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Michał Brzoza-Brzezina – Narodowy Bank Polski and Warsaw School of Economics;
michal.brzoza-brzezina@nbp.pl
Marcin Kolasa – Narodowy Bank Polski and Warsaw School of Economics;
marcin.kolasa@nbp.pl
Krzysztof Makarski – Narodowy Bank Polski and Warsaw School of Economics;
krzysztof.makarski@nbp.pl

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Abstract

This paper checks how international spillovers of shocks and policies are modified when banks are foreign owned. To this end we build a two-country macroeconomic 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. It also strenghtens the international transmission of monetary and macroprudential policies. We next replicate the financial crisis in the euro area and show how, by preventing bank capital outflow in 2009, the Polish regulatory authorities managed to reduce its contagion to Poland. We also show that under foreign bank ownership such policy is strongly prefered to a recapitalization of domestic banks.

JEL: E32, E44, E58

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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), in 51 out of 124 surveyed countries more than two-thirds of banking sector assets were 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 aspect.

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. Imbs (2006) argues that with financial integration cross-country correlations in GDP and consumption rise. Van Rijckeghem and Weder (2001) finds evidence that contagion can be explained by bank lending spillovers rather than trade linkages. 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 that the supply of credit to domestic entities 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 bank loans during the financial crisis. In Eastern Europe they find notable differences between foreign and domestic-owned banks, 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 to 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, even more importantly, 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 our knowledge, not been discussed in the literature yet. The closest papers to ours 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 using euro area and US data. He concludes that the presence of a global bank increases spillovers. In Kamber and Thoenissen (2013) banks lend to foreign enterprises, which exposes them to and facilitates international transmission of foreign shocks. Olivero (2010) builds a two country RBC model with noncompetitive financial intermediation to find that countercyclical endogenous margins on loans contribute to the international transmission of TFP shocks. 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 us to study several important questions related to foreign ownership of banks. 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. All retail banks are owned by foreign-based parent banks who manage their balance sheets and, as a result, determine their 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 role of the banking sector in strengthening international spillovers. In particular, we show how the international transmission

of structural shocks (e.g. affecting capital quality or 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 negative spillovers.

In order to provide a quantitative assessment, we calibrate our model to the Polish and euro area (EA) data. Poland is a small open economy with tight trade links with the EA. Importantly, more than 60% of its banking sector assets are controlled by foreign entities, which are mainly 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 size of this effect depends crucially on the type of shock. In particular, the amplification is larger for shocks originating in the financial sectors (e.g. capital quality shock) and weaker for standard (productivity) shocks. Second, foreign ownership of banks can sizably amplify the international transmission of monetary and regulatory policies. Third, preventing capital outflows significantly mitigates the impact of negative foreign shocks (especially originating in the banking sector) on the domestic economy. We demonstrate this feature in a scenario that replicates the shocks faced by the euro area in 2008-09 and mimics the reaction of the Polish regulatory authorities that prevented repatriation of profits abroad. We also discuss how foreign ownership of banks, and hence the possibility of bank net worth transfers across borders, might make such an intervention preferred to a standard crisis-management policy such as capital injections to the banking sector.

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 dynamic stochastic general equilibrium (DSGE) model with banking sector that is owned by agents living in one country. 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 the reader's convenience, we describe the domestic economy in detail, because the foreign economy is mostly analogous. The only difference is that banks are owned by foreign households and we describe in detail how this feature affects the two economies.

2.1 Households

There is measure ω of agents in the domestic and $\omega^* = 1 - \omega$ of agents in the foreign economy.[1] Agents are indexed by ι. Denote consumption of agent ι as $c_t(\iota)$ and her hours worked as $l_t(\iota)$. Average consumption and labor are denoted as c_t and l_t, respectively. Each household consumes, supplies labor, keeps deposits $D_t(\iota)$ with banks at the interest rate R_t, and pays lump-sum taxes $T_t(\iota)$. Additionally, domestic households own all domestic firms and obtain dividends $\Pi_t(\iota)$. Similarly, foreign households own foreign firms, but also all banks. 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

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

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, where $\pi_t \equiv P_t / P_{t-1}$.

