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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. 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, in our model foreign ownership of banks amplifies spillovers from foreign shocks. It also strengthens the international transmission of monetary and macroprudential policies. We next use the model to 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 find that under foreign bank ownership such policy is strongly preferred to a recapitalization of domestic banks.

Keywords:

foreign-owned banks, monetary and macroprudential policy, international spillovers, DSGE models with banking

JEL Classification

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, see Figure 1. 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 banks 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 transmitting shocks between countries. 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. Finally, Pawlowska et al. (2015) show that foreign-owned banks provided liquidity to their Polish subsidiaries when these faced liquidity shortages in 2008 and 2009.

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. Fourth, we show that foreign ownership influences the transmission of domestic shocks. For instance, shocks that destroy banking capital are attenuated as foreign banks recapitalize their domestic branches.

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 a 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

¹We employ the following notation: foreign variables and parameters have the same symbol as domestic ones, but for an asterisk. We express all variables in per capita terms of the given country.

worked as $l_t(\iota)$. Average consumption and labor are denoted as c_t and l_t , respectively. Each household consumes final goods purchased at price P_t , supplies labor at the wage rate W_t , 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

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

subject to the budget constraint

$$P_t c_t(\iota) + D_t(\iota) + T_t(\iota) = W_t l_t(\iota) + R_{t-1} D_{t-1}(\iota) + \Pi_t(\iota) \quad (2)$$

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

$$\Lambda_{t,t+1} = \frac{(c_{t+1} - hc_t)^{-\sigma_c}}{\pi_{t+1}(c_t - hc_{t-1})^{-\sigma_c}} \quad (3)$$

which firms take into account while solving their problems, where $\pi_t \equiv P_t/P_{t-1}$.

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 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 a homogenous final good \tilde{y}_t with the following technology

$$\tilde{y}_t = \left((1-\eta)^{\frac{1}{\phi}} y_{F,t}^{\frac{\phi-1}{\phi}} + \eta^{\frac{1}{\phi}} y_{H,t}^{\frac{\phi-1}{\phi}} \right)^{\frac{\phi}{\phi-1}} \quad (4)$$

where

$$y_{H,t} = \left(\int_0^1 y_{H,t}(i)^{\frac{1}{\mu}} di \right)^\mu \quad (5)$$

$$y_{F,t} = \left(\int_0^1 y_{F,t}(i)^{\frac{1}{\mu}} di \right)^\mu \quad (6)$$

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

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

$$k_t = (1 - \delta)\xi_t k_{t-1} + \left(1 - S\left(\frac{i_t}{i_{t-1}}\right)\right)i_t \quad (7)$$

where ξ_t is an AR(1) shock to capital quality (and $\xi_t k_{t-1}$ is the effective quantity of capital at time t), δ denotes the depreciation rate for capital, and the 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 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

$$y_{w,t} = z_t (\xi_t k_{t-1})^\alpha l_t^{1-\alpha} \quad (8)$$

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 $P_{k,t}$. It follows that

$$k_t = s_t \quad (9)$$

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

$$R_{k,t+1} = \frac{\alpha P_{m,t+1} \frac{y_{m,t+1}}{\xi_{t+1} k_t} + (1 - \delta) P_{k,t+1}}{P_{k,t}} \xi_{t+1} \quad (10)$$

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. Our banking system features several channels of international financial flows. First, domestic and foreign households can hold deposits at both domestic and foreign banks. Second, due to foreign ownership of banks, dividends from domestic branches are paid out to foreign households. Third, there are net worth flows between domestic and foreign branches. Since the dividend policy is assumed to be exogenous, the key cross-border financial flows are related to deposits and net worth reallocation.

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 . In order to ensure stability of the model we follow Schmitt-Grohe and Uribe (2003), and assume that the risk premium depends on the deviation of the ratio of foreign debt d_t to GDP from its steady state value

$$\rho_t = \varrho \exp\left(\frac{d_t}{y_t} - \frac{d}{y}\right) \quad (11)$$

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

$$P_{k,t} s_t = N_t + N_{g,t} + D_{H,t} + \mathcal{E}_t D_{F,t} \quad (12)$$

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

$$\tilde{V}_t \geq \lambda P_{k,t} s_t \quad (13)$$

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

$$\tilde{V}_t(j) = \mathcal{E}_t \max E_t \left\{ \beta^* \Lambda_{t,t+1}^* \mathcal{E}_{t+1}^{-1} [R_{k,t+1} P_{k,t} s_t(j) - R_t D_{H,t}(j) - \rho R_t^* \mathcal{E}_{t+1} D_{F,t}(j)] \right\} \quad (14)$$

subject to the balance sheet constraint (12) and the incentive compatibility constraint (13). Note that the fact that banks can obtain deposits from abroad 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

$$\tilde{N}_{t+1} = \theta [(R_{k,t+1} P_{k,t} s_t - R_t D_{H,t} - \rho R_t^* \mathcal{E}_{t+1} D_{F,t}) (N_t + N_{g,t})] \quad (15)$$

