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How Do Savings of Different Sectors Respond to Interest Rate Change?

Michał Gradzewicz*

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Abstract

The literature investigates the relation between savings and interest rate mainly for household sector, but in recent decades households ceased to be the main source of savings in the economy. We try to identify how the savings of different sectors respond to the interest rate change using the SVAR methodology. We focus on Poland and generalize the results for other European economies. We find that although the household savings rate tends to rise after an increase of interest rate, the corporate savings simultaneously fall, inducing a negative conditional correlation between them. The responses of savings rate of general government and foreign savings are diverse (although the former usually declines after an interest rate increase) and does not seem to be related to factors like the membership in the currency union or the level of public debt. We also check the existence of the 'crowding-out' effects and conclude it only applies in the case of government savings crowding out household savings.

Keywords: savings, interest rate, responsiveness, sectoral analysis, SVAR

JEL Classification: E21, E43, E52, C32

*Warsaw School of Economics and National Bank of Poland; e-mail: michal.gradzewicz@sgh.waw.pl; ORCID: 0000-0002-4303-4505

1 Introduction

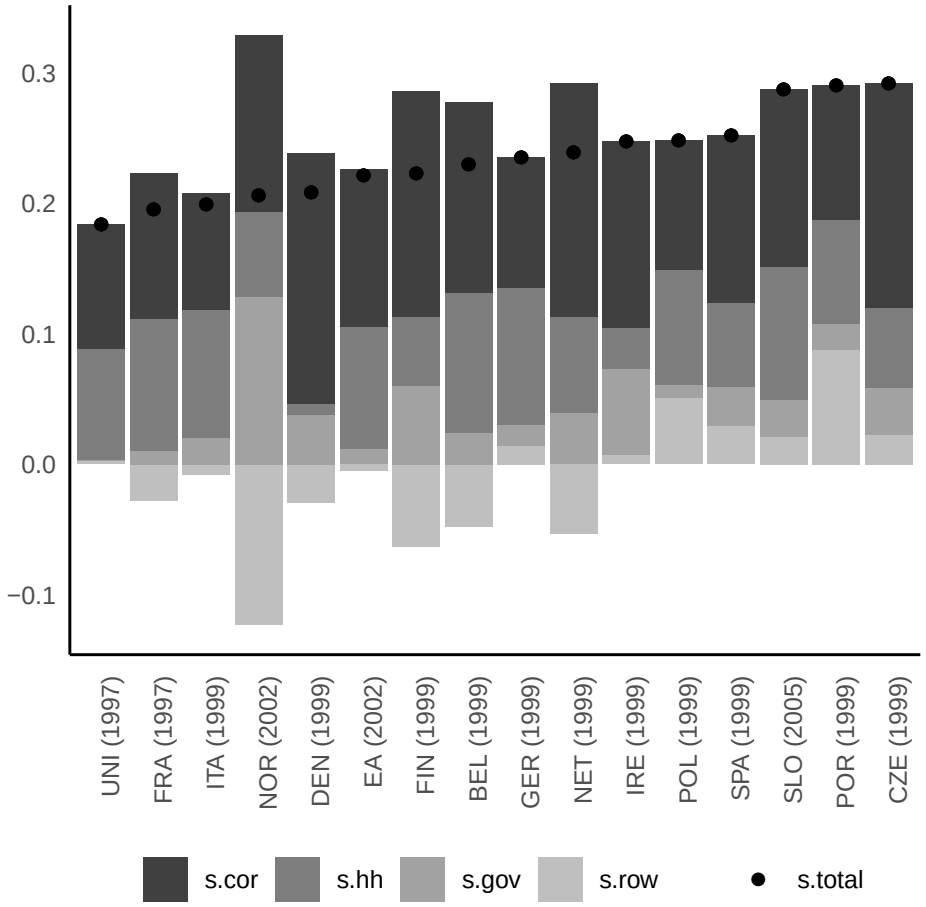
The theory underlying the relation between savings and interest rates treats the household sector as the main source of savings in the economy. This is not the case in recent decades. The data from sectoral national accounts show that in most of the European countries since at least the beginning of 2000 households generate a relatively small fraction of total savings (see Figure 1). Households savings usually accounted for less than a half of total savings. Moreover, for most of the European countries savings are generated to a large extent by the corporate sector (we define corporate sector as both non-financial and financial, with savings concentrated in the former). On the contrary, both savings of the general government and the rest of the world (ROW, calculated as a difference between investment and domestic savings) are usually small in relation to GDP. Figure 2 shows that since ca. 2000 in most of the European countries household savings declined even further (except for Denmark, Ireland and Germany) whereas savings of the corporates increased (except for Finland, Czech Republic and Denmark). Most countries experienced also declines of general government savings and increases of foreign savings, but to a lesser extent.

In the analysis that follows we try to identify the responsiveness of savings of other sectors (mainly corporates) to interest rate changes. Moreover, given heterogeneity in the responses of savings, we try to assess whether shifts in the structure of savings translate into changes of overall responsiveness of total savings to interest rates. We first focus on Poland – an example of a country which experienced a substantial fall in total savings rate, to a large extent driven by a significant fall of household savings with a counteracting rise of corporate savings. Then we try to generalize the results for other European economies. We focus our analysis mainly on households and corporates savings, but we will also discuss the results for other sectors.

We use the SVAR methodology, as it is best suited to answer the question at hand. To identify the model, we utilize the fact that the interest rate, apart from being an equilibrating variable for savings and investments, is simultaneously an instrument for monetary policy. It implies that some of the real interest rate variation is not related to changes in savings and investment schedules. We filter out these interest rate shocks and investigate the responses of savings of different sectors to these shocks. We found that responsiveness of savings of various sectors to interest rate changes is diversified among European countries. In most of cases the savings of households rise after an interest rate increase and corporate savings fall. Putting it differently, we found the negative conditional correlation (conditional on interest rate changes) between household and corporate savings. We also found that the direction of responses of general government and foreign savings can be diverse (although the former usually decline after an interest rate increase) and does not seem to be correlated with factors like the membership in the currency union or the level of debt.

