

Crisis, contagion and international policy spillovers under foreign ownership of banks*

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Abstract

This paper checks how international spillovers of shocks and policies are modified when banks are foreign owned. We build a two-country DSGE model with banking sectors that are owned by residents of one (big and foreign) country. Consistently with empirical findings we find that foreign ownership of banks amplifies spillovers from foreign shocks. Moreover, it also strenghtens the international transmission of monetary and macroprudential policies. Finally, we replicate the financial crisis in the euro area and show how, by preventing bank capital outflow in 2009 Polish regulatory authorities managed to reduce its spillover to Poland. We also show that under foreign bank ownership such policy is strongly preferred to a recapitalization of domestic banks.

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1 Introduction

In several countries substantial parts of domestic banking sectors are owned by foreign financial institutions. According to the Bank Regulation and Supervision Survey (Cihak et al., 2012), 51 out of 124 surveyed countries had more than 2/3 of their banking sector assets foreign-controlled in 2010. This has potentially far reaching and multidirectional consequences for domestic macroeconomic performance. On the one hand, foreign bank ownership plays an important role in strengthening the domestic financial sector by providing know-how and funding (either directly or indirectly by allowing domestic bank to enter foreign wholesale funding markets). On the other hand, in particular in times of financial stress, foreign ownership of banks can transmit problems of foreign owners to the domestic economy. In this paper we concentrate on the latter aspects.

There exists ample empirical evidence that confirms the important role of foreign-owned banks in driving the credit boom before the financial crisis and the subsequent bust after the crisis erupted. Popov and Udell (2012) study the sensitivity of credit supply to bank financial conditions in 16 emerging European countries before and during the financial crisis. They find in particular that the supply of credit reflects the balance sheet conditions of foreign parent banks. Cull and Martínez Pería (2013) use bank-level data for Eastern European and Latin American countries to analyze growth of banks' loans during the financial crisis. In Eastern Europe they find notable differences between foreign and domestic-owned bank credit growth, with foreign bank lending falling by more than domestic bank credit. Haas and Lelyveld (2014) compare the lending of foreign subsidiaries of large multinational banking groups during the Great Recession with lending of domestic banks. They find that multinational bank subsidiaries had to slow down credit growth almost three times as fast as domestic banks. Feyen et al. (2014) apply panel vector autoregressions to a global panel of 41 countries for the period 2000-2011 and show that private credit growth depends on cross-border funding shocks around the world. This relationship is particularly strong in Central and Eastern Europe, which is important given our paper's focus on this region.

While the surveyed empirical studies convincingly document the important role of foreign ownership and funding for the transmission of banking sector related shocks, they lack the ability to speak about structural macroeconomic shocks and, in particular, about the spillovers from monetary, regulatory or macroprudential policy. Given the current implementation of macroprudential policy in several countries and the missing empirical evidence on its effects, modeling it seems of particular importance. While structural models designed to analyze the domestic effects of macroprudential policy have recently become abundant (see e.g. Angeloni and Faia (2013); Christensen et al. (2011); Gertler and Kiyotaki (2010); Gerali et al. (2010)), the consequences of foreign bank ownership have, to the best of our knowledge, not been discussed in the literature yet. The closest papers include those that model

international spillovers through the financial system. For instance Iacoviello and Minetti (2006) construct a two-country general equilibrium model where entrepreneurs can borrow against collateral from domestic or foreign lenders. The interaction between relative credit frictions, domestic and foreign debt exposure and collateral values amplifies the international transmission of technology shocks in their framework. Dedola and Lombardo (2012) develop a model where leveraged financial institutions operate across borders and, thus amplify the international transmission of shocks. Kollmann (2013) constructs a two country model with a global bank and estimates it on euro area and US data. He concludes that the global bank increases spillovers. In Kamber and Thoenissen (2013) banks lend to foreign enterprises which exposes them to foreign shocks and hence facilitates their international transmission. However, none of these papers model explicitly foreign ownership of banks nor speak about the international transmission of regulatory or macroprudential policy.

Against this background we provide a structural model that allows to study several important questions related to foreign bank ownership. The model features a small (domestic) and a large (foreign) economy, both with retail banking sectors that collect deposits from households and lend to enterprises. Retail banks are owned by foreign-based parent banks who manage their balance sheets and, as a result, lending activities. This ownership structure allows shocks to be transmitted between countries not only via the traditional trade channel, but also through lending activities of retail banks. As a result, we are able to model the banking sector role in strengthening international spillovers. In particular, we show how the international transmission of structural shocks (e.g. to capital quality or to productivity) and macroeconomic policies (monetary and macroprudential) is modified when banks are foreign-owned. Furthermore, we are able to check whether domestic regulatory actions (like recommendations on dividend payments) can help mitigate the spillovers.

In order to provide a quantitative assessment, we calibrate our model to Polish and Euro Area (EA) data. Poland is a small open economy with crucial trade links with the EA. Moreover, more than 60% of its banking sector assets are foreign-controlled, mainly by financial institutions from the EA. Even more interestingly, the Polish supervisory authorities implemented policies that prevented the outflow of bank capital to parent banks during the financial crisis. All this makes Poland an excellent study case for our purposes.

Our main findings are as follows. First, foreign bank ownership modifies the transmission of shocks from the EA to Poland. However the strength depends crucially on the type of shock. In particular, the amplification is larger for shocks originating in the banking or financial sectors (e.g. capital quality shock) and weaker for standard (productivity) shocks. Second, foreign ownership of banks can significantly strengthen the international transmission of monetary and regulatory policies. Third, in the presence of foreign shocks (especially originating in the banking sector), preventing capital outflows significantly mitigates the impact on the domestic economy. We document this feature in a scenario that replicates the

shocks faced by the euro area in 2008-09 and the reaction of the Polish regulatory authorities that prevented the distribution of profits. We also discuss how foreign ownership of banks and hence the possibility of bank net worth transfer across borders might make such an intervention preferred to standard crisis-management policies such as capital injections to the banking sector or direct lending to non-financial firms by the monetary authority.

The rest of the paper is structured as follows. Section two describes the model and section three its calibration. Section four discusses the transmission of foreign shocks and policies to the domestic economy, the role of foreign ownership in this process and the effects of domestic regulatory policies. Section five concludes.

2 Model

We develop a two country DSGE model with a foreign bank ownership. Our economy is populated by households, banks, wholesale good producers, capital good producers and monopolistically competitive retailers. There are several frictions in our model. Prices and wages are sticky, agents' preferences feature external habit formation, capital formation is subject to investment adjustment cost, and banks face a moral hazard problem. For convenience of the reader we describe the domestic economy in detail, foreign economy is mostly analogous. The only difference is that banks are owned by foreign households and we describe in detail how it affects both economies.

