin{aligned} E_t \left(\beta \frac{C_t^R}{C_{t+1}^R} \left(1 + r_{t+1}^k + \left(f' \left(\frac{I_{t+1}}{K_{t+1}} \right) \right)^{-1} \left(1 - \delta + f \left(\frac{I_{t+1}}{K_{t+1}} \right) - \frac{I_{t+1}}{K_{t+1}} f' \left(\frac{I_{t+1}}{K_{t+1}} \right) \right) \right) \right) \\ = P_t \frac{I_{t+1}}{K_{t+1}} \left(f' \left(\frac{I_{t+1}}{K_{t+1}} \right) \right)^{-1} \end{aligned} \tag{9}$$

The final good (Y_t) is produced based on continuum of intermediate goods indexed by $i \in [0, 1]$, according to Dixit and Stiglitz (1977) aggregator:

$$Y_t = \left(\int_0^1 y_t(i)^{\frac{1}{1 + \lambda_p}} di \right)^{1 + \lambda_p}, \tag{10}$$

where $y_t(i)$ is the intermediate good of type i , and λ_p is the mark-up in the goods market.

On the basis of cost minimization, we have

$$y_t(i) = Y_t \left(\frac{p_t(i)}{P_t} \right)^{\frac{-(1+\lambda_p)}{\lambda_p}}, \quad (11)$$

where $p_t(i)$ is the price of intermediate goods of type i .

The production function of intermediate good i takes the form:

$$y_t(i) = A_t k_t(i)^\alpha l_t(i)^{1-\alpha} - FC, \quad (12)$$

where A_t is the total factor productivity, $k_t(i)$, $l_t(i)$ are capital and labour hired to produce intermediate good i , and FC is the fixed costs, $\alpha \in (0, 1)$.

The total factor productivity changes according to the autoregressive process:

$$A_t = (1 - \rho_A)\bar{A} + \rho_A A_{t-1} + \xi_{A,t}, \quad (13)$$

where $\rho_A \in (0, 1)$, $\bar{A} > 0$, $\xi_{A,t} \sim N(0, \sigma_A^2)$.

Prices are set according to the Calvo (1983) schedule; that is, the price is optimized in a given period with probability $1 - \xi_p$. Thus, the equation describing price dynamics is given by

$$P_t = \left((1 - \xi_p) P_t^* \frac{1}{\lambda_p} + \xi_p P_{t-1} \frac{1}{\lambda_p} \right)^{-\lambda_p}, \quad (14)$$

where P_t^* is the price optimized at time t , $\xi_p \in (0, 1)$.

The monetary policy follows the simple Taylor (1993) rule given by

$$r_t = r^* + \phi_\pi \pi_t + \varepsilon_{r,t}, \quad (15)$$

where r^* is the steady state interest rate, π_t is the inflation, $\varepsilon_{r,t}$ is the monetary policy shocks, $\phi_\pi \geq 0$.

Interest rate shocks follow a first-order autoregressive process:

$$\varepsilon_{r,t} = \rho_r \varepsilon_{r,t-1} + \xi_{r,t}, \quad (16)$$

where $\rho_r \in (0, 1)$, $\xi_{r,t} \sim N(0, \sigma_R^2)$.

The government budget constraint is given by

$$P_t T_t + \frac{B_{t+1}}{(1+r_t)} = B_t + P_t G_t, \quad (17)$$

where T_t is the taxes, G_t is the government spending.

Taxes consist of taxes paid by both Ricardians and non-Ricardians:

$$T_t = \varpi T_t^{NR} + (1 - \varpi) T_t^R. \quad (18)$$

Similarly as Chung, Davig, and Leeper (2007) and Davig and Leeper (2011), we assume that taxes adjust to fulfil the fiscal rule given by

$$T_t - T^* = \tau_G (G_t - G^*) + \tau_B \left(\frac{B_t}{P_{t-1}} - \frac{B^*}{P^*} \right), \quad (19)$$

where T^* , G^* , B^* and P^* is a steady state level of taxes, government spending, bonds and price respectively, $\tau_G, \tau_B > 0$.