The rest of the paper is organized as follows. The next section reviews literature and discusses the definition of corporate savings. Then, data sources and methodology

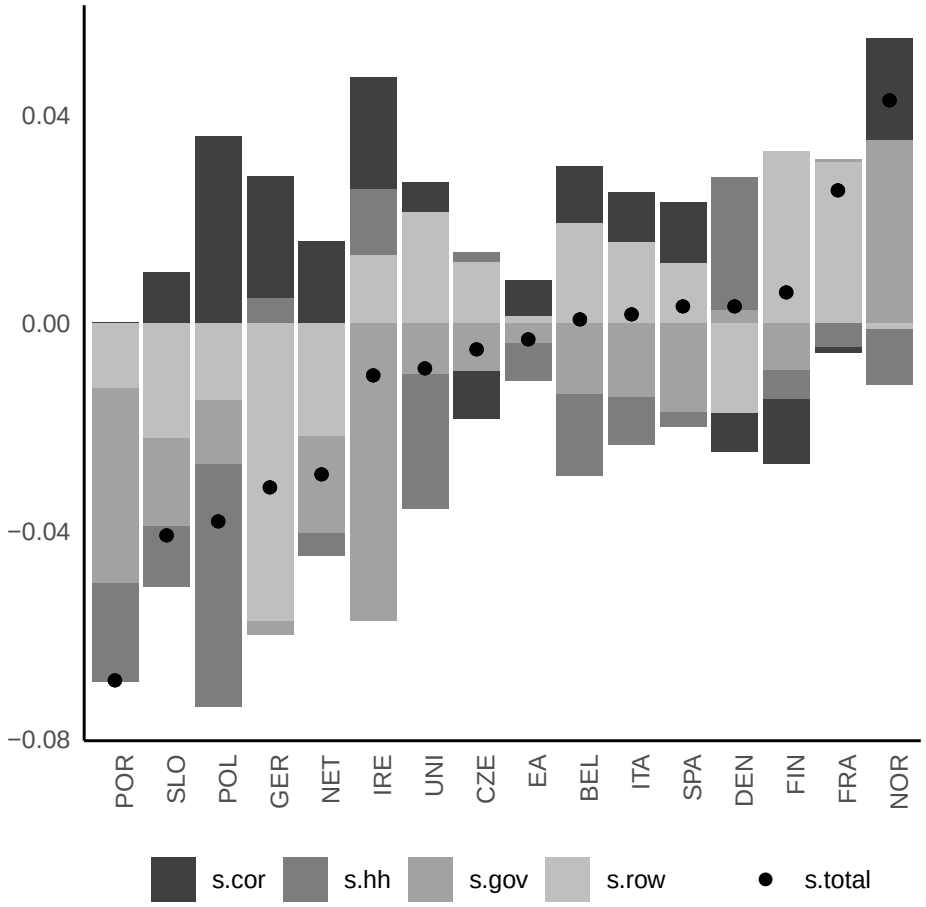
Figure 1: Domestic and foreign sources of total savings around 2000 in selected European countries



Notes: All variables expressed in terms of GDP. Moment of measurement in parenthesis reflect the beginning of data for each country.
Source: Eurostat

are presented. We then focus on the results for Poland to present the details of the adjustments of savings to interest rate change. Next, we check if our results also hold for a group of European countries present in the database. Then, we conclude.

Figure 2: Cumulated change in total savings and its sources in selected European countries in the period 1999-2016



Notes: All changes expressed in pp. of GDP.
Source: Eurostat

2 Overview of the literature

The literature focusing on savings of different agents is rather limited. A recent contribution especially important for our study is Chen et al. (2017), which build on the findings in Karabarbounis and Neiman (2012). It documents, on a global level, the shifts in the composition of savings from households to corporates. It also

attaches a natural interpretation to the definition of the savings of the corporate sector in the national accounts. Namely, the national accounts define gross value added as a composition of gross operating surplus (GOS), compensation of labour and net taxes on production. The GOS, in turn, can be decomposed into savings, net dividends, taxes on profits, interest and other net transfers, corrected for reinvested earning on FDIs. Due to the fact that corporate profits is a sum of gross savings and net dividends, it follows that the corporate savings can be defined as retained profits (EBITDA corrected for interest, dividends and corporate taxes).

Chen et al. (2017) concentrates on the long term and looks for the sources of the increase in corporate savings and highlights the role of a decline of both real interest rate and relative investment goods price, but also points at the role of an increase of corporate taxes and profit margins. Our contribution concentrates on the short-term aspects of observed shift of the structure of savings. We focus on the interest rate as an important factor shaping short-term behavior of savings of different sectors. We find that in the short term the responses of savings of these sectors to interest rate are diversified and thus responses of total savings to interest rate may change over time due to changes in the structure of savings in the economy.

Our study is naturally related to literature on factors influencing decisions of firms to retain profits. An important aspect of the literature in our context is a relation between interest rates and corporate profits. The two basic channels of this relation are straightforward – firstly, as interest payment is a cost for corporations, higher interest rates translate directly into lower profits. Secondly, interest rate is an instrument of stabilization policy and monetary policy sets higher interest rates to achieve lower inflation via lower level of economic activity. Thus, higher interest rates translate into lower sales and in effect the profits of corporates decline. The procyclicality of profits is documented e.g. in Knoop (2015).

There are also other factors that could affect the behavior of corporate profits. Falato et al. (2013) points that the importance of intangibles in the assets of many firms is increasing. As intangibles are rarely accepted as a collateral in external financing, the importance of internal financing and the accumulation of profits is increasing. Armenter and Hnatkovska (2017) stress the fiscal factors and find that demand for net savings of corporates is driven by a precautionary motive as firms seek to avoid being financially constrained in future periods. It implies that even with fiscal advantages associated with debt firms could increase their demand for equity and net savings. Guvenen et al. (2017) also points at the role of fiscal optimization in the accumulation of profits, but in the context of multinationals. The offshoring of activity translates not only in shifting activity, but also profits to foreign affiliates. It is important to stress that the abovementioned considerations affect the long run of corporate profits in the long run (and we will try to control for that using deterministic trends) but could also induce heterogeneity of savings behavior between countries, which we explore in our analysis.

Finally, the direction of the adjustments of profits to interest rate shocks is also related

to the cyclicality of profit margins. If profit margins are procyclical then even without changes in costs and output, corporate profits will drop after an increase in interest rates. The empirical evidence on the cyclicality of markups is however mixed, but the procyclicality of markups seems to dominate the literature. Hall (1986) was one of the first to show that markups are procyclical (implying higher profits in low interest rates episodes). On the contrary, Bils (1987) and Rotemberg and Woodford (1999) found, using different identification assumptions, that markups are countercyclical. However, more recent study of Nekarda and Ramey (2013) show that substituting new methods and new data into their methodology restores the procyclicality of markups. Gradzewicz and Hagemejer (2007) also documented the procyclicality of markups in case of Poland.