2.1 Households

There is measure ω of agents in the domestic economy and $\omega^* = 1 - \omega$ of agents in foreign economy.¹ Agents are indexed by ι . Denote consumption of agent ι as $c_t(\iota)$ and her labor supply as $l_t(\iota)$. Average consumption and labor are denoted as c_t and l_t , respectively. Each household consumes, supplies labor, keeps deposits in the bank $D_t(\iota)$ at the interest rate R_t , pays lump-sum taxes T_t . Additionally, domestic households own all domestic firms and obtain dividends from them Π_t while foreign households own foreign firms and all banks and also obtain stream of dividends Π_t^* . Households maximize the following utility function

$$\mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \beta^t \left[\frac{(c_t(\iota) - hc_{t-1})^{1-\sigma_c}}{1-\sigma_c} - A_n \frac{l_t(\iota)^{1+\sigma_n}}{1+\sigma_n} \right] \right\}$$

subject to the budget constraint

$$P_t c_t(\iota) + D_t(\iota) + T(\iota) = W_t(\iota) l_t(\iota) + R_{t-1} D_{t-1}(\iota) + \Pi_t(\iota)$$

¹We employ the following notation: foreign variables and parameters have the same symbol as domestic ones, but with an asterisk.

where $h \in [0, 1]$ denotes the degree of external habits and $\sigma_c, \sigma_n > 0$. It is convenient to define the following stochastic discount factor

$$\Lambda_{t,t+1} = \frac{(c_{t+1} - hc_t)^{-\sigma_c}}{\pi_{t+1}(c_t - hc_{t-1})^{-\sigma_c}}$$

which firms take into account while solving their problems.

Households supply differentiated labor services in a monopolistically competitive market to competitive aggregators who pool them into homogenous labor services l_t with the following function

$$l_t = \left[\frac{1}{\omega} \int_0^\omega l_t(\iota)^{\frac{1}{\mu_w}} d\iota \right]^{\mu_w}$$

We assume that nominal wages W_t are sticky and in each period with probability $1 - \theta_w$ each household gets a Calvo signal to reoptimize them. Otherwise wages are indexed to the steady state inflation $\bar{\pi}$. Additionally, since households can perfectly insure against the idiosyncratic part of wage income shocks, wage stickiness does not result in heterogeneity in consumption.

2.2 Producers

In our economy undifferentiated wholesale goods are produced using capital and labor. Next, they are sold to foreign and domestic retailers who differentiate them. Then, domestic and foreign aggregators produce final goods using domestic and foreign varieties. Final goods can be consumed by households, purchased by the government, or invested.

2.2.1 Final good producers

Perfectly competitive final good producers use domestic and foreign varieties $y_{H,t}(i)$ and $y_{F,t}(i)$ to produce homogenous final good with the following technology

$$y_t = \left((1 - \eta)^{\frac{1}{\phi}} y_{F,t}^{\frac{\phi-1}{\phi}} + \eta^{\frac{1}{\phi}} y_{H,t}^{\frac{\phi-1}{\phi}} \right)^{\frac{\phi}{\phi-1}} \quad (1)$$

where

$$y_{H,t} = \left(\int_0^1 y_{H,t}(i)^{\frac{1}{\mu}} di \right)^{\mu} \quad (2)$$

$$y_{F,t} = \left(\int_0^1 y_{F,t}(i)^{\frac{1}{\mu}} di \right)^{\mu} \quad (3)$$

We denote home bias as η , the elasticity of substitution between domestic and foreign varieties as ϕ , and μ determines the elasticity of substitution between differentiated intermediate

products.

2.2.2 Capital producers

Capital producers use undepreciated capital k_t and investment i_t to produce new capital according to the following formula

$$k_t = (1 - \delta)\xi_t k_{t-1} + \left(1 - S\left(\frac{i_t}{i_{t-1}}\right)\right)i_t$$

where ξ_t denotes shock to capital quality (and $\xi_t k_{t-1}$ is effective quantity of capital at time t), δ denotes the depreciation rate for capital and capital adjustment cost function is given by $S(i_t/i_{t-1}) = \kappa(1 - i_t/i_{t-1})^2/2$, with $\kappa > 0$.

2.2.3 Retailers

Retailers, indexed by i , purchase undifferentiated wholesale goods at price $P_{m,t}$ and brand them (thus differentiating them) in order to sell them in domestic and foreign markets. They exchange undifferentiated wholesale goods into differentiated intermediate goods with the following technology

$$y_{H,t}(i) + \frac{1 - \omega}{\omega} y_{H,t}^*(i) = y_{m,t}(i)$$

where $y_{m,t}(i)$ denotes wholesale goods purchased by firm i . They compete in a monopolistically competitive markets and set their prices according to the Calvo scheme, i.e. with probability $1 - \theta_H$ they get the signal to reoptimize their prices in domestic market and with probability $1 - \theta_H^*$ in the foreign market. If they do not receive the Calvo signal, they index their prices to the steady state inflation in a given market.

2.2.4 Wholesale good producers

Perfectly competitive wholesale good producers use labor and capital to produce undifferentiated wholesale goods

$$y_{w,t} = z_t (\xi_t k_{t-1})^\alpha l_t^{1-\alpha}$$

where z_t denotes an AR(1) productivity shock. To produce wholesale goods, firms hire labor and purchase capital in advance. To this end, they obtain funds from local financial intermediaries. Each firm issues s_t claims to capital acquired k_t and prices them at the price of capital $P_{k,t}$. Then

$$k_t = s_t$$

Since each financial intermediary has perfect information about firms to which it lends and has no problem with enforcing payoffs, the return on capital for financial intermediary is

given by

$$R_{k,t+1} = \frac{\alpha P_{m,t+1} \frac{y_{m,t+1}}{\xi_{t+1} k_t} + (1 - \delta) P_{k,t+1}}{P_{k,t}} \xi_{t+1}$$

2.3 Banking

In our model there is a continuum of parent banks residing in foreign country that own branches in each country. Branches are independent in their daily operations and are subject to supervision by financial regulator in a country they operate. They face a moral hazard problem as proposed by Gertler and Karadi (2011). However, while making their decisions, branches take into account the goals of their parent banks.