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

Households supply differentiated labor services in a monopolistically competitive market to competitive aggregators, who pool them into homogenous labor services l_t using 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 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

Undifferentiated wholesale goods are produced using capital and labor. They are next sold to foreign and domestic retailers who differentiate them. Domestic and foreign aggragetors produce final goods using domestic and foreign variates. 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 a homogenous final good $\tilde{y}_t$ with the following technology

$$\tilde{y}_t = \left((1-\eta)^{\frac{1}{\phi}} y_{F,t}^{\frac{\phi-1}{\phi}} + \eta^{\frac{1}{\phi}} y_{H,t}^{\frac{\phi-1}{\phi}}\right)^{\frac{\phi}{\phi-1}} \tag{1}$$

where

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

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

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

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

where ξ_t is 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 $\kappa \geq 0$.

2.2.3 Retailers

Retailers, indexed by i, purchase undifferentiated wholesale goods at price $P_{m,t}$ and brand (differentiate) them in order to sell in domestic and foreign markets. They compete in 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 the domestic market and with probability $1-\theta_H^*$ in the foreign market. If they do not receive a 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, it follows that

$$k_t = s_t$$

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 a

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

2.3.1 Retail 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 home central bank, and the interest rate on foreign deposits is equal to the foreign interbank interest rate R_t^* adjusted for a risk premium ρ_t. As it is standard in the literature, we assume that the 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

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

where $N_{g,t}$ denotes possible capital injections from the government (in standard simulations 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 a retail branch can divert a fraction λ of available funds to her parent bank at the cost of declaring bankruptcy. Therefore, for the lenders to be willing to deposit funds in a branch, the following incentive compatibility constraint must be met

$$\tilde{V}_t \geq \lambda P_{k,t} s_t \tag{5}$$

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

$$\tilde{V}_t(j) = \mathcal{E}_t \max E_t \left\{ \beta^* \Lambda^*_{t,t+1} \mathcal{E}^{-1}_{t+1} \left[R_{k,t+1} P_{k,t} s_t(j) - R_t D_{H,t}(j) - \rho R^*_t \mathcal{E}_{t+1} D_{F,t}(j) \right] \right\} \tag{6}$$

subject to the balance sheet constraint (4) and the incentive compatibility constraint (5). Note that the fact that banks can obtain depostits 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

$$\tilde{N}_{t+1} = \theta \left[(R_{k,t+1} P_{k,t} s_t - R_t D_{H,t} - \rho R^*_t \mathcal{E}_{t+1} D_{F,t} \right] (N_t + N_{g,t}) \tag{7}$$

where θ is the fraction of bank earnings that are retained (not paid out to ultimate owners, i.e. foreign households), while $\tilde{N}_{t+1}$ is the beginning of period $t+1$ equity of retail branches, i.e. before cross-border transfers have been made 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

$$\omega \mathcal{E}_t^{-1} \tilde{N}_t + (1 - \omega) \tilde{N}^*_t = \omega \mathcal{E}_t^{-1} N_t + (1 - \omega) N^*_t \tag{8}$$

In allocating equity, a parent bank may be constrained by the domestic regulatory authority. This constrainet is introduced using a 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

$$E_0\Bigg\{\sum_{t=0}^{\infty}(\beta^*)^{t+1}\Lambda^*_{0,t+1}\Bigg[\omega\mathcal{E}_{t+1}^{-1}\Big((R_{k,t+1}-R_t)\phi_t(N_t+N_{g,t})+R_t(N_t+N_{g,t})\Big) + (1-\omega)\Big((R^*_{k,t+1}-R^*_t)\phi^*_t(N^*_t+N^*_{g,t})+R^*_t(N^*_t+N^*_{g,t})\Big)\Bigg] - \sum_{t=0}^{\infty}(\beta^*)^t\Lambda^*_{0,t}\left[\omega\mathcal{E}_t^{-1}\Phi\Big(\frac{N_t}{\tilde{N}_t}\Big)N_t\right]\Bigg\} \quad (9)$$

subject to (5), equation for net worth accumulation in its domestic branch (7), 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