3 Methodology and data sources

As the focus of the paper is on the short-term volatility and the comovement of interest rates and savings, the structural vector autoregression (SVAR) is a natural tool to analyze this phenomenon. We decided (due to relatively short time series) not to analyze explicitly the whole macroeconomic adjustments via GDP and prices and focus instead on interest rate and sectoral savings rate. Therefore, we use VAR (utilizing R package *vars* – see Pfaff, 2008) with 5 variables: real short-term interest rate (r) and savings rates of 4 institutional sectors: households (s_{HH}), corporates (s_{COR}), government (s_{GG}) and foreign (s_{ROW}):

$$Z_t = B_1 Z_{t-1} + \cdots + B_q Z_{t-q} + u_t, \tag{1}$$

where $Eu_t u'_t = V$, u_t is uncorrelated with all variables dated $t-1$ and earlier and $Z_t = \begin{bmatrix} r & s_{ROW} & s_{COR} & s_{GG} & s_{HH} \end{bmatrix}'$.
To identify the VAR in (1) we assume that there exists an invertible square matrix A_0 that relates VAR disturbances u_t to the fundamental economic shocks ϵ_t as $A_0 u_t = \epsilon_t$, with $E\epsilon_t \epsilon'_t = D$. Then (1) becomes:

$$A_0 Z_t = A_1 Z_{t-1} + \cdots + A_q Z_{t-q} + \epsilon_t, \tag{2}$$

where $B_i = A_0^{-1} A_i,\ i = 1, \ldots, q$ and

$$V = A_0^{-1} D \left(A_0^{-1}\right)'. \tag{3}$$

We assume that shocks in ϵ_t are uncorrelated. With additional normalization of equations, it translates into $D = I$. When we impose that A_0 is lower triangular then A_0 may be identified using a Cholesky decomposition of an estimated variance matrix V from (3): $V = A_0^{-1} \left(A_0^{-1}\right)'$.
The triangularity assumption imposed on A_0 means that we identify the interest rate

shock in the VAR using a recursive scheme (with the ordering of variables defined in Z_t). The assumption that interest rate shocks is a first element in a recursive ordering of variables in the system, together with the assumption of orthogonality of shocks implies that interest rate shocks reflect pure price shocks, unrelated to other, non-price changes in the saving and investment schedules. Considering that interest rate is a monetary policy instrument, the changes in monetary policy should be one of, but not the only, source of volatility of interest rate shocks identified here (although one should have bear in mind that the setup does not identify monetary policy shock like in Sims and Zha (2006), who utilize the information on GDP and price movements). We are primarily interested in the identification of the interest rate shock. In this case Christiano, Eichenbaum, Evans (1999) proves that unless any sectoral savings shock precedes the interest rate shock in the recursive scheme, the ordering of shocks to savings of various sectors is irrelevant for the identification of interest rate shock. Moreover, we do not impose any long-run restrictions on a system. For stable VARs it implies that our identified transitory shocks to interest rates have no long-run effect on the structure of savings. We instead assume that the long-term changes in the savings structure, which were described in the introduction, are determined outside of our model and are driven by deterministic trends, which are additionally included in the specification of VAR systems.

The real interest rate used in the study is measured as nominal 3-months market interest rate (taken from OECD and Eurostat databases) corrected by expected inflation, proxied by the current HICP inflation (taken from Eurostat). Savings rates of the institutional sectors are defined as a ratio of gross savings of the corresponding sector to the GDP, all expressed in current prices and taken from quarterly sectoral national accounts complied by Eurostat. Foreign savings are defined in line with the standards of the national accounts as gross capital formation less domestic savings (implying that there is an implicit information on investments in the estimated VAR systems) and corporate savings include both non-financial and financial corporates.

Due to data availability we analyzed 16 countries: Belgium, Czech Republic, Denmark, Germany, Ireland, Spain, France, Italy, Netherlands, Poland, Portugal, Slovenia, Finland, UK, Norway and EA. All data are quarterly (except for monthly data for inflation and interest rates, which were converted to quarterly frequency using means) and the seasonality was removed with X-13-ARIMA-SEATS (see Table 1 for the results of QS tests for seasonality in adjusted series). In most of the 16 countries analyzed the sample range was 1Q1999 – 4Q2016. To check the stationarity of the time series we performed the KPSS unit root test as it directly tests trend-stationarity (which is accounted for in the VAR specification) against unit root. The tests (see Table 1 for the results) indicate that (after accounting for deterministic trend) almost all the variables used in the analysis are trend stationary.

The VAR models were estimated with a lag number chosen with Akaike Information Criterion. The maximum lag was limited to 3 due to small sample considerations. In most cases p-values of the QS tests – see Table 1 – indicate that the seasonality

was properly accounted for, suggesting that there is no need for the 4^{th} lag and additional experiments with setting the maximum lag to 4 shows that in countries where specification changes the results do not change qualitatively. As both the literature and the data suggest the presence of long term trends in both interest rates and saving rates, the stochastic specification was augmented with a deterministic trend and a constant. All the estimated VARs were checked for stability (in terms of both characteristic roots being outside unity and in terms of stability of the residuals), autocorrelation, heteroscedasticity and normality. The details of the tests are presented in Table 2. Only in case of Finland and Czech Republic the models have problems with autocorrelation of residuals, in some cases there were problems with the normality of residuals. In most cases additional dummy variables were introduced, either to address the issues of breaks in data or outliers in residuals or to address econometric deficiencies of the VARs. The exact locations of dummies are presented in Table 3, together with the order q of the VARs and with the adjusted R^2 of the VAR equations.

Table 1: Results of tests for seasonality and stationarity in adjusted series of real interest rates and savings rates

	QS tests					KPSS tests				
	r	s.row	s.cor	s.gg	s.hh	r	s.row	s.cor	s.gg	s.hh
EA	0.319	1.000	0.556	1.000	1.000	0.100	0.040	0.010	0.100	0.010
Belgium	1.000	1.000	0.346	1.000	1.000	0.100	0.010	0.010	0.010	0.021
Czech Republic	1.000	0.999	1.000	1.000	0.995	0.100	0.031	0.026	0.100	0.100
Denmark	1.000	1.000	1.000	0.015	1.000	0.100	0.010	0.040	0.100	0.096
Germany	1.000	1.000	1.000	1.000	1.000	0.100	0.100	0.010	0.010	0.100
Ireland	1.000	0.823	0.000	0.354	1.000	0.100	0.026	0.025	0.010	0.020
Spain	1.000	1.000	1.000	0.947	1.000	0.100	0.042	0.010	0.010	0.100
France	1.000	1.000	1.000	0.391	1.000	0.100	0.010	0.017	0.010	0.100
Italy	1.000	1.000	1.000	0.144	1.000	0.100	0.087	0.021	0.100	0.010
Netherlands	1.000	1.000	1.000	1.000	1.000	0.100	0.013	0.012	0.047	0.100
Poland	1.000	1.000	1.000	1.000	1.000	0.100	0.100	0.010	0.100	0.010
Portugal	1.000	1.000	1.000	0.703	1.000	0.100	0.025	0.010	0.010	0.010
Slovenia	1.000	0.000	1.000	1.000	1.000	0.100	0.051	0.010	0.100	0.100
Finland	1.000	1.000	1.000	1.000	1.000	0.100	0.010	0.100	0.010	0.100
UK	1.000	1.000	1.000	1.000	0.392	0.100	0.010	0.029	0.010	0.030
Norway	1.000	0.027	0.371	1.000	1.000	0.100	0.011	0.019	0.100	0.100