2.3.1 Branches

Branches in each country collect deposits $D_{H,t}$ from domestic households and $D_{F,t}$ from foreign households and, using net worth N_t , grant loans to non-financial firms. The interest rate on domestic deposits is equal to the interbank interest rate R_t which is determined by the central bank and the interest rate on foreign deposits is equal of the foreign intermarket interest rate R_t^* adjusted by risk premium ρ_t . As it is standard in the literature we assume that risk premium depends on deviation of the ratio of foreign debt d_t to GDP y_t from its steady state value

$$\rho_t = \varrho \exp\left(\frac{d_t}{y_t} - \frac{d}{y}\right)$$

where $\varrho > 0$. The balance sheet of a branch is given by

$$P_{k,t} s_t = N_t + N_{g,t} + D_{H,t} + \mathcal{E}_t D_{F,t} \quad (4)$$

where s_t denotes the claims on non-financial firms' capital, $N_{g,t}$ denotes possible capital injections from the government (in the baseline model kept at zero), and \mathcal{E}_t is the nominal exchange rate. Banks face a moral hazard problem, i.e. at the beginning of each period they can divert a fraction λ of available funds to the parent bank at the cost of decreasing bankruptcy. A bankrupting financial intermediary allows to recover $1 - \lambda$ of its assets. Therefore, for the lenders to be willing to deposit funds in the bank, the following incentive compatibility constraint must be met

$$\tilde{V}_t \geq \lambda P_{k,t} s_t \quad (5)$$

where \tilde{V}_t is the value of a branch. Branches' problem is to maximize

$$\tilde{V}_t(j) = \mathcal{E}_t \max E_t \left\{ \beta^* \Lambda_{t,t+1}^* \mathcal{E}_{t+1}^{-1} [R_{k,t+1} P_{k,t} s_t(j) - R_t D_{H,t}(j) - \rho R_t^* \mathcal{E}_{t+1} D_{F,t}(j)] \right\}$$

subject to the balance sheet constraint (4) and the incentive compatibility constraint (5). Note that the fact that banks can obtain deposits from abroad allows for capital flows (other than net worth) and gives rise to the standard uncovered interest parity (UIP) condition.

At the beginning of each period, local branches use retained net worth N_t to accumulate bank equity according to the following law of motion

$$\tilde{N}_{t+1} = \theta [(R_{k,t+1}P_{k,t}s_t - R_t D_{H,t} - \rho R_t^* \mathcal{E}_{t+1} D_{F,t}) (N_t + N_{g,t})] \quad (6)$$

where \tilde{N}_{t+1} is the beginning of period $t+1$ equity, i.e. before cross-border transfers done by parent banks.

Assuming that (5) binds, it is easy to show that the solution to the problem of a branch leads to the following condition

$$P_{k,t}s_t = \frac{\eta_t}{\lambda - \nu_t} (N_t + N_{g,t}) = \phi_t (N_t + N_{g,t})$$

where

$$\nu_t = E_t \left\{ \beta^* \Lambda_{t,t+1}^* \frac{\mathcal{E}_t}{\mathcal{E}_{t+1}} (R_{k,t+1} - R_t) \right\}$$

and

$$\eta_t = E_t \left\{ \beta^* \Lambda_{t,t+1}^* \frac{\mathcal{E}_t}{\mathcal{E}_{t+1}} R_t \right\}$$

We can interpret ν_t as the expected marginal gain to the banker of expanding assets by a unit, η_t is the expected value of having another unit of net worth, and ϕ_t is the leverage ratio.

2.3.2 Parent bank

At the beginning of each period a parent bank (there are only foreign parent banks) allocates net worth between its two branches subject to the constraint

$$\omega \mathcal{E}_t^{-1} \tilde{N}_t + (1 - \omega) \tilde{N}_t^* = \omega \mathcal{E}_t^{-1} N_t + (1 - \omega) N_t^* \quad (7)$$

In allocating equity, a parent bank may be constrained by the domestic regulatory authority. This constraint is introduced as penalty function in the form $\Phi(N_t/\tilde{N}_t) = \kappa_{N,t} (N_t/\tilde{N}_t - 1)^2/2$, where $\kappa_{N,t}$ is a policy instrument that can be used to restrict cross-border dividend flows, see next section for details. The goal of a parent bank is to allocate net worth between

its branches in order to maximize total profits

$$E_0 \left\{ \sum_{t=0}^{\infty} (\beta^*)^{t+1} \Lambda_{0,t+1}^* \left[\omega \mathcal{E}_{t+1}^{-1} \left((R_{k,t+1} - R_t) \phi_t(N_t + N_{g,t}) + R_t(N_t + N_{g,t}) \right) \right. \right. \\ \left. \left. + (1 - \omega) \left((R_{k,t+1}^* - R_t^*) \phi_t^*(N_t^* + N_{g,t}^*) + R_t^*(N_t^* + N_{g,t}^*) \right) \right] \right. \\ \left. - \sum_{t=0}^{\infty} (\beta^*)^t \Lambda_{0,t}^* \left[\omega \mathcal{E}_t^{-1} \Phi \left(\frac{N_t}{\tilde{N}_t} \right) N_t \right] \right\} \quad (8)$$

subject to (5), equation for net worth accumulation in its domestic branch (6) and its analog for a foreign branch.

2.4 Monetary and macroprudential policy

Monetary policy in each country is run according to the standard Taylor rule

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R} \right)^{\gamma_R} \left[\left(\frac{\pi_t}{\pi} \right)^{\gamma_\pi} \left(\frac{y_t}{y} \right)^{\gamma_y} \right]^{1-\gamma_R} e^{\varepsilon_{R,t}} \quad (9)$$

where y_t denotes GDP, y , R and π are the steady state values of GDP, interest rate and inflation, $\gamma_R \in [0, 1]$, $\gamma_y, \gamma_\pi > 0$, and $\varepsilon_{R,t}$ denotes the monetary policy shock.

We also consider a capital injection policy. This policy is run by the macroprudential authority. To conduct this policy, a special fund F_t financed by banks is created. In case of insufficient funds in the fund, it may issue bonds to households at the interest rate R_t . Note that, if positive, $N_{g,t}$ can be interpreted as capital injections during a crisis, while if negative, it denotes lump sum taxes necessary to finance the fund spending. Capital injections/taxes to domestic banks are done according to the following rule

$$N_{g,t} = \rho_{N_g} N_{g,t-1} + (1 - \rho_{N_g}) [N_g + \varphi_F (F_t - F) + \varphi_R ((E_t R_{k,t+1} - R_t) - (R_k - R))] + \varepsilon_{N_g,t} \quad (10)$$

where N_g , F , R_k , and R denote the steady state values of the respective variables, φ_F is the speed with which the steady state level of the fund is restored after its possible use during a crisis, φ_R denotes aggressiveness of the fund reaction to financial stress manifested by increase in the finance premium, ρ_{N_g} is the autoregression of the capital injection policy and finally, $\varepsilon_{N_g,t}$ stands for capital injection policy shock. Note that this policy is used only during financial crises, which means that during normal times $\varphi_R = \varepsilon_{N_g,t} = 0$ and possible movements in $N_{g,t}$ only reflect the process of rebuilding F if it was used in the past.