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\gamma_R}\left[\left(\frac{\pi_t}{\pi}\right)^{\gamma_\pi}\left(\frac{y_t}{y}\right)^{\gamma_y}\right]^{1-\gamma_R} e^{\varepsilon_{R,t}} \quad (10)$$

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 a 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. The fund may issue bonds to households or deposit its assets at the central bank. In both cases, the policy rate R_t applies. The fund evolves according to the following equation

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

where, if positive, $N_{g,t}$ can be interpreted as capital injections (e.g. made during a crisis), while, if negative, it denotes lump sum taxes levied on retail branches to finance the fund's future spending. Capital injections/taxes to domestic banks

are done according to the following rule

$$N_{g,t} = \rho_{N_g} N_{g,t-1} + (1-\rho_{N_g})[N_g + \varphi_F(F_t - F) + \varphi_R((E_t R_{k,t+1} - R_t) - (R_k - R))] + \varepsilon_{N_g,t} \tag{12}$$

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's reaction to financial stress manifested by an increase in the finance premium, ρ_{N_g} is the autoregression of the capital injection policy, and $\varepsilon_{N_g,t}$ stands for a capital injection policy shock. Note that this policy is used only in our financial crisis scenario, while for generating impulse responses to standard shocks we assume $\varphi_R = \varepsilon_{N_g,t} = 0$.

Another tool at disposal of the macroprudential authorities that we consider in our model 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 the penalty curvature $\kappa_{n,t}$ in equation ((9)) according to the following rule

$$\kappa_{n,t} = \rho_{\kappa_n} \kappa_{n,t-1} + (1 - \rho_{\kappa_n})[\kappa_n + \nu_R((E_t R_{k,t+1} - R_t) - (R_k - R))] + \varepsilon_{\kappa_n,t} \tag{13}$$

where ν_R denotes the aggressiveness with which the authority restricts dividends in case of financial distress (manifested by an increase in the finance premium), ρ_{κ_N} is the autoregression of this policy and $\varepsilon_{\kappa_N,t}$ is a 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

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

$$\Delta^*_{H,t} = \int_0^1 \left(\frac{p^*_{H,t}(i)}{p^*_{H,t}} \right)^{\frac{\mu^*}{1-\mu^*}} di$$

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

$$\mathcal{E}_t P^*_{H,t} \frac{1-\omega}{\omega} y^*_{H,t} + \mathcal{E}_t D^*_t + (\tilde{N}_t - N_t) = P_{F,t} y_{F,t} + (1-\theta)\left[(R_{k,t} - R_{t-1})\phi_{t-1} + R_{t-1}\right] N_{t-1} + \mathcal{E}_t \varrho_{t-1} R^*_{t-1} D^*_{t-1}$$

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

$$c_t + g_t + i_t = \tilde{y}_t$$

where g_t is government spending financed by lump sum taxes levied on households[2]. Finally, the market clearing condition for the wholesale goods is as follows

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

[2]Since our focus is not on fiscal policy, we assume that the government budget is balanced in each period.

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 EA. 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 EA, 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 EA 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 EA of 2.92%.

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 in line with the estimated DSGE models for the euro area (Christoffel et al., 2008).

Unless stated otherwise, macroprudential policy in the model is assumed to be inactive. This means in particular that capital injections are zero and the curvature of penalty on cross-border profit transfers is fixed at its steady-state level, which is pinned down using stochastic simulations. More specifically, we calibrate it, as well as the standard deviations and cross-country correlation of productivity shocks,[3] to simultaneously match the standard deviations of the cyclical components of output in Poland and EA, and the standard deviation

[3]The 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 aplying to foreign banks in normal times.

As a final step we check how well our model matches the main moments observed in the data - standard deviations, correlations with output and correlations with foreign variables. The results are presented in Table 3, and, given our parsimonious stochastic environment can be considered successful. Regarding domestic relationships the model provides a close match for all moments but correlation of labor with output. This is a typical feature of New Keynesian models with sticky wages and our extensions do not provide a fix since they are not related to the labor market structure. Regarding international correlations the fit is also good. In particular the model is able to invert the negative correlation between domestic and foreign output characteristic for the international RBC framework (Backus et al., 1992) and fares similarly well as the banking model described by Olivero (2010).[5]

We solve the model by linearizing its equilibrium conditions around the non-stochastic steady state, and next applying standard perturbation techniques.