Notes: The left part of the table presents p-values of QS statistics for all variables used in the study (H_0 : no seasonality in the series, see Maravall, 2006), the right part – the p=values of KPSS tests (H_0 : the process is trend-stationary, H_1 : the process has a unit root; p-values lower than 0.01 are presented as 0.01 and p-values higher than 0.1 are presented as 0.1)

Table 2: Diagnostic statistics of estimated VARs for countries under study

	AC(1)	AC(2)	AC(3)	AC(4)	ARCH	NORM	root
EA	0.206	0.053	0.208	0.297	0.272	0.779	0.977
Belgium	0.107	0.155	0.190	0.050	0.040	0.545	0.831
Czech Republic	0.005	0.001	0.000	0.000	0.237	0.556	0.880
Denmark	0.134	0.194	0.030	0.022	0.307	0.000	0.871
Germany	0.082	0.146	0.166	0.028	0.069	0.471	0.958
Ireland	0.160	0.047	0.025	0.090	0.608	0.389	0.941
Spain	0.198	0.068	0.110	0.087	0.456	0.316	0.946
France	0.425	0.082	0.027	0.010	0.482	0.953	0.893
Italy	0.092	0.016	0.017	0.001	0.371	0.682	0.957
Netherlands	0.022	0.051	0.079	0.048	0.877	0.000	0.914
Poland	0.501	0.599	0.764	0.018	0.219	0.264	0.875
Portugal	0.817	0.126	0.004	0.000	0.129	0.000	0.915
Slovenia	0.935	0.127	0.089	0.016	0.952	0.995	0.886
Finland	0.059	0.006	0.005	0.004	0.004	0.000	0.926
UK	0.085	0.055	0.131	0.053	0.094	0.456	0.931
Norway	0.727	0.870	0.823	0.562	0.995	0.086	0.955

Notes: Columns 'AC(i)' present p-values of tests for multivariate autocorrelation of order i, using the Edgerton and Shukur (1999) small sample correction; column 'ARCH' presents p-values of multivariate ARCH LM test; column 'NORM' presents p-values of multivariate Jarque-Bera tests; column 'root' presents the largest unit root of a VAR.

Table 3: Goodness of fit of individual equations and dummies used in estimated VARs

	VAR	Adjusted R^2					Dummies
	order	r	s.row	s.cor	s.gg	s.hh	
EA	2	0.936	0.932	0.862	0.916	0.875	2009Q1, 2010Q1
Belgium	1	0.867	0.712	0.342	0.802	0.853	2006Q3, 2010Q2
Czech Republic	2	0.808	0.861	0.728	0.692	0.193	2009Q3, 2010Q3
Denmark	1	0.853	0.853	0.613	0.904	0.649	2009Q1, 2015Q1
Germany	2	0.930	0.954	0.861	0.949	0.848	2004Q1, 2005Q4, 2009Q1
Ireland	2	0.848	0.821	0.843	0.986	0.791	2005Q3
Spain	3	0.819	0.957	0.979	0.995	0.628	2002Q3, 2007Q3, 2007Q4
France	3	0.927	0.977	0.954	0.752	0.544	1998Q4, 2007Q2, 2009Q3
Italy	1	0.895	0.916	0.425	0.347	0.842	2009Q1
Netherlands	2	0.857	0.736	0.750	0.816	0.673	2006Q1, 2008Q4, 2009Q1
Poland	1	0.946	0.767	0.811	0.670	0.872	2002Q1, 2009Q4
Portugal	2	0.837	0.980	0.882	0.564	0.883	–
Slovenia	3	0.829	0.836	0.419	0.855	0.886	2011Q3
Finland	1	0.909	0.900	0.492	0.908	0.250	2000Q4, 2003Q1
UK	2	0.978	0.918	0.865	0.962	0.798	1999Q1, 2009Q1, 2011Q1-Q2
Norway	1	0.816	0.508	0.429	0.877	0.986	2004Q1, 2005 Q2-Q3, 2006Q1, 2016Q1

4 Results for Poland

When discussing the results, we first focus on Poland as in this case the structure of savings changed in a way that is common to other countries – including a substantial fall in overall savings with a significant fall of household savings and a counteracting rise of corporate savings. Then we will try to generalize the results for the other European economies, in which the analysis is plausible.

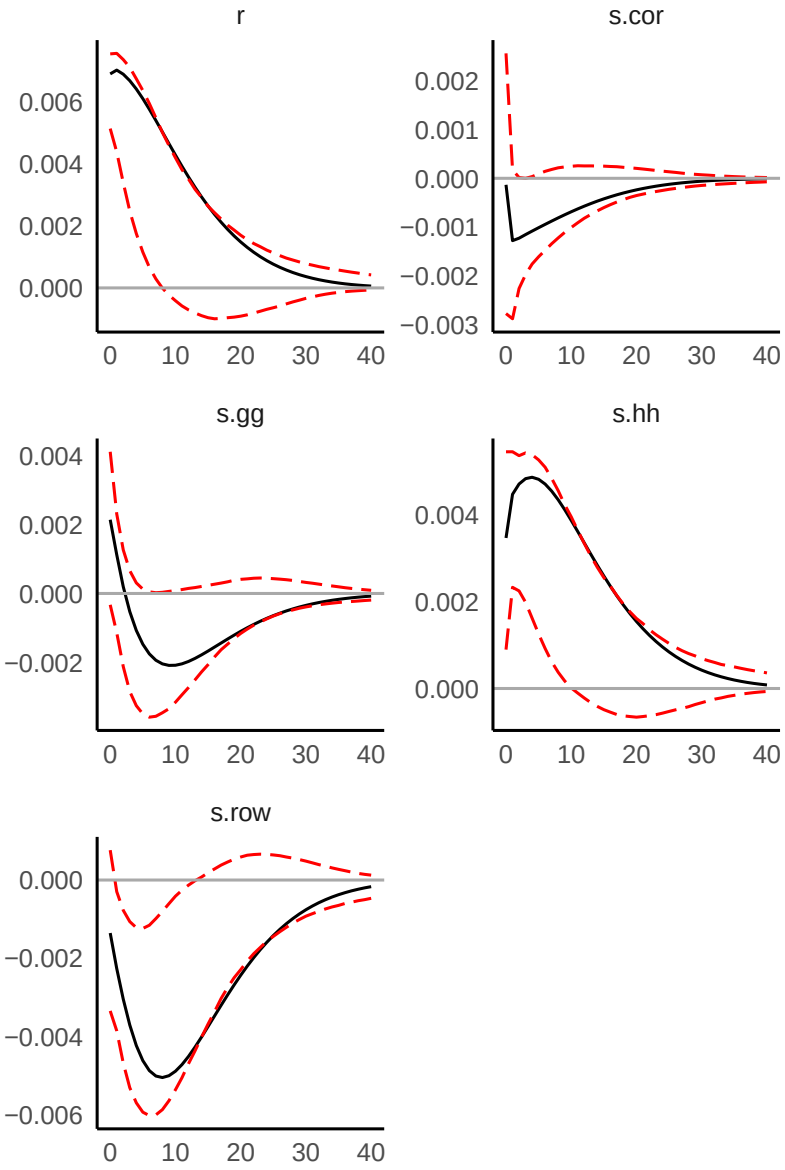
Figure 3 shows the impulse-response function (IRF) of saving rates of various sectors to the increase of real interest rate. The shock of interest rate is quite persistent and fades out after a couple of years, which implies that savings adjustment tends to be long-lasting either. Importantly, household savings respond exactly like the permanent income theory (Friedman, 1957) predicts – they increase for a period approximately equal to a period of high interest rate. Additionally, the savings rates of other institutional sectors decline (although not always in a statistically significant manner) in reaction to an increase of real interest rate.