The fund evolves according to the following equation

$$F_t = R_t F_{t-1} - N_{g,t} \quad (11)$$

Another tool at disposal of macroprudential authorities that we consider is the dividend policy. The macroprudential authority may restrict net worth transfer from domestic to foreign bank subsidiaries during a period of financial stress (i.e. when the finance premia sharply increase) by making such flows more costly. We model such interventions by allowing the macroprudential authority to control $\kappa_{n,t}$ in equation (8) according to the following rule

$$\kappa_{N,t} = \rho_{\kappa_N} \kappa_{N,t-1} + (1 - \rho_{\kappa_N}) [\kappa_N + \nu_R ((E_t R_{k,t+1} - R_t) - (R_k - R))] + \varepsilon_{\kappa_N,t} \quad (12)$$

where ν_R denotes the aggressiveness with which the authorities restrict dividends in case of financial distress manifested by increasing finance premium, ρ_{κ_N} is autoregression of this policy and $\varepsilon_{\kappa_N,t}$ is the dividend policy shock.

2.5 Closing the model

We define GDP as

$$y_t = \Delta_{H,t} y_{H,t} + \frac{1 - \omega}{\omega} \Delta_{H,t}^* y_{H,t}^*$$

where

$$\begin{aligned} \Delta_{H,t} &= \int_0^1 \left(\frac{p_{H,t}(i)}{p_{H,t}} \right)^{\frac{\mu}{1-\mu}} di \\ \Delta_{H,t}^* &= \int_0^1 \left(\frac{p_{H,t}^*(i)}{p_{H,t}^*} \right)^{\frac{\mu^*}{1-\mu^*}} di \end{aligned}$$

The net foreign debt evolves according to the following formula (balance of payments)

$$\mathcal{E}_t P_{H,t}^* \frac{1 - \omega}{\omega} y_{H,t}^* + \mathcal{E}_t D_t^* + (\tilde{N}_t - N_t) = P_{F,t} y_{F,t} + \mathcal{E}_t \varrho_{t-1} R_{t-1}^* D_{t-1}^*$$

There are also standard market clearing condition. The resource constraint is given by

$$c_t + g_t + i_t = y_t$$

where g_t is government spending financed by lump sum taxes levied on households². Market clearing condition for the wholesale goods is as follows

$$\int_0^1 y_{m,t}(i) di = y_{m,t}$$

3 Calibration

We calibrate our model to Poland (home) and the euro area (foreign). Since our main goal is to concentrate on the spillovers resulting from foreign ownership of banks, we keep the degree of heterogeneity between the two regions to a minimum, allowing only for differences in country size, composition of the final goods basket and sources of aggregate risk. The chosen parameter values are reported in Table 1 and are taken from the literature or set to match the key proportions observed in the euro area over the period 2002-2013, or cyclical characteristics of GDP in Poland and the euro area. These matched moments are reported in Table 2. Throughout, the unit of time is one quarter.

Based on the average GDP figures for Poland and the euro area, the relative size of the home economy is calibrated at 3.2%. The home bias in Poland is set to 0.28 to capture the average share of imports in Poland's GDP, corrected for the import content of exports using the estimates in Bussiere et al. (2013). The composition of the euro area basket of final goods is calibrated consistently with the assumption of balanced trade in the long run, which essentially means that this region can be considered a closed economy.

We match exactly the steady-state output shares of investment and government spending to the respective average shares of gross capital formation and government consumption in the euro area GDP. Following Gertler and Karadi (2011), the amount of funds that banks can divert is calibrated such that the banking sector leverage equals 4. The exogenous dividend rate is set to match the average spread on bank loans observed in the euro area.

The parametrization of household preferences, price and wage rigidities follows closely Brzoza-Brzezina et al. (2014). The curvature of investment adjustment cost is taken from Gertler and Karadi (2011). The coefficients of the Taylor rule are calibrated at values roughly in line with estimated DSGE models for the euro area (Christoffel et al. (2008)).

Finally, the parameter describing the curvature of penalty on dividends transfer profits across border is pinned down using stochastic simulations. More specifically, we calibrate its value, as well as the standard deviations and cross-country correlation of productivity shocks,³ to simultaneously match the standard deviations and cross-country correlation of the cyclical components of output in Poland and the euro area, and the standard deviation

²Since in our model Ricardian equivalence holds, we assume that the government budget is balanced in each period.

³The autocorrelation of productivity shocks is set to a conventional value of 0.95.

of the dividend payout ratio in the Polish banking sector.⁴ We treat the thus obtained parametrization of the adjustment cost function as describing explicit or implicit restrictions on capital flows applying to foreign banks in normal times.

4 Results

In this section we conduct several experiments on our model. First, we document how the model works, and in particular how foreign ownership modifies spillovers from the foreign to the domestic economy. In this part we check whether our model is in line with the empirical evidence on the impact of foreign ownership on the international transmission of shocks. Second, we analyze a banking crisis scenario under which a bank capital destruction in the euro area is transmitted to Poland. We check to what extent the Polish supervisory authorities decision to ban outflow of bank capital in the form of dividend payments prevented a deeper slowdown of the Polish economy. We also compare this policy to one that recapitalizes domestic banks.

4.1 Spillovers from shocks and policy

In what follows we use impulse responses to explain how our model works and to analyze what international spillovers it generates. To this end on Figures 1 - 4 we compare the impulse response of our baseline model (solid line) with those without foreign ownership (dotted line). For the latter the model has been modified in two places - we prevent transfers of bank capital between domestic and foreign retail banks (i.e. $N_t = \tilde{N}_t$) and modify the balance of payments accordingly.