where θ is the exogenous fraction of bank earnings that are retained and hence augment banks' net worth,² 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 (13) binds, it is easy to show that the solution to the problem of a branch leads to the following condition

$$P_{k,t} s_t = \frac{\eta_t}{\lambda - \nu_t} (N_t + N_{g,t}) = \phi_t (N_t + N_{g,t}) \quad (16)$$

where

$$\nu_t = E_t \left\{ \beta^* \Lambda_{t,t+1}^* \frac{\mathcal{E}_t}{\mathcal{E}_{t+1}} (R_{k,t+1} - R_t) \right\} \quad (17)$$

and

$$\eta_t = E_t \left\{ \beta^* \Lambda_{t,t+1}^* \frac{\mathcal{E}_t}{\mathcal{E}_{t+1}} R_t \right\} \quad (18)$$

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.

²Parameter $\theta < 1$ plays a similar role as in Gertler and Karadi (2011). It ensures that over time banks do not reach the point where they can fund all investments from their own capital. The remaining fraction $1 - \theta$ of earnings is paid out to ultimate owners, i.e. foreign households, and included in term $\Pi_t^*(\iota)$ of their budget constraint that is analogous to equation 2.

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 constraint³

$$\omega \mathcal{E}_t^{-1} \tilde{N}_t + (1 - \omega) \tilde{N}_t^* = \omega \mathcal{E}_t^{-1} N_t + (1 - \omega) N_t^* \quad (19)$$

In allocating equity, a parent bank may be constrained by the domestic regulatory authority. This constraint 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

$$E_0 \left\{ \sum_{t=0}^{\infty} (\beta^*)^{t+1} \Lambda_{0,t+1}^* \left[\omega \mathcal{E}_{t+1}^{-1} \left((R_{k,t+1} - R_t) \phi_t(N_t + N_{g,t}) + R_t(N_t + N_{g,t}) \right) + (1 - \omega) \left((R_{k,t+1}^* - R_t^*) \phi_t^*(N_t^* + N_{g,t}^*) + R_t^*(N_t^* + N_{g,t}^*) \right) \right] - \sum_{t=0}^{\infty} (\beta^*)^t \Lambda_{0,t}^* \left[\omega \mathcal{E}_t^{-1} \Phi\left(\frac{N_t}{\tilde{N}_t}\right) N_t \right] \right\} \quad (20)$$

subject to (13), equation for net worth accumulation in its domestic branch (15), and its analog for a foreign branch. By affecting the lending conditions, reallocation of net worth is the key channel through which foreign ownership of the banking sector impacts on the domestic economy.

2.4 Monetary and macroprudential policy

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

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R} \right)^{\gamma_R} \left[\left(\frac{\pi_t}{\pi} \right)^{\gamma_\pi} \left(\frac{y_t}{y} \right)^{\gamma_y} \right]^{1-\gamma_R} e^{\varepsilon_{R,t}} \quad (21)$$

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 an iid 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

³Since all the variables are expressed in per capita terms of a given country and this constraint is expressed in aggregate terms, we multiply each variable by the respective population size.

policy rate R_t applies. The fund evolves according to the following equation

$$F_t = R_t F_{t-1} - N_{g,t} \quad (22)$$

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 to (or taxes on) domestic banks are done according to the following rule⁴

$$N_{g,t} = \rho_{N_g} N_{g,t-1} + (1 - \rho_{N_g}) [N_g + \varphi_F (F_t - F) + \varphi_R ((E_t R_{k,t+1} - R_t) - (R_k - R))] + \varepsilon_{N_g,t} \quad (23)$$

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 banking crisis scenario (which is described in section 4.2), while for generating the 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 (20) according to the following rule

$$\kappa_{n,t} = \rho_{\kappa_n} \kappa_{n,t-1} + (1 - \rho_{\kappa_n}) [\kappa_n + \nu_R ((E_t R_{k,t+1} - R_t) - (R_k - R))] + \varepsilon_{\kappa_n,t} \quad (24)$$

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. Note that we use this policy only for generating the impulse response and in our banking crisis scenario, otherwise we assume $\kappa_{n,t}$ equal to its steady state level.

2.5 Closing the model

We define GDP as

$$y_t = \Delta_{H,t} y_{H,t} + \frac{1 - \omega}{\omega} \Delta_{H,t}^* y_{H,t}^* \quad (25)$$

⁴The assumption that macroprudential policy responds to the finance premium is borrowed from Gertler and Karadi (2011).

where

$$\Delta_{H,t} = \int_0^1 \left(\frac{p_{H,t}(i)}{p_{H,t}} \right)^{\frac{\mu}{1-\mu}} di \quad (26)$$

$$\Delta_{H,t}^* = \int_0^1 \left(\frac{p_{H,t}^*(i)}{p_{H,t}^*} \right)^{\frac{\mu^*}{1-\mu^*}} di \quad (27)$$

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

$$\begin{aligned} & \mathcal{E}_t P_{H,t}^* \frac{1-\omega}{\omega} y_{H,t}^* + \mathcal{E}_t D_t^* + (\tilde{N}_t - N_t) \\ &= P_{F,t} y_{F,t} + (1-\theta) [(R_{k,t} - R_{t-1})\phi_{t-1} + R_{t-1}] N_{t-1} + \mathcal{E}_t \varrho_{t-1} R_{t-1}^* D_{t-1}^* \end{aligned} \quad (28)$$

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

$$c_t + g_t + i_t = \tilde{y}_t \quad (29)$$

where g_t is government spending financed by lump sum taxes levied on households⁵. Finally, the market clearing condition for the wholesale goods is as follows

$$\int_0^1 y_{m,t}(i) di = y_{m,t} \quad (30)$$

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.