The most important reason why the savings rates of enterprises, government and the rest of the world fall with an interest rate increase is related to a specific role that the real interest rate plays in modern economies. Namely, it is a monetary policy instrument (actually, central banks control the nominal interest rates but unless Taylor principle (see Taylor, 1993) is violated the real rate moves in line with the nominal one). It rises when central bank wants the economy and prices to cool down and falls otherwise. With an increase of real interest rates the level of economic activity declines together with government tax revenues, corporate sales and imports. We will focus now on the adjustments in each sector separately.

For the government savings the lower level of economic activity induces a decline of tax revenues and an increase of some cycle-related spending (for instance unemployment benefits), in line with automatic stabilizers. Moreover, higher interest rate rises debt service costs, amplifying a decline of government savings. Undoubtedly, not all government revenues decline (and expenditures increase), but the IRF suggest that on aggregate in Poland savings rate declines after an increase of the interest rate.

The adjustment of foreign savings is more complex, and its direction is *a priori* ambiguous, as there are various forces at play. Firstly, the increase of interest rates should lead, *ceteris paribus*, to the adjustments on the financial side of the balance of payments – a decline of net capital outflows, inducing an increase of foreign savings. Secondly, the adjustments on the current account act in the opposite direction. Declining levels of economic activity and absorption following an interest rate increase imply a fall of imports. Exports are rather unresponsive to an increase of interest rate, so the current account should improve, which is mirrored in an increase of net capital outflows and a fall of foreign savings. Kang and Shambaugh (2013) indeed found that the variation of current accounts is to a large extent driven by cyclical factors – increasing with a fall of GDP associated for example with an increase of

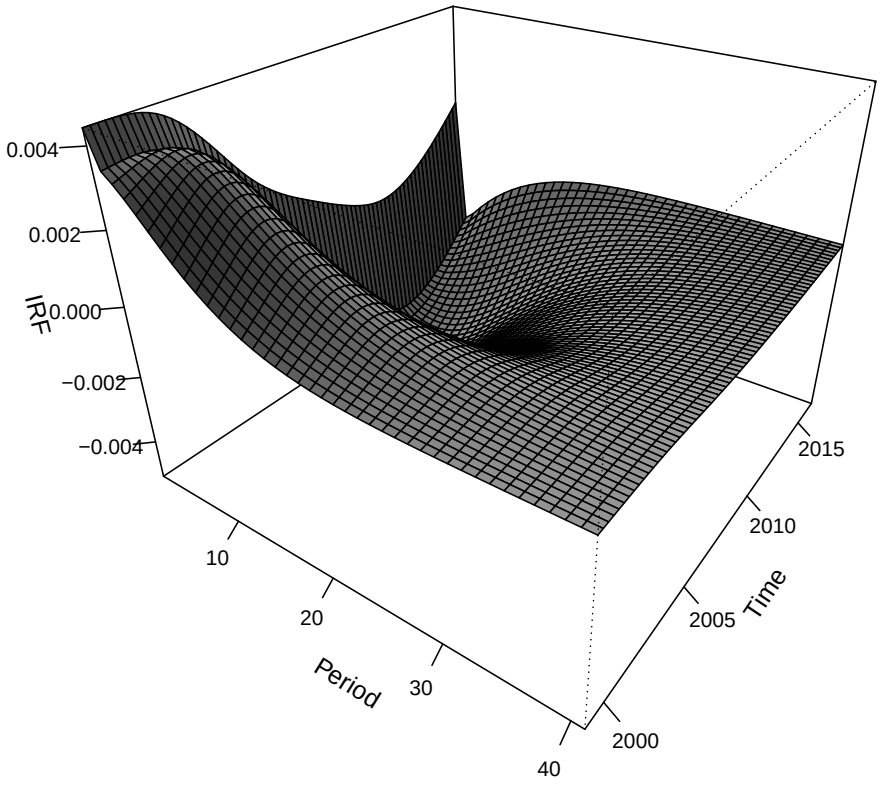
Figure 3: Impluse-response function for orthogonal shock to real interest rate in Poland



Notes: 90% confidence intervals calculated using bootstrap method with 10000 runs. Calculations based on vars package of R (Pfaff, 2008)

interest rates. Finally, there is also an adjustment due to changes in the exchange rate. The uncovered interest parity condition, which is often used to describe short-term exchange rate movements, implies that exchange rate should depreciate with an increase of interest rate, amplifying improvement of the current account. Adding pieces together, the natural tendency (stemming from adjustments in the capital account of the balance of payments) for net capital outflows to decrease with interest rate is in the short run dominated by both the depreciation of the exchange rate and falling imports, implying a fall of foreign savings.

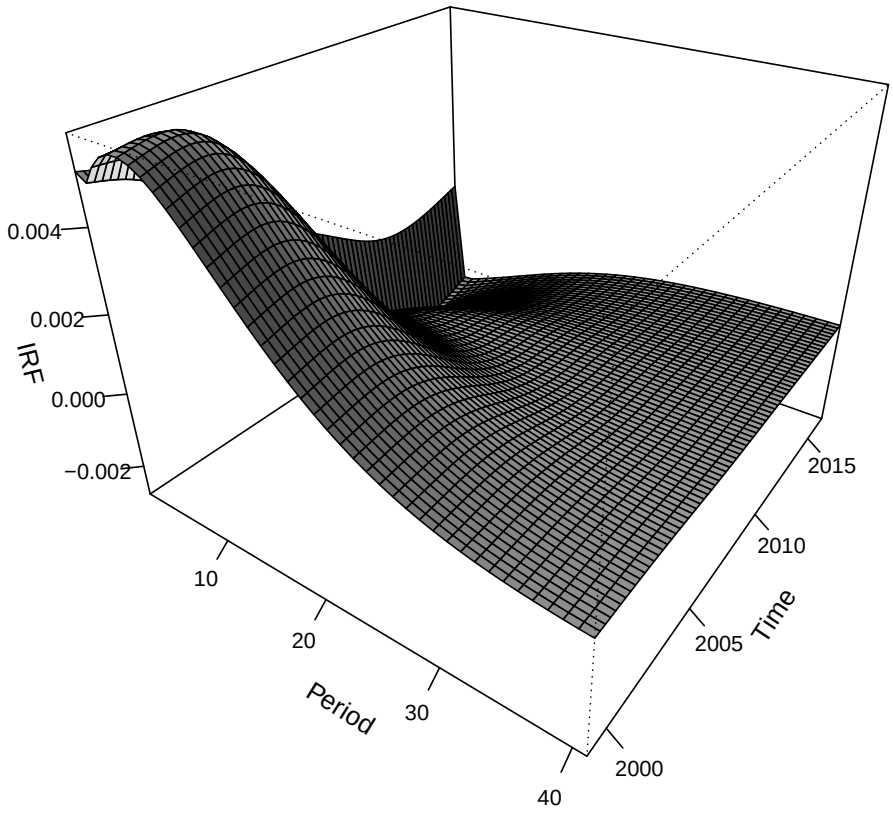
Figure 4: Time-varying impulse-response of domestic savings to a real interest rate shock