First, we explain the main mechanism that determines the direction of capital flows, and hence of spillovers after all shocks. The objective of the parent bank is to maximize (8). Let us, for the sake of simplicity, ignore capital injections, the fixed part of dividend transfers as well as the penalty for capital flows and assume (as in our calibration) equal leverage ratios. Moreover, let us consider only the static part of the problem (i.e. leave out the impact of considerations about future profits). Then the parent bank's objective boils down to maximizing:

$$\lambda_t^* E_t \left[\omega \mathcal{E}_{t+1}^{-1} \left((R_{k,t+1} - R_t) \phi_t N_t + R_t N_t \right) + (1 - \omega) \left((R_{k,t+1}^* - R_t^*) \phi_t N_t^* + R_t^* N_t^* \right) \right] \quad (13)$$

subject to (7). The solution to this problem is:

⁴For reasons that will be explained in the next section, while calculating the volatility of the dividend payout ratio we drop year 2009.

$$E_t \frac{\mathcal{E}_t}{\mathcal{E}_{t+1}} \left[R_{k,t+1} - \frac{\phi_t - 1}{\phi_t} R_t \right] = E_t \left[R_{k,t+1}^* - \frac{\phi_t - 1}{\phi_t} R_t^* \right] \quad (14)$$

Hence, the parent bank transfers capital between its domestic and foreign branches so as to equalize the expected, effective (i.e. taking leverage into account) finance premia in both economies (corrected for the impact of the exchange rate). For instance, when the finance premium increases in the foreign economy capital will be transferred in this direction. As a consequence the premium will rise at home and decline abroad. In other words capital flows into the country where it has become relatively more scarce. Of course in the complete framework this mechanism is modified due to the impact of future expected premia and the cost of adjusting net worth. It should be noted that given the difference in size of the countries this process will exert a potentially large impact on the domestic economy and a negligible impact on the foreign one.

Productivity shock

We begin with analysing the consequences of a positive, foreign productivity shock (Figure 1). In the medium term it has relatively standard consequences for the foreign economy - it raises investment (not shown) and output, lowers marginal cost and inflation (not shown). However on impact the reactions are less standard. As known from the financial frictions literature (e.g. Iacoviello 2005) the decline in prices induces, via a debt deflation effect, a fall in investment and an increase of the expected return on capital. Hence, in the short term foreign output declines. Turning to spillovers, in a world without foreign ownership (dotted line), domestic output falls first (as a result of falling foreign output and exchange rate appreciation) and increases slightly in the longer run (following higher foreign output and import demand). This pattern is modified when foreign ownership is assumed. The higher foreign rate of return generates a capital outflow from the domestic bank. As a result domestic banks reduce their balance sheets, investment falls and the initial decline in output is deepened. In the medium term output still remains below the response under domestic bank ownership.

Capital quality shock

This shock, presented on Figure 2, brings about a deterioration of foreign financial intermediaries assets and, as a result, negatively affects their net worth. Bank lending declines accordingly and so does the price of capital. The resulting rise of the expected return on capital and finance premium is substantially larger in the foreign than in the domestic economy. The parent bank attempts to equalize the premia by transferring capital abroad. As a result the domestic finance premium increases, lending declines and investments and GDP

drop. These developments amplify the negative impact of the capital quality shock on the domestic economy via the trade channel (dotted line).

Monetary policy

Next, we look how the international transmission of monetary policy is affected by the foreign ownership of banks. Figure 3 presents impulse responses to a contractionary foreign monetary policy shock. The resulting reaction of the foreign economy is standard, when the interest rate increases output and inflation decline. This reduces demand for domestic goods, thus transmitting the slowdown to the home economy. The spillover is attenuated by the depreciation of the real exchange rate which raises the competitiveness of domestic goods. These, standard spillovers are substantially amplified by foreign bank ownership. Since foreign investments decline, so does the price of capital. The resulting rise of the expected return on capital generates a capital outflow from the domestic economy in an attempt to equalize the finance premia. Consequently the domestic finance premium rises, investment drops and the output decline deepens substantially.

Capital injection

Our final experiment documents the transmission of one particular type of macroprudential policy. As described in Section 2.4 our model features a (possibly countercyclical) capital buffer. Banks transfer a part of their profits to a specialized fund which can be used to recapitalize the sector in a systematic or unsystematic way. Here we experiment with the latter option, systematic policy will be used later. A capital injection shock, equivalent to a one-off recapitalization of the foreign bank generates a sharp decline in the return on capital, investment growth (not shown) and output expansion. These developments transmit weakly to the domestic economy via the trade channel. An additional boost is given by the bank ownership channel. Capital is partly transferred to the domestic economy, lowering the finance premium there and boosting investment demand too. As a consequence the spillover to output increases. Compared to previously analysed shocks, capital injection has an additional important feature. As visible from equation (10), after the recapitalization the capital fund must be renewed. As a result, over time capital is being redrawn from foreign banks, lowering output abroad and reversing the direction of capital flows. Hence, in the medium term the spillover also becomes negative.

Summing up, our model seems consistent with the empirical evidence reviewed in the Introduction. In particular, foreign ownership amplifies the effects of foreign shocks on the domestic economy. Not surprisingly, the spillovers are stronger for shocks originating in the banking and financial sectors than for real shocks.

4.2 Banking crisis and the role of regulation

In 2009 the euro area faced a serious economic and financial crisis. A substantial role in its propagation was played by shocks originating in its banking sector. Due to heavy losses on international toxic assets and domestic housing markets, as well as limited access to wholesale funding, banks restricted lending to the private sector. Several banks had to be bailed out by the governments. In this section we simulate such a scenario. However, what we are most interested in are the consequences of regulatory actions applied in a small economy that is closely linked to the euro area. When the crisis erupted, the Polish supervisory authorities successfully enforced recommendations that prevented dividend payouts from the 2008 profits, which, given the predominant foreign ownership structure in the Polish banking sector effectively meant a freeze on capital transfer from domestic to foreign banks. As shown on Figure 5, in 2009 only 13% of profits were paid out as dividends, compared to an average of 50% in the five-year period preceding the crisis.

Similarly to Gertler and Karadi (2011), we use a negative capital quality shock to generate a heavy recession in the foreign economy. The size of the shock is chosen such that foreign output declines by 2.6% at the trough, which corresponds to the maximum deviation of the euro area GDP from the Hodrick-Prescott trend during the 2009 recession. Figure 6 plots the crisis scenario together with two types of regulatory policy described in section 2.4 and applied by the home economy, i.e. a limit on dividend payout and capital injection to domestic banks. To make these policies comparable, both are calibrated such that they reduce the increase in risk premium at home on impact by a half.

Absent any policy intervention, the magnitude of output collapse at home is substantial, reaching nearly 2%. As already discussed, such strong spillover effects are clearly related to foreign ownership of financial intermediaries as the parent banks withdraw around 10% of net worth from their subsidiaries operating at home. This generates a sharp increase in the domestic risk premium and a collapse in investment. If the regulator prevents such big capital outflows by making it more costly to transfer bank capital across borders, the spillovers are limited and hence the recession at home not so deep. Similar effects can be obtained by injecting capital to domestic financial intermediaries. However, there are important differences between these two policies. First of all, to achieve the same effect on the risk premium as the dividend policy, the amount of capital injection needs to be very high, or 18% of annual GDP during the first year of the crisis. This is because a substantial portion of this injection is immediately transferred to ailing daughter banks operating abroad. Actually, this transfer is big enough to have a non-negligible effect on the balance sheets of foreign financial intermediaries, and hence helps to reduce the magnitude of output collapse abroad, despite the fact that the home country is small.