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

[5]This holds true even if we assume the same correlation of domestic and foreign productivity shocks as in Backus et al. (1992).

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 domestic economy. In this part we check whether our model is in line with empirical evidence on the impact of foreign ownership on international transmission of shocks. Second, we analyze a banking crisis scenario originating in the euro area and check to what extent the Polish supervisory authorities' decission 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 banks operating in Poland.

4.1 Spillovers from shocks and policy

In what folows, we use the 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 responses to shocks generated with our baseline model (solid line) to those obtained in its variant without foreign ownership (dotted line). The latter is achieved by reformulating the retail bank problem (6) such that profits are discounted consistently with domestic households' utility, shutting down transfers of bank capital between domestic and foreign retails banks (i.e. $N_t = \tilde{N}_t$ every period), and modifying the balance of payments accordingly.

First, we explain the main mechanism that determines the direction of capital flows, and hence of spillovers after shocks. The objective of the parent bank is to maximize (9). Let us, for the sake of simplicity, ignore capital injections ($N_{g,t} = N^*_{g,t} = 0$), the fixed part of dividend transfers ($\theta = \theta^* = 1$) as well as the penalty for capital flows $\Phi(N_t/\tilde{N}_t) = 0$, and assume equal initial leverage ratios across the countries ($\phi_t = \phi^*_t$). Moreover, let us consider only the static part of the problem (i.e. leave out the impact on future profits). Then the parent bank's objective boils down to maximizing

$$E_t\Big\{\Lambda^*_{t,t+1}\Big[\omega\mathcal{E}^{-1}_{t+1}\Big((R_{k,t+1}-R_t)\phi_t+R_t\Big)N_t+(1-\omega)\Big((R^*_{k,t+1}-R^*_t)\phi^*_t+R^*_t\Big)N^*_t\Big]\Big\} \tag{14}$$

subject to (8). The solution to this problem is

$$E_t\Big\{\Lambda^*_{t,t+1}\frac{\mathcal{E}_t}{\mathcal{E}_{t+1}}\Big[R_{k,t+1}-\frac{\phi_t-1}{\phi_t}R_t\Big]\Big\} = E_t\Big\{\Lambda^*_{t,t+1}\Big[R^*_{k,t+1}-\frac{\phi_t-1}{\phi_t}R^*_t\Big]\Big\} \tag{15}$$

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 transfered 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 meachanism is more complex due to the impact of expected future premia and the cost of transfering net worth. It should be noted that, given the difference in size between the two countries, cross-border capital flows will exert a potentialy large impact on the domestic economy but will have a negligible effect on the foreign one.

Foreign 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 and output, and lowers marginal cost and inflation (for brevity, we show only the response of output). 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 in the expected return on capital. Hence, in the short term foreign output declines.

Turning to the spillovers, in a world without foreign ownership (dotted lines), domestic output falls first (as a result of a decrease in foreign output and exchange rate apreciation) and increases slightly in the longer run (following a recovery in foreign output and stronger import demand). This pattern is modified when foreign ownership is assumed (solid lines). The higher rate of return on capital abroad generates a capital outflow from domestic retail banks. As a result, they reduce their balance sheets, investment falls and the initial decline in output is deepened. This effect is quite persistent as output remains below its path in the case of domestic bank ownership also in the medium run.

Foreign capital quality shock

This shock, presented in Figure 2, brings about a deterioration of assets held by foreign financial intermediaries and, in consequence, negatively affects their net worth. Bank lending abroad 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 economy. The parent bank attempts to equalize the premia by transfering capital abroad. As a result, the domestic finance premium increases, lending at home declines, and investment and GDP drop. These cross-border capital transfers amplify the negative impact of the capital quality shock on the domestic economy compared to the situation in which banks are owned by residents, and in which case transmission occurs mainly via the trade channel.