Fiscal policy affects the economy through shocks to government spending. Spending shocks follow a first-order autoregressive process:

$$\frac{G_t - G^*}{Y^*} = \rho_G \frac{G_{t-1} - G^*}{Y^*} + \xi_{G,t} \quad (20)$$

where $\rho_G \in (0, 1)$, $\xi_{G,t} \sim N(0, \sigma_{\xi,G}^2)$.

The model is closed by the standard equilibrium condition on goods market; that is, output equals the sum of demand by households for consumption, investment and government demand:

$$Y_t = C_t + I_t + G_t. \quad (21)$$

After log-linearization, the model can be shown as a following system of log-deviations from the steady state:

$$\begin{bmatrix} 0 & 0 & 0 & 1 & 0 & \frac{\delta}{1-A_1} \\ 0 & 0 & \beta & 0 & 0 & 0 \\ \frac{\omega(1+\varphi)}{(C^*/Y^*)\lambda_p - \omega} & 1 & \frac{(1-\alpha)}{1 - \frac{\omega(1-\alpha)}{\lambda_p(C^*/Y^*)}} & 0 & A_2\tau_B & A_2(\rho_{g/y} - 1)\tau_B \\ A_3(1+\varphi) + \beta(1-\alpha) & A_3 - \beta A_1 & \frac{A_3 - 1}{f(\delta)\delta} & -A_3 - \beta(1-A_1 - \alpha) & 0 & 1 - \beta\rho_G \\ 0 & 0 & 0 & 0 & 1 & \frac{\tau_G - 1}{\beta} \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \tilde{l}_{t+1} \\ \tilde{c}_{t+1} \\ \tilde{\pi}_{t+1} \\ \tilde{k}_{t+1} \\ \tilde{b}_{t+1} \\ \tilde{g}_t \end{bmatrix} \\ = \begin{bmatrix} \frac{\delta(1-\alpha)}{1-A_1} & \frac{\delta A_1}{1-A_1} & 0 & 1 - \delta + \frac{\delta\alpha}{1-A_1} & 0 & 0 \\ -\frac{(\alpha+\varphi)(1-\beta\xi_p)(1-\xi_p)}{\xi_p} & -\frac{(1-\beta\xi_p)(1-\xi_p)}{\xi_p} & 1 & \frac{\alpha(1-\beta\xi_p)(1-\xi_p)}{\xi_p} & 0 & 0 \\ -\frac{\lambda(1-\alpha)(1+\varphi)}{(C^*/Y^*)\lambda_p - \omega(1-\alpha)} & 1 & \frac{\phi_\pi(A_3 - 1)}{f''(\delta)\delta} & 0 & A_2\tau_B & 0 \\ 1 - \alpha & \frac{C^*}{Y^*} & -\frac{\phi_\pi(1-A_1)}{f''(\delta)\delta} & A_1 + \alpha - 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & \frac{1-\tau_B}{\beta} & 0 \\ 0 & 0 & 0 & 0 & 0 & \rho_G \end{bmatrix} \begin{bmatrix} \tilde{l}_t \\ \tilde{c}_t \\ \tilde{\pi}_t \\ \tilde{k}_t \\ \tilde{b}_t \\ \tilde{g}_t \end{bmatrix} + \xi_t \quad (22)$$

where \tilde{x}_t log-deviations from the steady state, C^* and I^* – steady state level of consumption and investment respectively, ξ_t – vector of shocks,

$$A_1 = \frac{C^*}{Y^*} + \frac{G^*}{Y^*}, A_2 = \frac{\varpi \lambda_p}{(C^*/Y^*)\lambda_p - \omega(1 - \alpha)}, A_3 = -\frac{1 - \beta(1 - \delta)(1 - A_1)}{f''(\delta)\delta}$$

$$= \eta(1 - \beta(1 - \delta)(1 - A_1)).$$

5. Bayesian estimation and simulation results

Parameters of the model are estimated on the basis of quarterly data for Hungarian economy for the period 1999q1–2016q4. We apply Bayesian methodology to estimate most of the parameters of the model. Bayesian estimation is based on a priori information concerning parameters distribution and takes into account a priori knowledge about the economic phenomena while being relatively robust to model specification errors (see Fernandez-Villaverde, 2010). We assume the following a priori means of structural parameters:

- the parameter ϖ equal to 0.5; that is, a priori the same share of Ricardian and non-Ricardian households,
- the mean of elasticity of wages with respect to hours equal to 0.2 (see Rotemberg & Woodford, 1999),
- the mean of elasticity of investment-capital ratio with respect to Tobin's Q ratio set equal to 1 (see King & Watson, 1996),
- the mean of elasticity of output with respect to capital at standard level, that is equal to 1/3,
- the mean of parameter ξ_p equal to 0.75, that is the average price duration of one year,
- price mark-up equal to 0.2 (see Rotemberg & Woodford, 1999),
- the mean of parameter ϕ_π in Taylor rule equal to 1.5. (see Woodford, 2001),
- the fiscal policy rule parameters τ_G, τ_B , equal to 0.1, and 0.33, respectively (see Galí et al., 2007).

The parameters ρ_A, ρ_r, ρ_G describing persistency of shocks are set to 0.9. Details of a priori distributions of parameters are presented in Appendix 4.

Calibration, as commonly applied in DSGE models, is only used in the case of the discount factor and the rate of capital depreciation. The discount factor and the rate of capital depreciation are calibrated on standard levels used in the literature (see e.g. Smets & Wouters, 2003). This means that we assume discount factor depreciation rate equal 0.99 and 0.025, respectively.

We calculated a posteriori distributions using the algorithm of Metropolis, Rosenbluth, Rosenbluth, Teller, and Teller (1953) and Hastings (1970) (see An & Schorfheide, 2007). There are three shocks in the model (one supply-side and two demand-side shocks), thus we should choose no more than three observable variables for estimation. The estimation covered the following observable variables for the Hungarian economy: GDP, employment and private consumption. We use quarterly data which comes from Eurostat.

We estimated the model for two sub-periods: 1999q1–2008q3 and 2008q4–2016q4, which is before Great Recession and after the crisis began. All variables were transformed

into logarithmic form and then seasonally adjusted using TRAMO/SEATS. The Hodrick-Prescott filter with the standard smoothing parameter for quarterly data was used to remove the trend. Numerical calculations were made using the Dynare software based on Matlab. The a posteriori means of model parameters were then presented in Appendix 5.

The most important difference between a posteriori estimates between pre-crisis and post-crisis sample is observed in case of parameter omega. We got a posterior mean of parameter omega equal to 0.6243 for pre-crisis sample and 0.7488 for post-crisis sample. It means that the share of non-Ricardians increased by 12 percentage points after crisis began.

It should be stressed that the estimates of parameter omega are similar to the survey data showing the share of households unable to face unexpected financial expenses (see [Figure 3](#)). This means that the plausible explanation of increase in the share of non-Ricardian households is the inability of Hungarian households to face unexpected financial expenses after crisis, that is their liquidity constraints during crisis. It is also worth noting that posterior means of almost all other parameters do not differ significantly between pre-crisis and post-crisis sub-period – only in case of parameter tau-b we observed noticeable increase in posterior mean after crisis.

On the basis of a posteriori estimates of the parameters, we then analysed the effects of fiscal policy in Hungary before and after Great Recession began. The analysis was based on impulse-response functions for two sub-periods: 1999q1–2008q3 and 2008q4–2016q4. The comparison of the effects of one standard deviation government shocks on GDP before and after the crisis is shown in [Figure 5](#). The impact of fiscal policy on other macroeconomic variables of the model is presented in Appendix 6.

The comparison presented in [Figure 5](#) shows that the share of non-Ricardian households has a significant impact on fiscal multipliers. After the crisis, when the share of non-Ricardians was relatively high, the impact of government spending shocks on GDP was almost twice as strong as before Great Recession.