Naturally, this export of stimulus has positive spillovers on the home economy via in-

creased demand for domestically produced goods. Also, as the capital injection comes from a fund that needs to be replenished in subsequent periods, this huge foreign capital outflow is next reversed and net worth is flowing to the domestic economy until the fund is restored to its pre-crisis value. Nevertheless, it is very unlikely that in real life domestic regulators would allow for such a large leakage of capital injection at the peak of the crisis. Therefore, while the capital injection policy can be considered very attractive in a country with domestically owned banking sector, it does not seem to be a viable option if it is dominated by foreign entities.

5 Conclusions

This paper analyses the role of a potentially important factor behind the international transmission of shocks and policies - foreign ownership of banks. Empirical evidence shows that foreign ownership is widespread around the world and that it amplifies international spillovers. We construct a structural model to gain a deeper understanding of the mechanisms driving spillovers and, in particular, to speak about the international transmission of macroprudential policy and the role of regulatory policy in dealing with externalities resulting from foreign ownership.

Our model is a standard new-Keynesian open economy DSGE augmented for the presence of domestic and foreign financial intermediaries both owned by a foreign parent bank. In a series of experiments we show that, consistently with empirical evidence, foreign ownership amplifies the impact of foreign shocks on the domestic economy. Our model also shows that both, foreign monetary and macroprudential policy transmission is amplified by foreign ownership.

Finally, we use the model to simulate the impact of a large bank capital shock in the euro area on the Polish economy. We concentrate on the question whether regulatory actions, like the one that prevented the outflow of bank capital from Poland in 2009 are an effective policy tool. We show that the regulation could have reduced the GDP slowdown by a third. Last but not least, we show that foreign ownership dramatically weakens the effectiveness of domestic capital injection policy. While such policy could possibly undo the spillovers from the foreign shock, it would be very costly for the domestic economy, since a large part of the recapitalization would have been transferred abroad. Hence, in a small economy with foreign bank ownership such policy must be undertaken only jointly with a policy that prevents capital flows.

References

- Angeloni, Ignazio, and Ester Faia (2013) ‘Capital regulation and monetary policy with fragile banks.’ *Journal of Monetary Economics* 60(3), 311–324
- Brzoza-Brzezina, Michał, Pascal Jacquinot, and Marcin Kolasa (2014) ‘Can We Prevent Boom-Bust Cycles During Euro Area Accession?’ *Open Economies Review* 25(1), 35–69
- Bussiere, Matthieu, Giovanni Callegari, Fabio Ghironi, Giulia Sestieri, and Norihiko Yamano (2013) ‘Estimating Trade Elasticities: Demand Composition and the Trade Collapse of 2008-2009.’ *American Economic Journal: Macroeconomics* 5(3), 118–51
- Christensen, Ian, Césaire Meh, and Kevin Moran (2011) ‘Bank leverage regulation and macroeconomic dynamics.’ Working Papers 11-32, Bank of Canada
- Christoffel, Kai, Günter Coenen, and Anders Warne (2008) ‘The New Area-Wide Model of the euro area - a micro-founded open-economy model for forecasting and policy analysis.’ Working Paper Series 944, European Central Bank
- Cihak, Martin, Asli Demirgüç-Kunt, María Soledad Martínez Pería, and Amin Mohseni-Cheraghrou (2012) ‘Bank regulation and supervision around the world: a crisis update.’ Research working paper 6286, World Bank
- Cull, Robert, and María Soledad Martínez Pería (2013) ‘Bank ownership and lending patterns during the 2008-2009 financial crisis: Evidence from Latin America and Eastern Europe.’ *Journal of Banking & Finance* 37(12), 4861–4878
- Dedola, Luca, and Giovanni Lombardo (2012) ‘Financial frictions, financial integration and the international propagation of shocks.’ *Economic Policy* 27(70), 319–359
- Feyen, Erik, Raquel Letelier, Inessa Love, Samuel Munzele Maimbo, and Roberto Rocha (2014) ‘The impact of funding models and foreign bank ownership on bank credit growth: is Central and Eastern Europe different?’ Policy Research Working Paper Series 6783, The World Bank, February
- Gerali, Andrea, Stefano Neri, Luca Sessa, and Federico M. Signoretti (2010) ‘Credit and banking in a DSGE model of the euro area.’ *Journal of Money, Credit and Banking* 42(s1), 107–141
- Gertler, Mark, and Nobuhiro Kiyotaki (2010) ‘Financial intermediation and credit policy in business cycle analysis.’ In *Handbook of Monetary Economics*, ed. Benjamin M. Friedman

- and Michael Woodford, vol. 3 of *Handbook of Monetary Economics* (Elsevier) chapter 11, pp. 547–599
- Gertler, Mark, and Peter Karadi (2011) ‘A model of unconventional monetary policy.’ *Journal of Monetary Economics* 58(1), 17–34
- Haas, Ralph, and Iman Lelyveld (2014) ‘Multinational Banks and the Global Financial Crisis: Weathering the Perfect Storm?’ *Journal of Money, Credit and Banking* 46(s1), 333–364
- Iacoviello, Matteo (2005) ‘House prices, borrowing constraints, and monetary policy in the business cycle.’ *American Economic Review* 95(3), 739–764
- Iacoviello, Matteo, and Raoul Minetti (2006) ‘International business cycles with domestic and foreign lenders.’ *Journal of Monetary Economics* 53(8), 2267–2282
- Kamber, Gunes, and Christoph Thoenissen (2013) ‘Financial Exposure and the International Transmission of Financial Shocks.’ *Journal of Money, Credit and Banking* 45(s2), 127–158
- Kollmann, Robert (2013) ‘Global Banks, Financial Shocks, and International Business Cycles: Evidence from an Estimated Model.’ *Journal of Money, Credit and Banking* 45(s2), 159–195
- Popov, Alexander, and Gregory F. Udell (2012) ‘Cross-border banking, credit access, and the financial crisis.’ *Journal of International Economics* 87(1), 147–161