Foreign monetary policy shock

Next, we look how the international transmission of monetary policy is affected by the foreign ownership of banks. Figure 3 presents the impulse responses to a foreign monetary policy tightening. The resulting reaction of the foreign economy is standard: an increase in the interest rate depresses output and inflation. The slowdown abroad reduces the demand for domestic goods, thus transmitting it to the home economy. The spillover is attenuated by the depreciation of the domestic currency. When domestic banks are foreign-owned, these standard spillovers are substantially amplified. Since foreign investment declines, so does the price of capital. The resulting rise of the expected return on capital abroad generates a capital outflow from the domestic economy. Consequently, the domestic finance premium rises, and investment and output decline more than under domestic bank ownership.

Capital injection to foreign banks

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 are obliged to transfer 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 discussed later.

To implement this shock, we need to parametrize the bank capital injection rule for the foreign economy, i.e. the foreign counterpart of equation (12). Since we want to first focus on the effects of unsystematic policy, we set the feedback coefficient φ_R^* to zero. We also make the rule persistent by calibrating its inertia to 0.95. Finally, the parameter controlling the speed at which the special fund is

repleted after the injection is set to 0.05.[6]

As shown in Figure (4), a bank capital injection shock abroad, equivalent to a one-off recapitalization of foreign banks, generates an increase in credit in the foreign economy, which leads to an expansion of investment and output in this region. Absent foreign ownership of banks, these developments transmit weakly to the domestic economy, mainly via trade linkages. An additional boost is given by the bank ownership channel. Some of the capital injection is transfered to the domestic economy, lowering the finance premium there and boosting investment demand. In consequence, the spillovers measured by the response of domestic output are significantly stronger. It has to be noted that, compared to the previously analysed standard shocks, capital injection has an additional important feature. As this recapitalization uses resources collected in the special fund, banks must transfer to it some of their earnings until the fund is repleted. As a result, for some time capital is being effectively withdrawn from foreign banks, lowering output abroad and reversing the direction of cross-border capital flows. Hence, in the medium term the spillover to the domestic economy 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 the banking sector. Due to heavy losses on international toxic asstes and domestic housing markets, as well as limited access to wholesale funding, banks restricted lending to the private sector. Several EA 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 succesfully 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

[6] Admittedly, our calibration of these last two parameters is arbitrary. However, it must be such for lack of empirical evidence on the implementation of this type of macroprudential policy in the EA.

domestic to foreign banks. As shown on Figure 5, in 2009 only 13% of profits were payed out as dividends, compared to an average of 50% in the five-year period preceeding 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 impact of this crisis scenario (solid lines) together with one of the two types of regulatory policy described in section 2.4 and applied by the home economy, i.e. a limit on dividend payout (dashed lines) and capital injection to domestic banks (dotted lines). To make these policies comparable, both are calibrated such that they reduce the increase in risk premium at home on impact by a half.[7]

Absent any policy intervention, the magnitude of output collapse at home due to the crisis abroad is substantial, reaching nearly 2%. As already discussed, such strong contagion is 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 contagion is 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 sister 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 relatively small. Naturally, this export of stimulus has a positive feedback on the home economy via increased demand for domestically produced goods. Also, as the capital injection comes from a fund that needs to be repleted in subsequent periods, this huge foreign capital outflow is next reversed and net

[7] More specifically, this requires setting the feedback coefficients on the financial premium in rules (12) and (13) to the following values: $\varphi_R = 13$ and $\nu_R = 8000$. Since we deal with a crisis scenario, we abstract away from any policy smoothing motives and hence set the persistence of both macroprudential rules to zero.

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.

In our model both domestic and foreign financial intermediaries are 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 foreign monetary and macroprudential policy transmission is amplified by foreign ownership.

Finaly, 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, can be effective in limiting the contagion of the crisis originating abroad. We show that such a regulation could have reduced the GDP slowdown in Poland substantially. Last but not least, we show that foreign ownership dramatically weakens the effectiveness of domestic bank capital injection policy. While this type of intervention can possibly undo some of the contagion, it is very costly for the domestic economy since a large part of the bank recapitalization is transfered abroad. Hence, in a small economy with foreign bank ownership, such policy must be undertaken only jointly with a policy that prevents capital outflows.