Thus, the results of our simulations indicate that access to the banking sector influences fiscal policy effectiveness. The impulse-response functions show that the increase in the

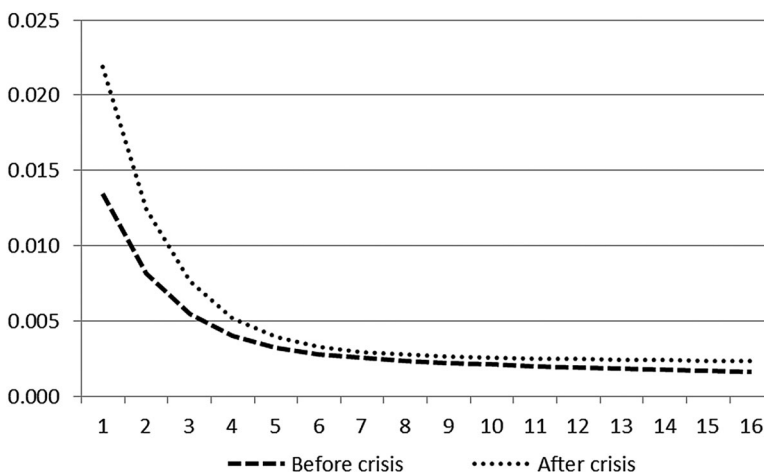


Figure 5. The impact of government spending shocks on GDP in Hungary.

share of households without access to the banking sector has translated into stronger impact of government spending on GDP in Hungary.

Stronger impact of government spending on output in case of non-Ricardian households is caused by the fact that fiscal stimulus, which increases aggregate demand output and income, translates one-to-one to non-Ricardians' increase in consumption. This group of households makes decisions only on the basis of current income and does not take into account the future consequences of fiscal stimulus, especially the impact of this stimulus on future taxes. Moreover, in case of liquidity constraints, fiscal stimulus leading to the increase in income is the only method which enables them to increase the level of consumption. On the contrary, the Ricardians make decisions on the basis of intertemporal budget constraint. These households anticipate that the higher government spending will presumably lead to increase in taxes and they take it into account in consumption decisions. In response to higher income generated by fiscal stimulus Ricardians increase savings (or decrease liabilities) to smooth consumption. So, they anticipate the future decrease in disposable income caused by higher taxes. Thus, the immediate impact of fiscal stimulus on Ricardian households is weaker.

The presented channels of government spending impact on GDP in case of Ricardians and non-Ricardians explain the differences in reaction of capital and prices in analysed sub-periods (see Appendix 6). Before the crisis, when the share of non-Ricardian households was lower, the fiscal stimulus led to smaller increase in prices and weaker crowding-out effect than after crisis. The reason is that in case non-Ricardians fiscal stimulus leads to strong increase in demand what makes additional price pressure. On the contrary, Ricardians' saving decisions in response to fiscal stimulus lead to lower price pressure. Moreover, the saving decisions of Ricardian households decrease crowding-out effect generated by government spending. As a result, higher share of this group of households translates into smaller crowding-out effect, and consequently lower decrease in investment and capital.

However, despite the described differences, it should be noticed that the impact of government spending on output for both sub-periods is transitory. Thus, although the share of non-Ricardians influences the strength of fiscal effects, it does not have the impact on the persistency of the fiscal stimulus effects.

6. Conclusions

The aim of the study was to analyse the effects of government spending shocks in the Hungarian economy before and after Great Recession. On the basis of the selected macro-economic and financial variables and simple SVAR model, we show that in Hungary, the relatively large value of government spending multiplier during economic slowdown was closely linked to the situation on credit market which influenced the behaviour of households.

One potential theoretical explanation of this phenomenon, as shown by Galí et al. (2007), is the impact of the share of non-Ricardian households on fiscal multipliers. Thus, for the pre- and post-crisis Hungarian economy, we have estimated the new-Keynesian dynamic stochastic general equilibrium model with heterogeneous households.

Posterior estimates confirm that the share of non-Ricardian households increased significantly after crisis began. Moreover, the estimates of pre-crisis and post-crisis shares of

non-Ricardians are similar to the survey data on households' inability to face unexpected financial expenses. Thus, the plausible explanation of increase in the share of non-Ricardian households is higher level of liquidity constraints during crisis.

The results of the study also confirm that the share of non-Ricardian households has a significant impact on fiscal multipliers. After the crisis, when the share of non-Ricardians in Hungary was very high, the impact of government spending shocks on GDP was almost twice as strong as before Great Recession. This means that there is some trade-off between the effectiveness of fiscal policy as a tool of GDP stabilization within the business cycle and household access to the credit market.