Tables and figures

Table 1: Calibration

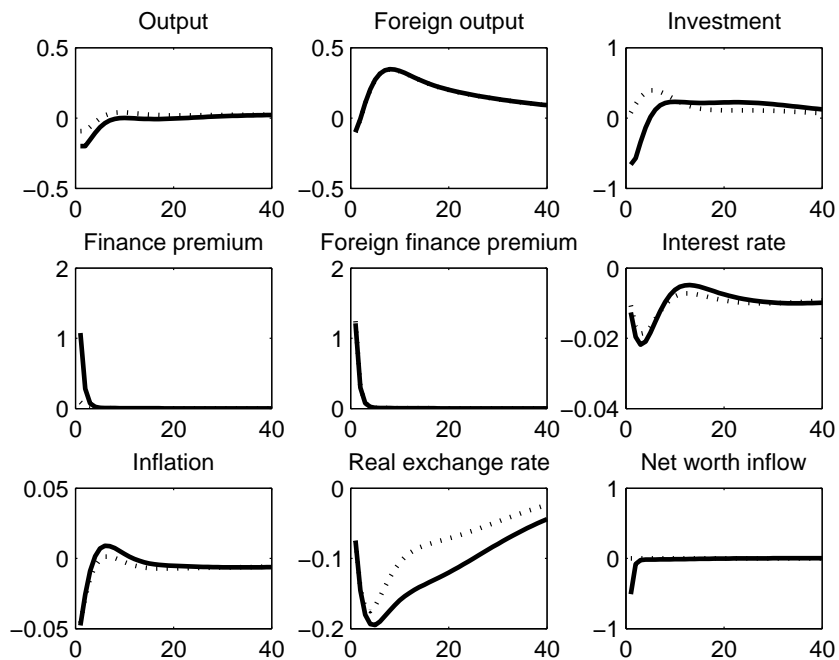
Parameter	Value	Description
β, β^*	0.993	Discount factor
σ_c, σ_c^*	2	Inverse of intertemporal elasticity of substitution
h, h^*	0.75	Consumption habits
σ_l, σ_l^*	2	Inverse of Frisch elasticity of labor supply
A_l, A_l^*	500	Weight on labor in utility
δ, δ^*	0.025	Depreciation rate
μ_w, μ_w^*	1.2	Steady-state wage markup
θ_w, θ_w^*	0.75	Calvo probability for wages
α, α^*	0.385	Output elasticity with respect to capital
μ, μ^*	1.2	Steady-state product markup
$\theta_H, \theta_H^*, \theta_F, \theta_F^*$	0.75	Calvo probability for prices
κ, κ^*	1.73	Investment adjustment cost curvature
λ, λ^*	0.255	Fraction of divertable funds
θ, θ^*	0.965	Fraction of retained bank earnings
κ_n	190	Cross-border flow of funds adjustment cost curvature
g_y, g_y^*	0.204	Steady-state share of government spending
π, π^*	1.005	Steady-state inflation
γ_R, γ_R^*	0.9	Interest rate smoothing in Taylor rule
γ_π, γ_π^*	2	Response to inflation in Taylor rule
γ_y, γ_y^*	0.15	Response to output in Taylor rule
ξ	0.001	Elasticity of finance premium wrt. foreign debt
ω	0.032	Relative size of home country
η	0.72	Share of domestic goods in home country's basket
η^*	0.01	Share of domestic goods in foreign country's basket
ϕ, ϕ^*	1.5	Elasticity of substitution btw. home and foreign goods
ρ, ρ^*	0.95	Autoregression of productivity shocks
σ, σ^*	0.0044	Standard deviation of productivity shocks
$corr(\varepsilon_t, \varepsilon_t^*)$	0.6	Cross-country correlation of productivity shocks

Table 2: Matched data moments

	Value
Steady-state investment share	0.217
Steady-state bank leverage	4
Standard deviation of output	1.35
Standard deviation of dividend payout ratio	11.2
Cross-country output correlation	0.58

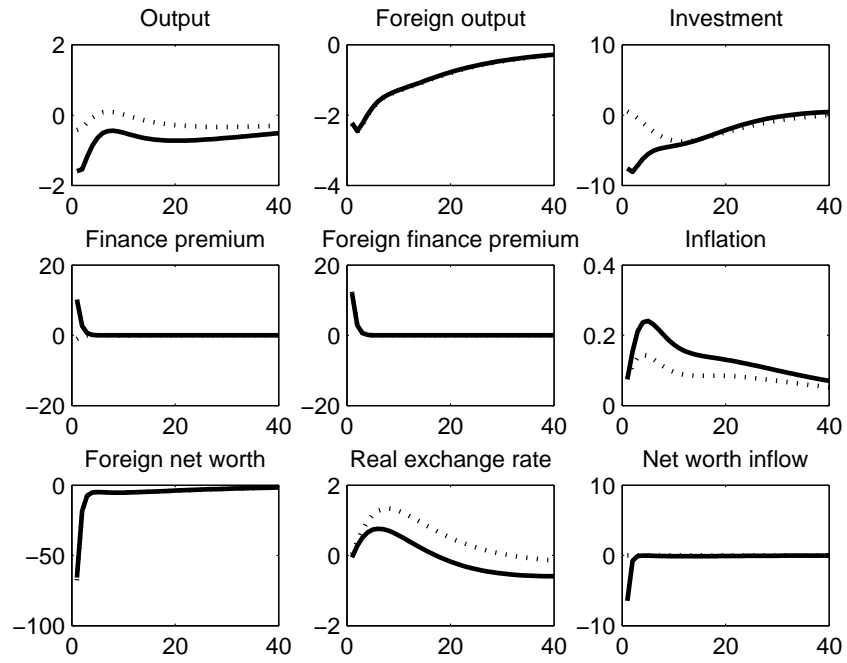
Note: The calculations are done using national accounts data published by the Eurostat. The model-implied first moments are matched to average observations over the period 2002-2013. The second moments for output are matched to HP-filtered quarterly GDP series for Poland and the euro area (source: Eurostat). Annual data on the dividend payout (or dividend-to-profit) ratio in the Polish banking sector are taken from the KNF (Polish Financial Supervision Authority) and quadratically interpolated to quarterly frequency.