⁵Since our focus is not on fiscal policy, we assume that the government budget is balanced in each period.

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 annualized spread on bank loans observed in the EA of 2.92%.

The parametrization of household preferences and price rigidities follows closely Brzoza-Brzezina et al. (2014). The curvature of investment adjustment cost is taken from Gertler and Karadi (2011) and scaled down by a factor of two to improve the fit of investment volatility implied by the model to the data. 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 net capital injections (and hence the value of special fund F_t) are zero and the curvature of penalty on cross-border profit transfers is fixed at its steady-state level κ_n , 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,⁶ to simultaneously match the standard deviations of the cyclical components of output in Poland and the EA, and the standard deviation of the dividend payout ratio in the Polish banking sector.⁷ 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.

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 good match for all moments, somewhat underestimating the comovement of labor with output and volatility of investment. Regarding international correlations, the fit is also reasonable. In particular, the model is able to invert the negative correlation between domestic and foreign output and investment that is characteristic for the international RBC framework (Backus et al., 1992). This holds true even if we assume the same correlation of domestic and foreign productivity shocks as in Backus et al. (1992), suggesting that the financial structure considered in our model helps overcome one of the important puzzles in international macroeconomics. It may be interesting to note that foreign ownership as such dampens the international comovement in output when productivity shocks are the only source of aggregate uncertainty. This is because bank capital flows to the country where productivity is high, tightening the

⁶The autocorrelation of productivity shocks is set to a conventional value of 0.95.

⁷For reasons that will be explained in the next section, while calculating the volatility of the dividend payout ratio we drop year 2009.

credit conditions and hence depressing economic activity in the other economy. Therefore, the high cross-country correlation of output implied by our model results from the financial frictions and not from the cross-border dividend flows. However, as we will see below, the opposite holds true for many other shocks, and foreign ownership can greatly amplify the effect of disturbances originating abroad on the home economy.

We solve the model by applying standard perturbation techniques to a model whose equilibrium conditions are approximated around the non-stochastic steady state.

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 empirical evidence on the impact of foreign ownership on the 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' 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 banks operating in Poland. Finally, we check how foreign ownership affects the transmission of domestic shocks.

4.1 Spillovers from shocks and policy

In what follows, we use the impulse responses to explain how our model works and to analyze what international spillovers it generates. To this end, on Figures 2 - 5 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 (14) 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.

We begin with a standard productivity shock, which in the literature is treated as one of the main driving forces of standard business cycles. Next, we move to a capital quality shock that Gertler and Karadi (2011) implement to simulate a financial crisis. Finally, we show how foreign bank ownership modifies the reactions to macroprudential and monetary policies. In all of these figures, the size of innovations to shocks are normalized to one percent (annualized in the case of the monetary shock).

However, before showing the impulse responses, 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 (20). 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

$$E_t \left\{ \Lambda_{t,t+1}^* \left[\omega \mathcal{E}_{t+1}^{-1} \left((R_{k,t+1} - R_t) \phi_t + R_t \right) N_t + (1 - \omega) \left((R_{k,t+1}^* - R_t^*) \phi_t^* + R_t^* \right) N_t^* \right] \right\} \quad (31)$$

subject to (19). The solution to this problem is

$$E_t \left\{ \Lambda_{t,t+1}^* \frac{\mathcal{E}_t}{\mathcal{E}_{t+1}} \left[R_{k,t+1} - \frac{\phi_t - 1}{\phi_t} R_t \right] \right\} = E_t \left\{ \Lambda_{t,t+1}^* \left[R_{k,t+1}^* - \frac{\phi_t - 1}{\phi_t} R_t^* \right] \right\} \quad (32)$$

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

Foreign productivity shock

We begin with analyzing the consequences of a positive, foreign productivity shock (Figure 2). In the medium term it has relatively standard consequences for the foreign economy – it raises investment and output, and lowers marginal cost and inflation. 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 follows closely that of the foreign economy, falling on impact and persistently expanding after the debt deflation effects have played out. This pattern is very similar when foreign ownership is assumed (solid lines), except that the higher rate of return on capital abroad generates a capital outflow from domestic retail banks. As a result, they reduce their balance sheets, the initial fall in investment is deeper and the path of output is below that under domestically owned banks.

Foreign capital quality shock

This shock, presented in Figure 3, 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 transferring capital abroad. As a result, the domestic finance premium increases, lending at home declines, and investment, labor and GDP drop. These cross-border capital transfers largely 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 the shock transmission occurs mainly via the trade channel.