Note

1. The subscribe R is omitted in case of investment, bonds, capital and dividends because only Ricardians invest and benefit from credit market and firms.

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Appendices

Appendix 1. Households unable to face unexpected financial expenses in EU countries in 2015 (Eurostat data).

Country	Percentage of total population
Austria	27.5
Belgium	35.2
Bulgaria	69.5
Croatia	69.0
Cyprus	68.7
Czech Republic	46.3
Denmark	33.3
Estonia	48.8
Finland	35.5
France	37.0
Germany	41.6
Greece	62.0
Hungary	76.1
Iceland	49.8
Ireland	61.6
Italy	46.3
Latvia	71.2
Lithuania	67.5
Luxembourg	30.1
Malta	32.8
Netherlands	33.1
Poland	54.0
Portugal	48.1
Romania	58.7
Slovakia	41.4
Slovenia	53.9
Spain	48.8
Sweden	31.8
United Kingdom	47.1

Appendix 2. SVAR model – lag length test for AIC information criterion

Lag	Full sample 1999q1–2016q4	Sub-sample 1999q1–2008q3	Sub-sample 2008q4–2016q4
0	–9.723420	–10.17427	–11.33832
1	–12.30910	–13.59700*	–13.03953
2	–12.35879*	–13.30242	–12.95317
3	–12.18742	–13.12114	–12.78584
4	–12.13603	–13.20556	–13.09036*

* indicates lag order selected by the criterion.

Appendix 3. SVAR model – parameters estimations

	Full sample 1999q1–2016q4	Sub-sample 1999q1–2008q3	Sub-sample 2008q4–2016q4
a_1	0.022661 (0.3060)	−0.026636 (0.0978)	0.166327 (0.0015)
a_2	−0.004951 (0.7281)	−0.027090 (0.0179)	−0.084857 (0.0100)
β_1	0.044148 (0.0000)	0.048805 (0.0000)	0.036103 (0.0000)
β_2	0.069090 (0.0000)	0.071244 (0.0000)	0.063883 (0.0000)
β_3	−0.008174 (0.0000)	0.004839 (0.0000)	−0.010781 (0.0000)

p -value in brackets.

Appendix 4. DSGE model – prior distributions of structural parameters

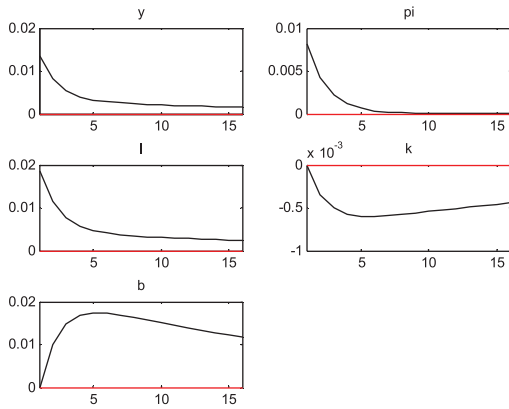
Parameter	Distribution	Mean	Standard error
ω	Beta	0.50	0.25
φ	Normal	0.20	0.10
η	Normal	1.00	0.25
α	Beta	0.33	0.10
ξ_p	Beta	0.75	0.25
λ_p	Normal	0.20	0.10
φ_π	Normal	1.50	0.25
τ_G	Normal	0.10	0.10
τ_B	Normal	0.33	0.10

Appendix 5. DSGE model – posterior means of structural parameters

Symbol	Sub-period 1999q1–2008q3	Sub-period 2008q4–2016q4
ω	0.6243	0.7488
φ	0.3495	0.3341
η	0.9896	0.9741
α	0.2757	0.2826
ξ_p	0.7436	0.7392
λ_p	0.1808	0.1953
φ_π	1.5496	1.5180
τ_G	0.1247	0.1109
τ_B	0.1715	0.1382

Appendix 6. DSGE model – the impulse-response functions

Sub-period 1999q1–2008q3



Sub-period 2008q4–2016q4