Notes: Time axis indicates the year of IRF weighting, period axis is the moment (in quarters) after the occurrence of the interest rate shock, the IRF axis measures the reaction of the saving rate (0.001 = 0.1 pp)

The discussion in the literature overview highlighted that corporate savings correspond to retained profits. It follows that the reaction of savings of corporates to interest rate increases depends on the adjustments of profits. The direct effect affects costs and is negative – debt services costs are increasing, translating into falling profits. But there are also indirect effects, stemming from the fact that heightened interest rates are associated with a lower level of economic activity, affecting both revenues and costs. Revenues drop in line with sales, but a fall of production also translates into falling costs. Although an overall effect on profits is *a priori* undetermined, the

Figure 5: Time-varying impulse-response of total savings to a real interest rate shock



Notes: see Figure 4

empirical literature (see Knoop, 2015 among others) finds profits to be procyclical – the revenues of corporates drop more than costs. There are at least two forces at play. Firstly, there are short term adjustments costs in some important cost categories, like the costs of labour and capital). Secondly, the reaction of profits also depends on pricing behavior of firms and the cyclicality of markups of prices over marginal costs. As discussed in the literature overview, markups are found to rather procyclical, implying that during recessions prices fall more than marginal costs, amplifying the procyclicality of profits.

We specified the SVAR in a way that allows us to construct a time-varying reaction of domestic savings rate and total savings rate (the latter calculated as a sum of domestic and foreign savings to GDP, i.e. investment rate) to interest rate changes. As the domestic savings are composed of savings of households, corporates and the government, the IRF of domestic savings can be expressed as weighted sum of component responses. We constructed the responses of domestic and total savings rate for each period using the composition of total (or domestic) savings from this period as weights. Such exercise assumes that the responses of different sectors do not change over time (consistently with our VAR assumption), but the relative importance of sectors in savings evolves, in total leading to the evolution of responses of aggregates, such as domestic of total savings to interest rates. Figure 4 and Figure 5 show the results of this procedure for the responses of domestic and total saving (investments rate) respectively. As there is some short-term volatility in the structure of savings and we are interested in secular shifts we HP-filtered the data (with a standard value for $\lambda = 1600$, implying a cut-off frequency of c.a. 10 years).

Figure 4 shows that changes in the savings structure in Poland translate into substantial changes in domestic savings responses to interest rate shock. In the first half of 2000's, when the importance of household savings was relatively high, domestic savings rise with an interest rate increase. However, as the role of households in the structure of savings declined in favor of corporates, the responses of domestic savings first started to be muted, and since the second half of sample – became negative and much less persistent. A similar picture emerges for the total savings (investment) rate, see Figure 5.

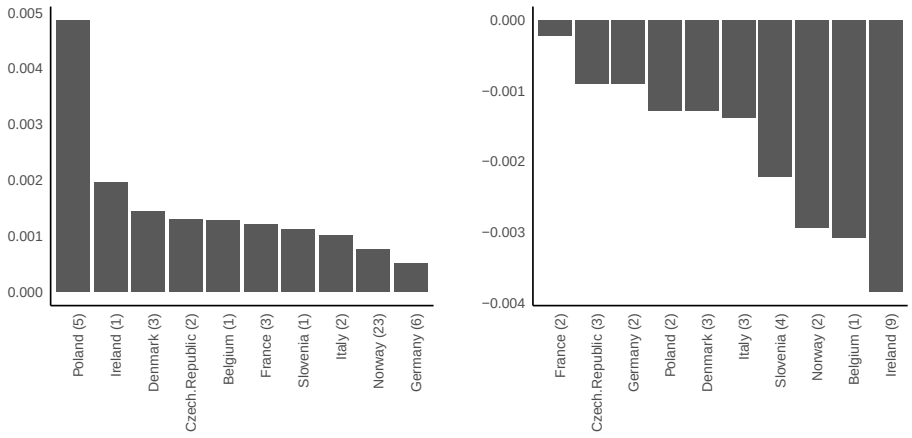
5 The results for the other countries

The SVAR analysis for Poland suggest that interest rate increase results in higher household savings and lower corporate savings, implying a negative correlation conditional on interest rates, $corr\left(s_{HH},\ s_{COR}|r\right) < 0$. This is a new result in the empirical literature and it is natural to check if it is observed also in other countries. We estimated analogous SVAR systems for a set of countries available in the dataset. We decided to present the results as the magnitudes and timings of peaks and troughs of the respective IRF functions. This is a condensed way to show most important information from diversified IRF functions. Only in case of our main

result we presented whole shapes of IRF. After estimating VARs (see Tables 2 and 3 for the diagnostics) we decided to exclude 6 cases (Finland, Netherlands, UK, EA, Portugal and Spain) from further analyses. For these countries we also found negative conditional correlation between the responses of savings of households and corporates to the interest rate shocks, but households savings rate increased after an interest rate rise, which we treat as implausible.