Foreign monetary policy

Next, we look how the international transmission of monetary policy is affected by the foreign ownership of banks. Figure 4 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, labor 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 (23). Since we want to first focus on the effects of unsystematic policy, we keep the feedback coefficient φ_R^* at 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 0.05.⁸

⁸Admittedly, 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.

As shown in Figure (5), 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, labor 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 transferred 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 analyzed 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 depleted. 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 assets 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. 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 in Figure 6, 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.⁹ The size of the shock is chosen such that foreign

⁹A negative capital quality shock affects not only asset valuation, but also reduces the volume of physical capital. Therefore, it may be argued that this shock is not a good proxy for the origins of the recent financial crisis as no physical destruction of productive capital actually took place. However, as discussed by Gertler

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 7 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 finance premium at home on impact by a half.¹⁰

Absent any policy intervention, the magnitude of output collapse at home due to the crisis abroad is substantial, reaching 2%. As already discussed, such strong contagion is clearly related to foreign ownership of financial intermediaries as the parent banks withdraw around 6% of net worth from their subsidiaries operating at home. This generates a sharp increase in the domestic finance 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. Qualitatively 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 finance premium as the dividend policy, the amount of capital injection needs to be very high, or 12% 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 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

and Karadi (2011) in a closed economy setup, the effects of a negative capital quality shock are very similar to those generated by news that this shock is likely to hit during a couple of future periods, where the news never materializes. This means that the bulk of transmission of a capital quality shock is via asset prices rather than physical destruction of capital. This would also be the case in our scenario with cross-border flows, since the news shock generates an increase in the finance premium and, hence, would imply capital flows in the same direction as a capital quality shock.

¹⁰More specifically, this requires setting the feedback coefficients on the financial premium in rules (23) and (24) to the following values: $\varphi_R = 12.5$ and $\nu_R = 12700$. The steady state value of the special fund F is assumed to be zero as setting it to a (reasonable) positive number does not have significant effect on the outcomes presented in this section. 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. The plotted scenarios are based on second order approximation to the model equilibrium conditions as variation in $\kappa_{n,t}$ does not affect the model solution obtained under first order approximation.

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.

4.3 Foreign ownership and domestic shocks

So far we have analyzed the role that foreign ownership of banks plays in transmitting to the domestic economy shocks originating abroad. Now we look at how this ownership structure affects the response of the domestic economy to its own shocks. Our findings are quite diverse. For some domestic shocks, and similarly to the case of foreign shocks, foreign-owned banks play a destabilizing role. However, foreign ownership of banks may also have a strongly stabilizing effect on the domestic economy.

This is the case of negative shocks to the quality of domestic assets, which we present in Figure 8. This kind of shock destroys banking assets held domestically and causes a decline in net worth of domestic branches. Therefore, the return on capital and the finance premium increase, which prompts the parent bank to transfer net worth to its domestic branch. This transfer prevents a substantial decline of investment, which would have happened if banks were owned by home residents. As a result, the decline in output under foreign ownership is much smaller. Due to the asymmetry in the country size, this substantial stabilization of GDP in the domestic economy (the decline in output on impact is reduced from almost 1% to 0.3%) is achieved with little cost for the foreign country.

The effect of foreign ownership on the economy is quite different for productivity shocks.¹¹ After a negative domestic productivity shock the return on capital in the domestic economy falls, hence a net worth outflow follows, which results in a larger decline in GDP than without foreign ownership of banks. Additionally, foreign ownership limits the effectiveness of monetary policy. After a contractionary monetary policy shock, there is a net worth inflow that limits the decline in GDP and, to a lesser extent, of inflation.

5 Conclusions

This paper analyzes 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.

¹¹The figures with the impulse response functions for domestic productivity and monetary policy shocks are available upon request.

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.

We also 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. We also 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 transferred abroad. Hence, in a small economy with foreign bank ownership, such policy must be undertaken only jointly with a policy that prevents capital outflows.

Finally, we demonstrate that foreign ownership influences the transmission of domestic shocks. For instance, shocks that destroy banking capital are attenuated, as foreign banks recapitalize their domestic branches.

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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
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^*	0.43, 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	165	Steady-state cross-border flow of funds adjustment cost curvature
F	0	Steady-state size of recapitalization fund
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
d	0	Steady state foreign debt
ϱ	0.001	Elasticity of risk 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^*	0.0036, 0.0044	Standard deviation of productivity shocks
$corr(\varepsilon_t, \varepsilon_t^*)$	0.77	Cross-country correlation of productivity shocks

Table 2: Targeted data moments

	Value
Steady-state investment share	0.217
Steady-state bank leverage	4
Steady-state spread (annualized)	0.029
Standard deviation of output (home and foreign)	1.27, 1.46
Cross-country output correlation	0.7
Standard deviation of dividend payout ratio	11.2