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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
θ_H, θ_H^*, θ_F, θ_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	Steady-state 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

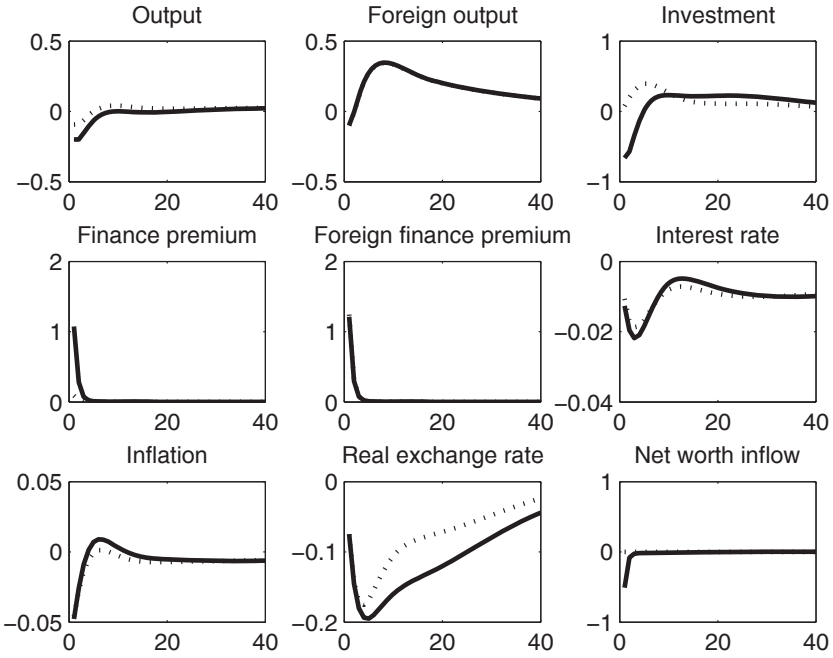
	Value
Steady-state investment share	0.217
Steady-state bank leverage	4
Steady-state spread (annualized)	0.029
Standard deviation of output	1.35
Standard deviation of dividend payout ratio	11.2
Cross-country output correlation	0.58

Note: The model-implied first moments are matched to average observations for the EA over the period 2002-2013 (source: Eurostat and ECB). 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 inerpolated to quarterly frequency.

Table 3: Moments matching.

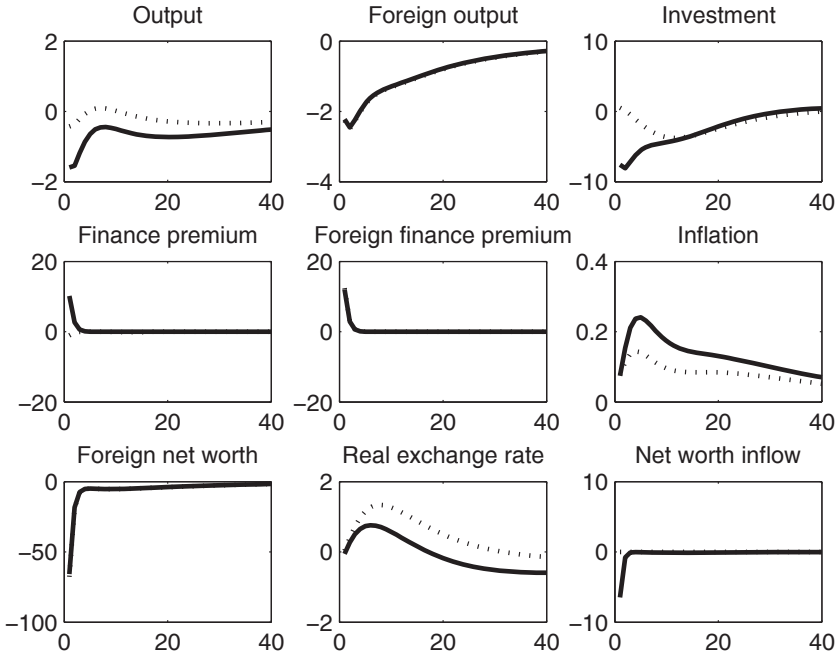
	Data	Model (calibration)
Standard Deviations		
GDP	1.30	1.40
Consumption	0.95	1.12
Investment	5.65	3.12
Employment	1.15	1.26
Correlations with GDP		
GDP	1.0	1.0
Consumption	0.74	0.80
Investment	0.92	0.88
Employment	0.76	-0.28
Correlation with foreign couterpart		
GDP	0.72	0.58
Consumption	0.50	0.91
Investment	0.74	0.78
Employment	0.65	0.85