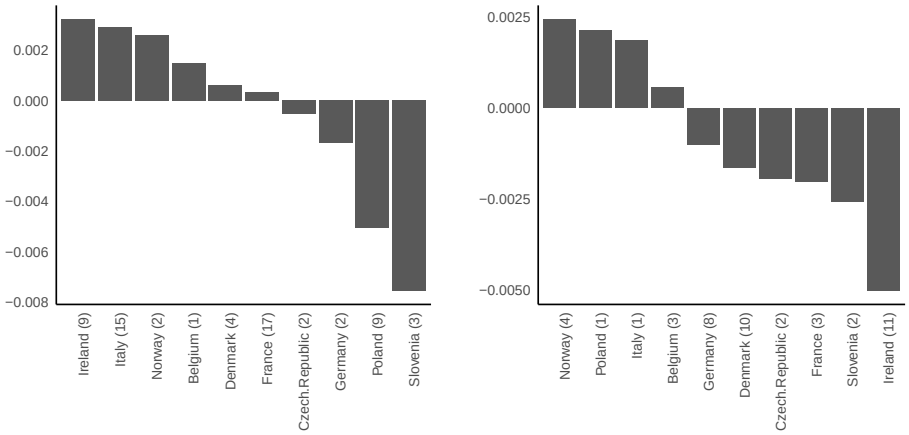
Figure 6 depicts both the maximum (over periods after a shock, left panel) response of household savings and the minimum (over periods after a shock, right panel) response of corporate savings to the shock to the interest rate. The complete IRF functions are depicted in Figure 10. They clearly indicate a negative conditional correlation between these two responses. The timings of the maxima of the household savings responses (presented in the parenthesis) are relatively short – they usually occur either on impact or with 2-6 quarters lag, implying a hump-shape. In case of Poland the maximum occurred after 5 quarters – see Figure 3 for comparison. Only in Norway the adjustment is more delayed. The adjustment of corporate savings to interest rate shock is usually a bit faster – the minimum response tends to occur no later than 1 year after the impulse (except Ireland). The results also reveal substantial heterogeneity in terms of the scale of adjustment, although it is partially a consequence of the heterogeneity in the volatility of both interest rates and savings rates among countries.

Figure 6: Maximum response of household savings (left panel) and minimum response of corporate savings (right panel) to an interest rate shock



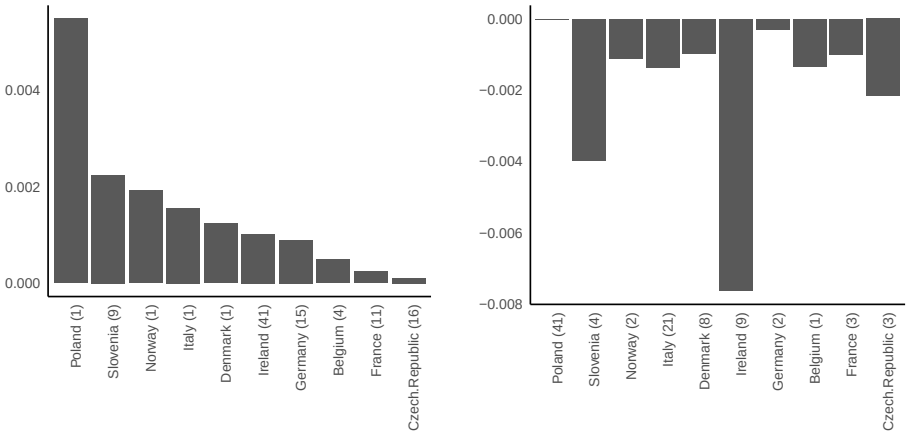
Notes: The figure represents $\max_s \partial s^i_{t+s}/\partial r_t$ where $i = HH$ for the left panel and $i = COR$ for the right panel, calculated for selected countries. Numbers in the parenthesis represent the respective $\text{argmax}_s \partial s^i_{t+s}/\partial r_t$.

Figure 7: Maximum absolute responses of foreign savings (left panel) and government savings (right panel) to an interest rate shock



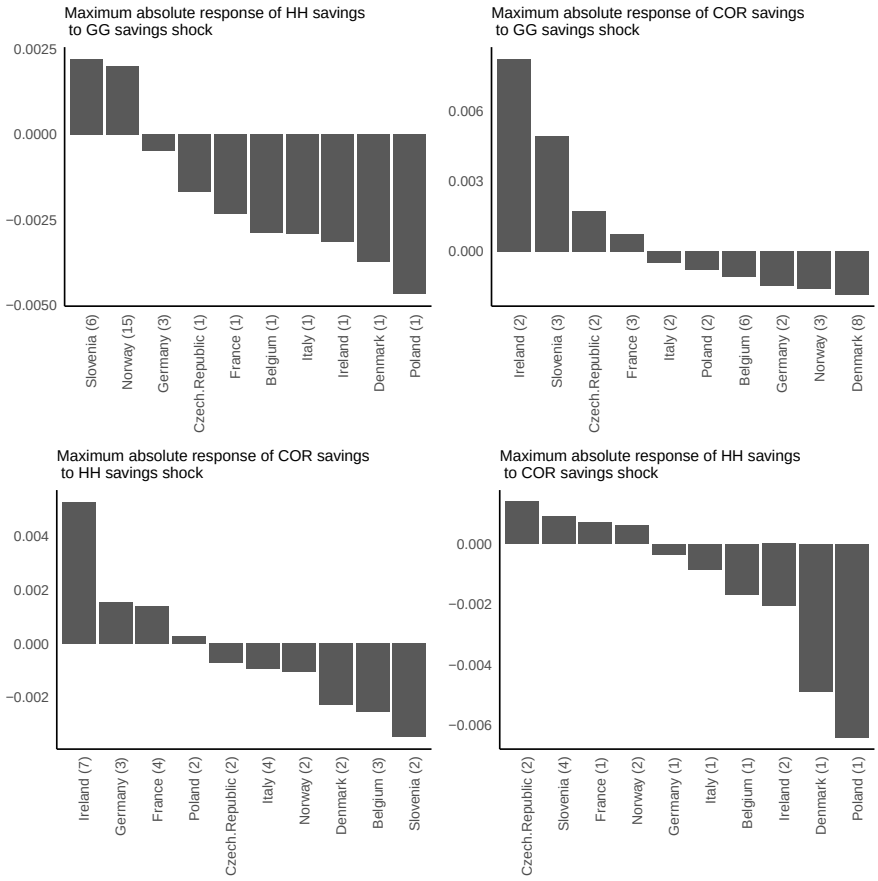
Notes: The figure represents $\max_s \left|\partial s^i_{t+s}/\partial r_t\right|$ where $i = ROW$ for the left panel and $i = GG$ for the right panel, calculated for selected countries. Numbers in the parenthesis represent the respective $\text{argmax}_s \left|\partial s^i_{t+s}/\partial r_t\right|$.

Figure 8: Maximum (left panel) and minimum (right panel) responses of domestic savings to interest rate shock



Notes: The figure represents $max_s\, \partial s^{DOM}_{t+s}/\partial r_t$ (the left panel) and $\min_s \partial s^{DOM}_{t+s}/\partial r_t$ (the right panel), calculated for selected countries. Numbers in the parenthesis represent the respective arguments that maximize or minimize the impulse-response function.

Figure 9: Maximum absolute responses savings of various sectors to shocks to the savings of the other sectors



Notes: The figure represents $\max_s \left|\partial s^i_{t+s}/\partial s^j_t\right|$ calculated for selected countries. Numbers in the parenthesis represent the respective $\text{arg}max_s \left|\partial s^i_{t+s}/\partial s^j_t\right|$.