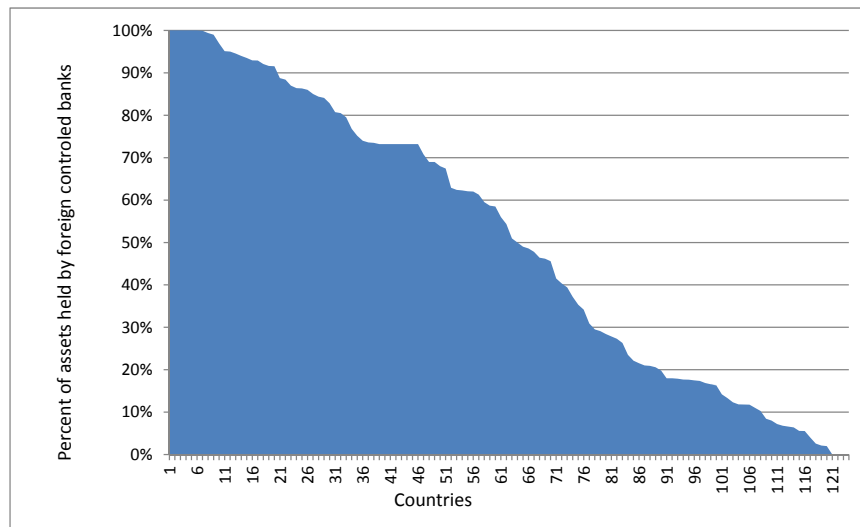
Note: The model-implied first moments are matched to average observations for the EA (source: Eurostat and ECB). The second moments for output are matched to HP-filtered quarterly series for Poland and the euro area (source: Eurostat). Annual data on the dividend payout (or dividend-to-profit) ratio in the Polish banking sector are taken from the KNF (Polish Financial Supervision Authority) and quadratically interpolated to quarterly frequency. All calculations are based on data covering the period 2002-2013, with 2009 excluded in the case of dividends.

Table 3: Non-targeted data moments for the home economy

	Data	Model
Standard Deviations		
Consumption	1.18	1.21
Investment	5.50	3.40
Employment	1.19	1.42
Correlations with GDP		
Consumption	0.67	0.74
Investment	0.83	0.87
Employment	0.69	0.11
Correlation with foreign counterpart		
Consumption	0.47	0.96
Investment	0.69	0.89
Employment	0.43	0.98

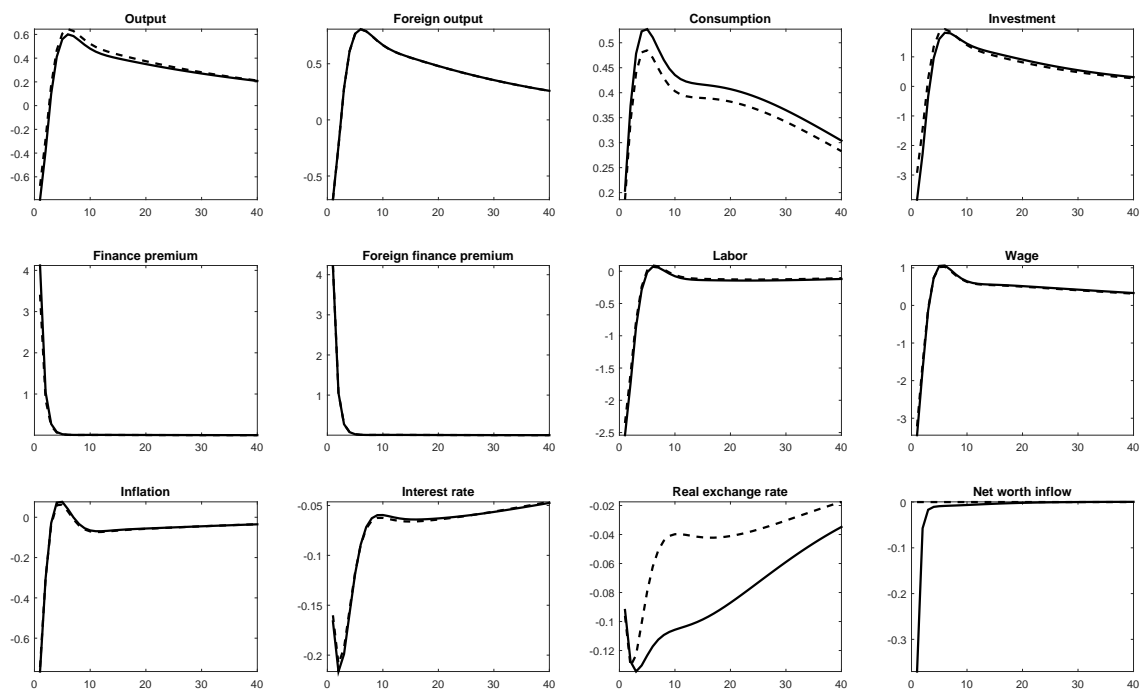
Note: The data moments are based on HP-filtered quarterly series for Poland over the period 2002-2013.

Figure 1: The share of assets held by foreign owned banks in banking sector assets.