Figure 1: Impulse responses to foreign productivity shock



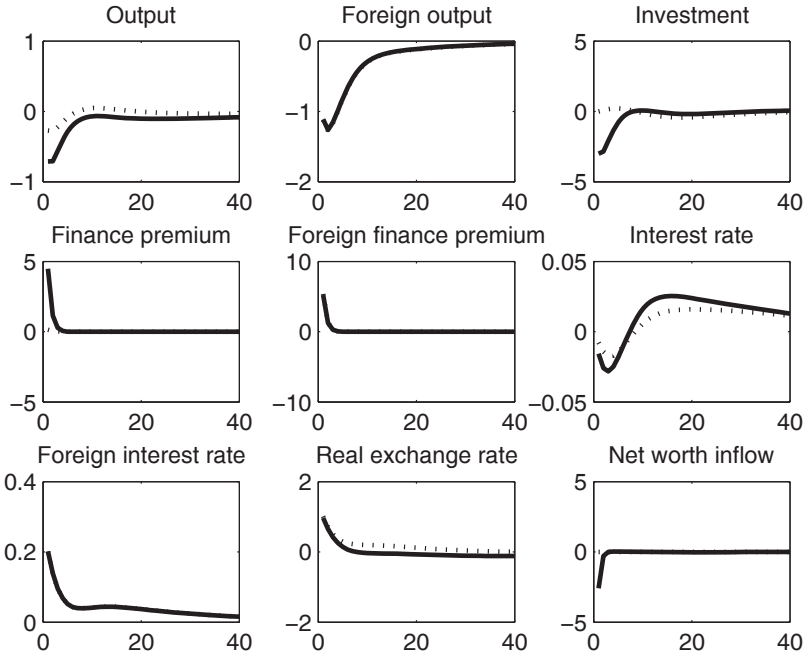
Note: solid line - baseline model; dashed line - model without foreign ownership.

Figure 2: Impulse responses to foreign capital quality shock



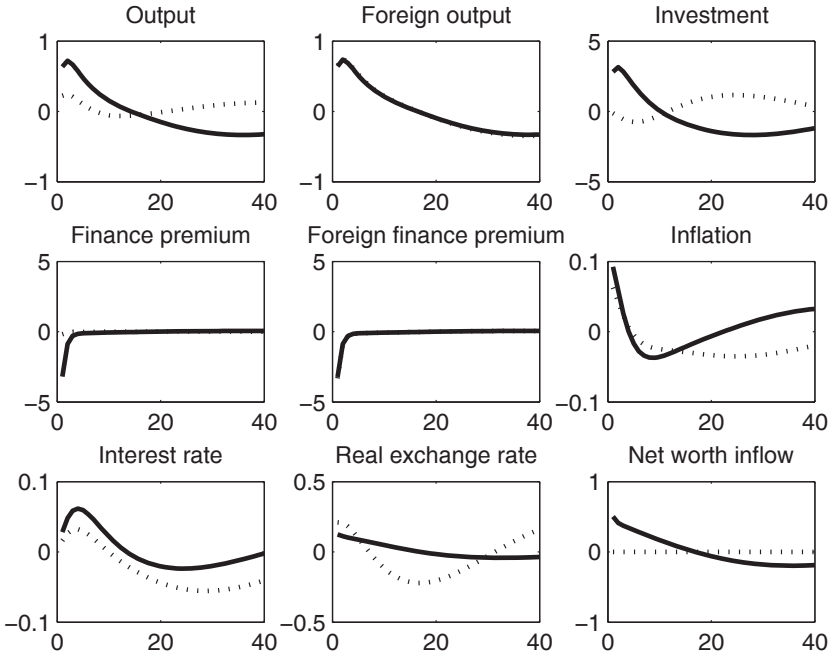
Note: solid line - baseline model; dashed line - model without foreign ownership.