Figure 1: Impulse responses to foreign productivity shock



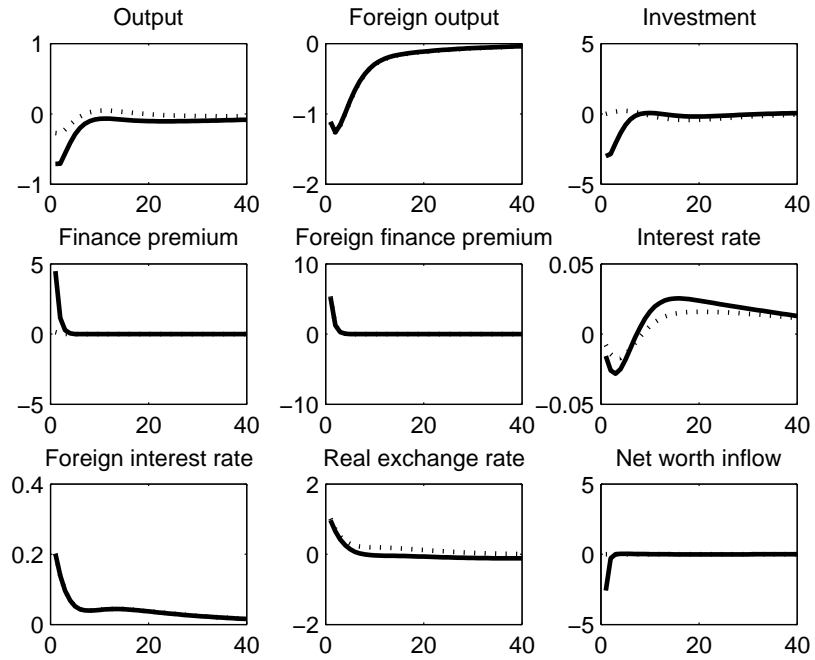
Note: solid line: baseline model; dashed line: model without foreign ownership

Figure 2: Impulse responses to foreign capital quality shock



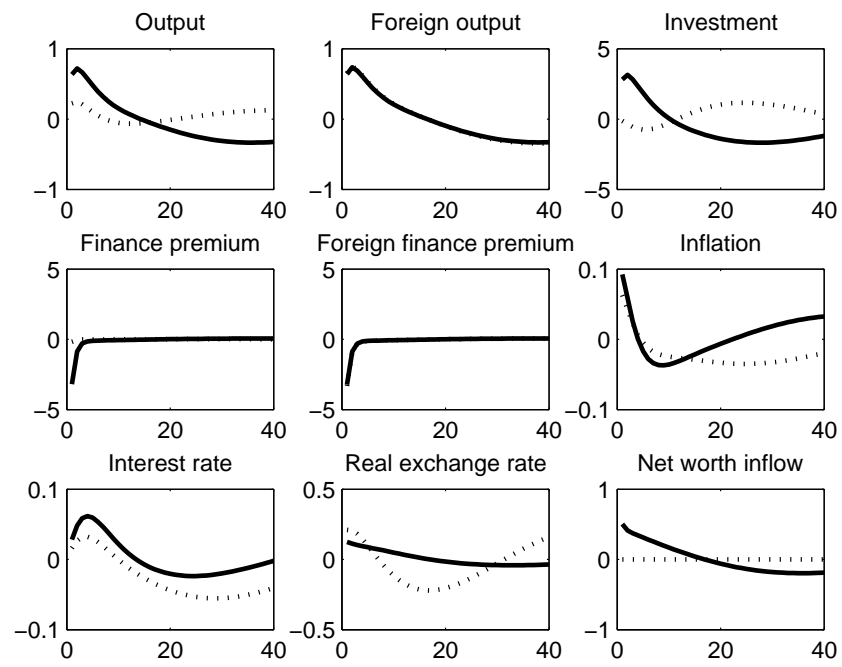
Note: solid line: baseline model; dashed line: model without foreign ownership

Figure 3: Impulse responses to foreign monetary policy shock



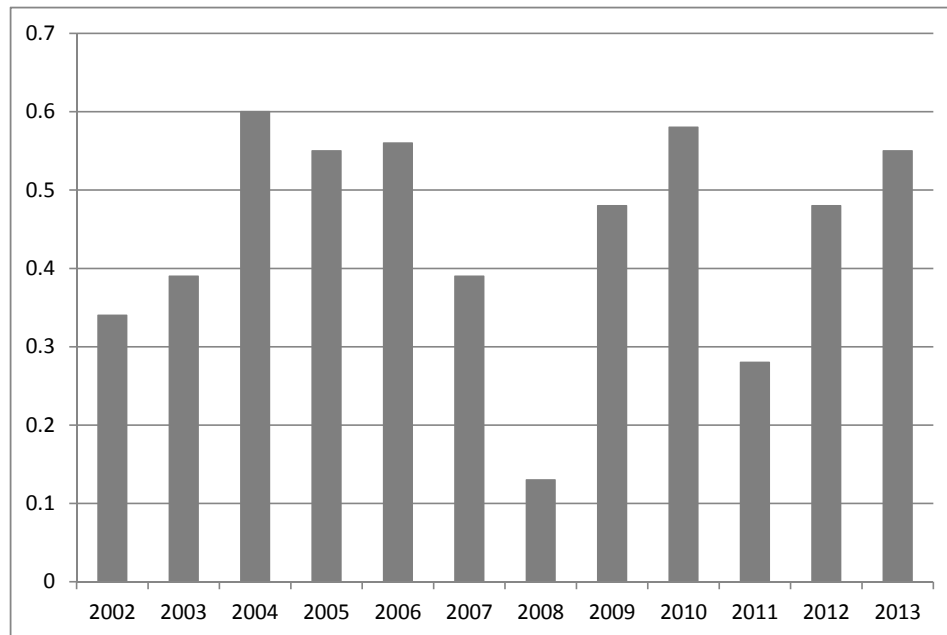
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Figure 4: Impulse responses to foreign capital injection shock



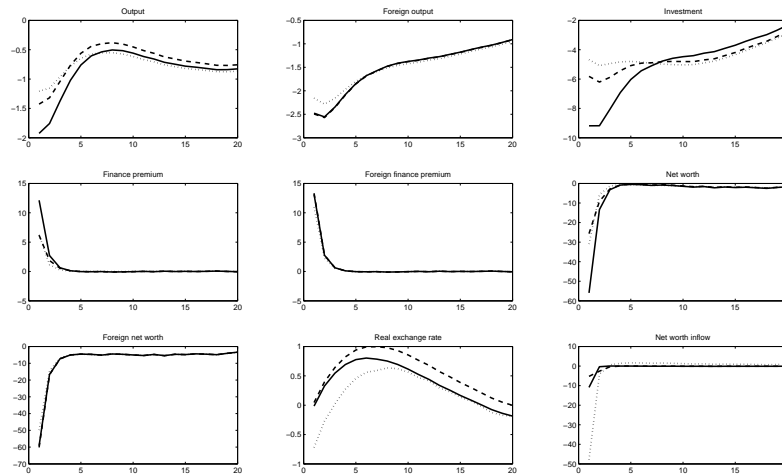
Note: solid line: baseline model; dashed line: model without foreign ownership

Figure 5: Distributed profits of the Polish banking sector (share of total)



Source: Polish Financial Supervision Authority

Figure 6: Impulse responses to foreign capital injection shock



Note: solid line - crisis scenario, dashed line - crisis scenario with dividend payout restriction; dotted line - crisis scenario with capital injection.