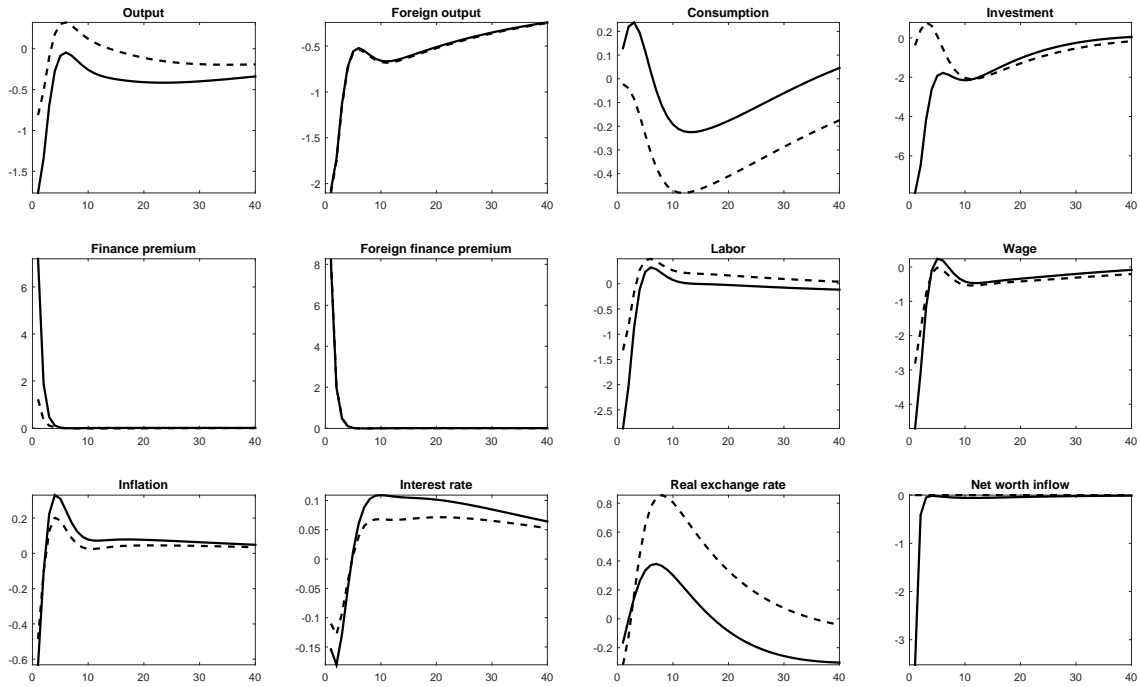
Source: Bank Regulation and Supervision Survey, World Bank,

Figure 2: Impulse responses to foreign productivity shock



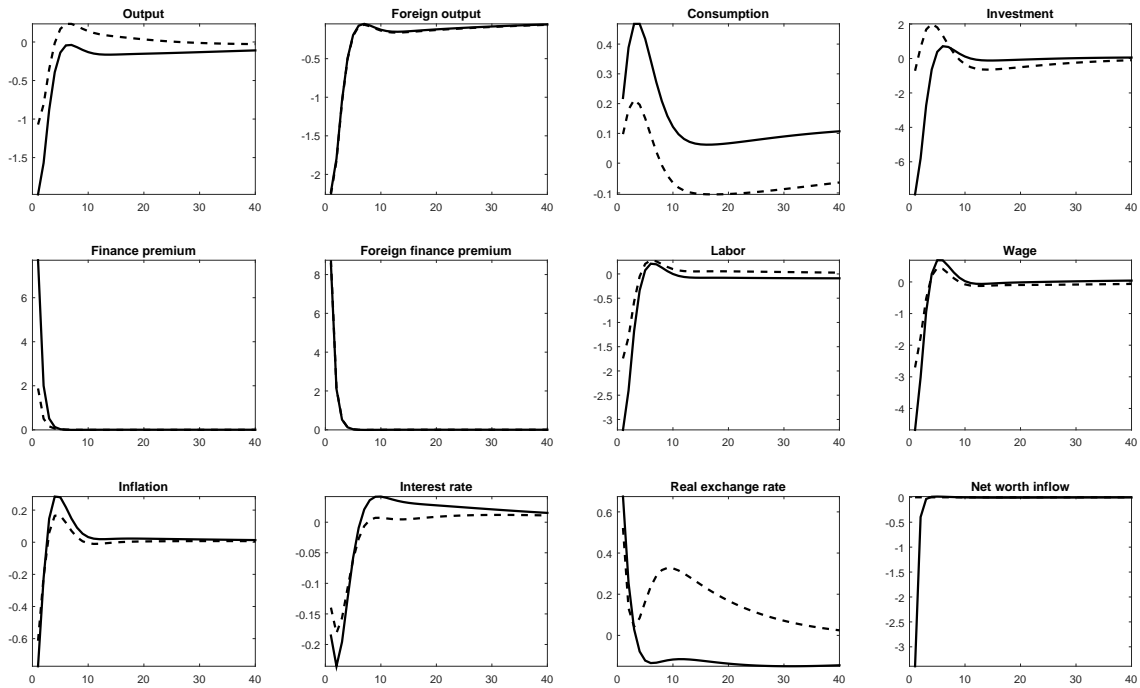
Note: solid line - baseline model; dashed line - model without foreign ownership.