The results for Poland also indicate that both foreign and government savings also exhibit a negative conditional correlation with household savings, but this result do not withstand the multi-country test. The impulse response functions calculated for countries in our dataset show a substantial heterogeneity, both in shape and sign. Figure 7 tries to reflect this heterogeneity, depicting maximum absolute responses of both foreign and government savings ($\max_s \left|\partial s^i_{t+s}/\partial r_t\right|$, where $i \in \{GOV,\ ROW\}$) and clearly indicates that both foreign and government savings may either increase

of decrease after an interest rate increase. The timings of maximum absolute responses are also diverse, as there is a variety of shapes of impulse-response functions. The sign of the foreign savings responses is unrelated either to exchange rate regime or NFA position of a country. The signs of responses of government savings are unrelated to the level of public debt.

Our analyses show that after an interest rate shock the direction of the response of domestic savings is ambiguous. Although the household savings increase after the shock, but simultaneously corporate savings decline, and the direction of foreign and government savings vary across countries. Figure 8 shows the maximum and minimum responses of domestic savings, together with their timing. For most of the countries considered an increase of household savings dominates and domestic savings increase after an interest rate shock. In case of Ireland, Slovenia, and Czech Republic a positive reaction of household savings is dominated by negative adjustments of both corporate, but also government savings.

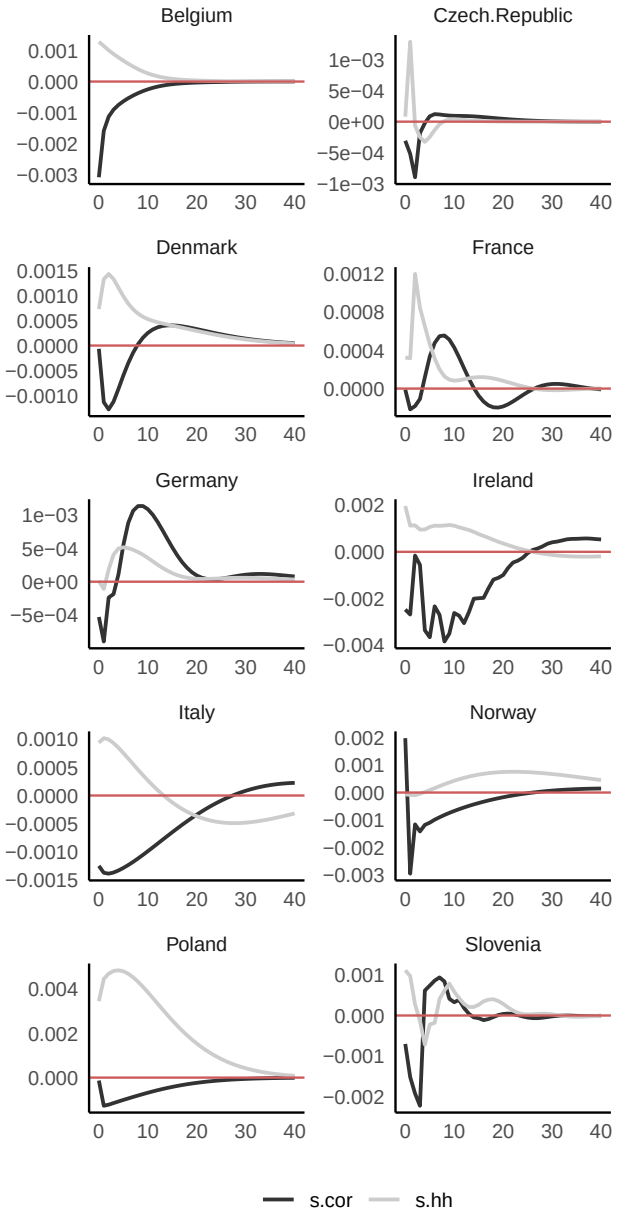
Although the identification of shocks to saving demand schedules of different sectors was not the focus of the paper, it is interesting to check if there are any adjustments to savings of one sector to a shock to the savings of the other sector – the crowding-out effects. Figure 9 shows the maximum absolute responses of savings of household and corporate sectors to shocks to savings schedules of government, household and corporate sectors. Firstly, within the analyzed sample there is no universal crowding-out pattern common for all countries. Secondly, in case of an increase of government savings, in 8 out of 10 countries there is a negative, counterbalancing adjustment of the savings of household, in line with the textbook 'crowding-out' effect. There is no such pattern in the responses of corporate savings – they fall much less and only in smaller set of countries. Finally, the mutual crowding-out of corporate and household savings is present, but only in some countries.

6 Conclusions

Chen et al. (2017) convincingly documents that there was a substantial shift in sources of savings on a global scale in last decades – a fall of household savings and a rise of corporate savings. Moreover, household sector ceased to be the main source of savings in many economies. As the theory of savings mainly concerns households, we tried to assess how different institutional sectors (particularly households and corporates) react to interest rate changes. To address that issue, we proposed a data-driven approach, using SAVR methodology with identification scheme that tries to disentangle price changes (interest rate shocks, that are partially due to monetary policy changes) from shifts of saving demand schedules. It allows us also to check whether the reaction total savings to interest rate shocks changes over time.

We find that the responsiveness of savings to interest rate is diversified among analyzed European countries. But there are some regularities. In line with the standard macroeconomic theory (see Friedman, 1957, among others) the savings

Figure 10: The impulse-response function of corporate and household savings to the shock to the real interest rate



of household rise after an interest rate increase. But the savings of other sectors can behave differently. In all countries analyzed corporate savings fall, exhibiting a negative correlation with household savings, conditional on interest rate shocks. The fall of corporate savings is related to the fact that corporate profits are procyclical and tend to decline with an increase of interest rate. The adjustments of government and foreign savings can be both positive and negative and the sign of conditional correlation is not related to factors like membership in currency union or the level of debt.

The diversity of responses of savings of various sectors suggest that the adjustments of domestic savings may also be diversified among countries. And it is indeed the case. For most of the countries however the positive adjustments of household savings dominates and domestic savings increase after an interest rate rise. We also tried to check empirically the existence of the crowding-out effects (increases of one sector savings counterbalanced by a fall of other sector savings) in countries in our dataset. We found relatively strong evidence of only the textbook effect of government savings crowding out the household savings.

We documented the heterogeneity in responses of different sectors savings to interest rate shocks. As we also observe changes in the structure of savings it indicates that we should observe that the responsiveness of aggregate savings, like domestic or total savings, change over time. This is indeed the case in many countries and we documented that in case of Poland, on which we focus in our analysis, as it is an example of a country which experienced a significant fall of household savings and a counteracting rise of corporate savings. We showed that in Poland in the first half of 2000-ties, when the role of household savings was relatively high, domestic savings rise with an interest rate increase. However, as the role of households in savings generation declined in favor of the corporate sector, the responses of domestic savings first started to be muted, and since 2008 they have become negative and much less persistent.

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