Figure 3: Impulse responses to foreign monetary policy shock



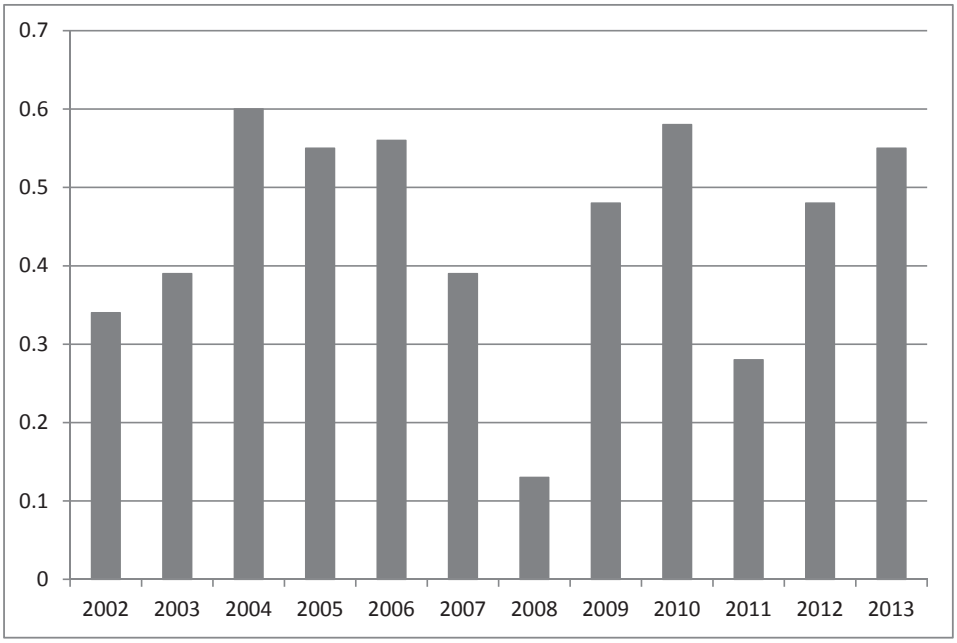
Note: solid line - baseline model; dashed line - model without foreign ownership.

Figure 4: Impulse responses to foreign capital injection shock



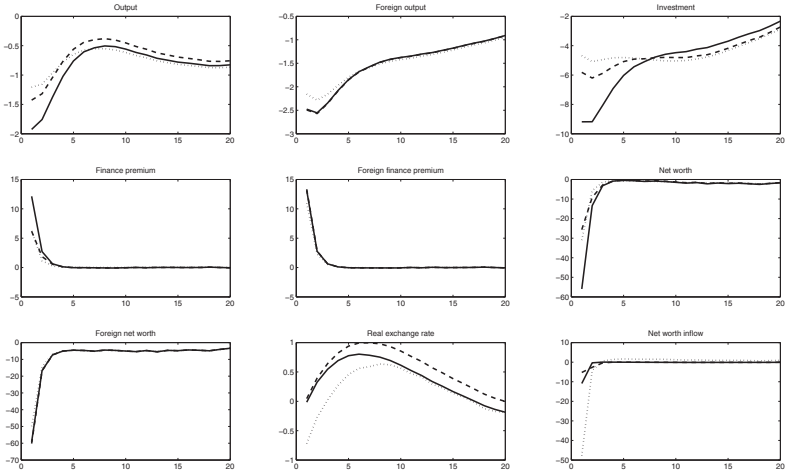
Note: solid line - baseline model; dashed line - model without foreign ownership.

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



Source: Polish Financial Supervision Authority.

Figure 6: Foreign crisis scenario with and without regulatory policies in home economy



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

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