Figure 3: Impulse responses to foreign capital quality shock



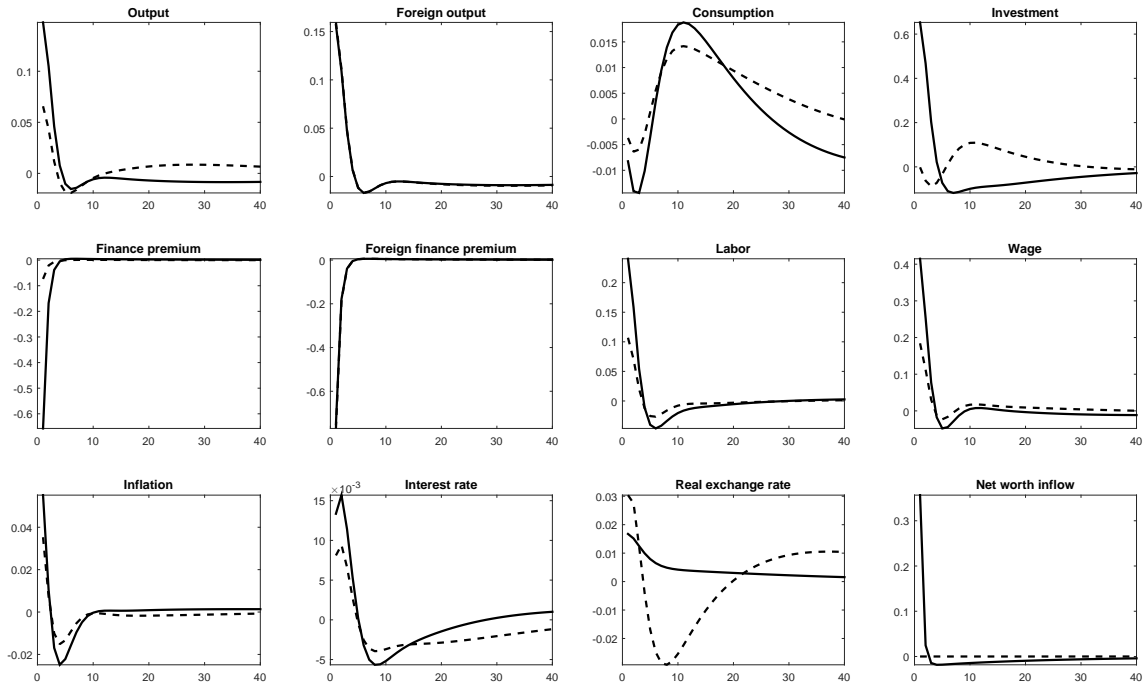
Note: solid line - baseline model; dashed line - model without foreign ownership.

Figure 4: Impulse responses to foreign monetary policy shock



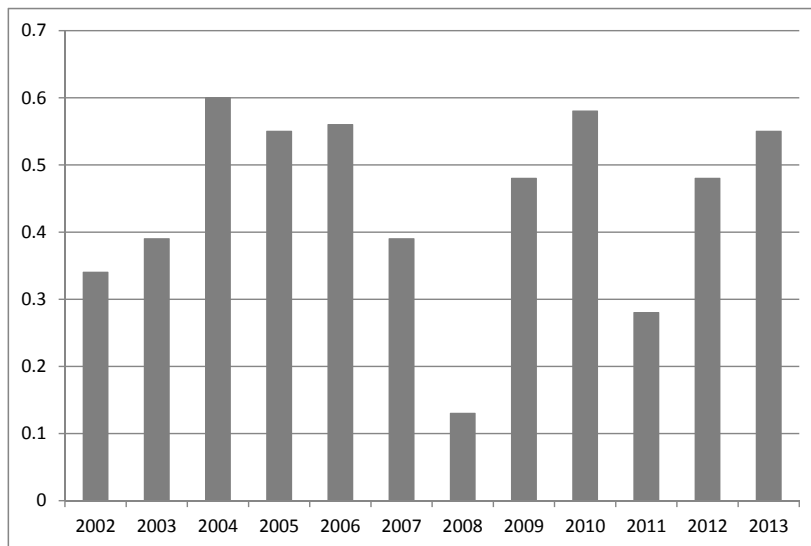
Note: solid line - baseline model; dashed line - model without foreign ownership.

Figure 5: Impulse responses to foreign capital injection shock



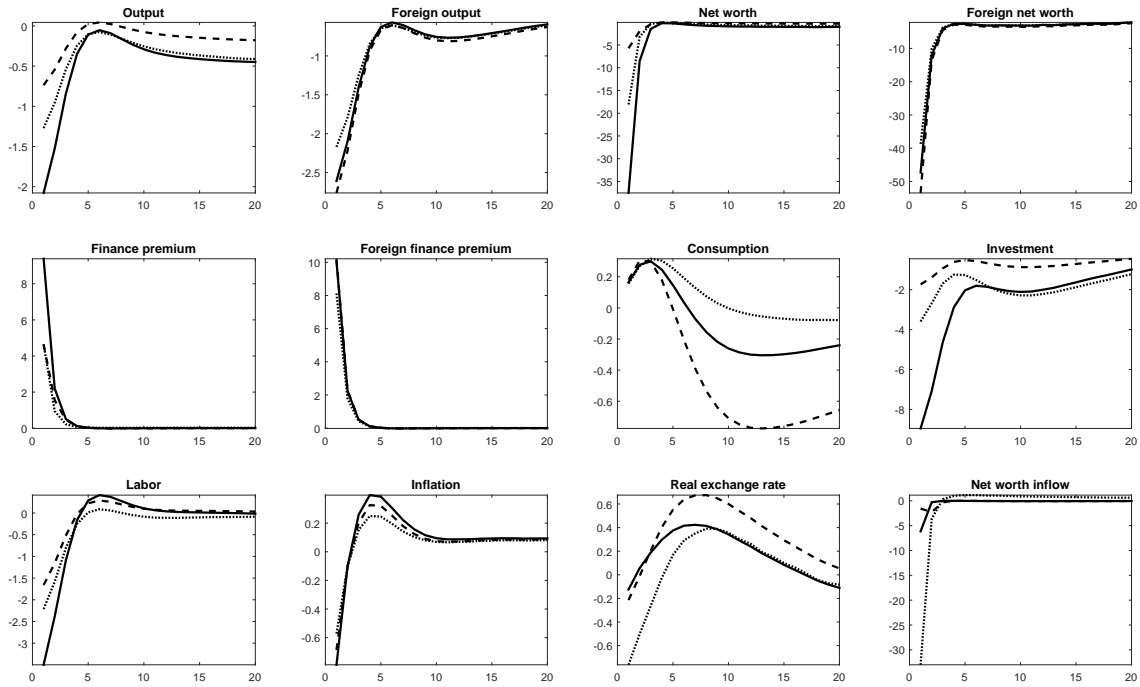
Note: solid line - baseline model; dashed line - model without foreign ownership.

Figure 6: Distributed profits of the Polish banking sector (share of total profits)



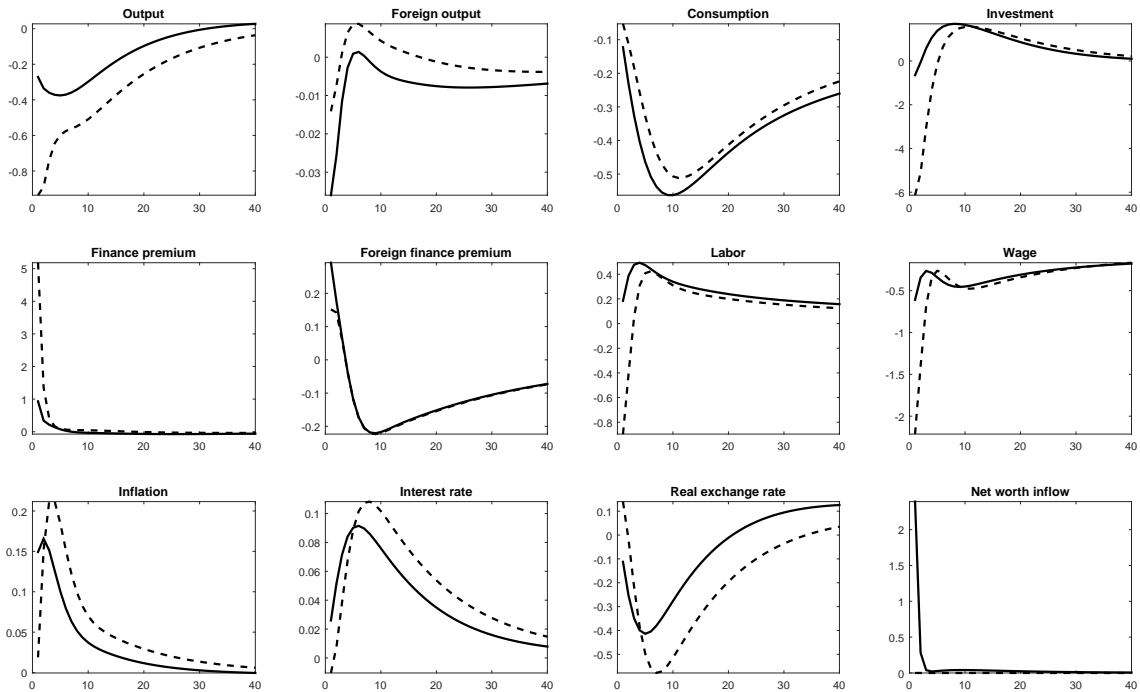
Source: Polish Financial Supervision Authority.

Figure 7: Foreign crisis scenario with and without regulatory policies in home economy



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

Figure 8: Impulse responses to domestic capital quality shock



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