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Financial Integration and International Shock Transmission – The Terms-of-Trade Effect

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WiSo-HH Working Paper Series
Working Paper No. 80
December 2023

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ISSN 2196-8128

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Financial Integration and International Shock Transmission – The Terms-of-Trade Effect*

Johanna Krenz†

December 22, 2023
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Abstract

What are the effects of financial integration on global comovement? Using a standard two-country DSGE model, I show that in response to country-specific supply shocks higher exposure to foreign assets leads to lower cross-country output correlations, while the opposite is true for country-specific demand shocks. I argue that an important, yet overlooked, transmission channel originates in the interplay between financial integration and terms of trade movements in response to the shocks hitting the economy. The transmission channel is independent of whether the agents who hold the foreign assets are financially constrained or not.

Keywords: Business cycle comovement, Financial cycle comovement, Financial integration, Demand versus supply shocks, Terms of trade, Transfer Problem, Balance sheet effect
JEL-Classification: E30, E44, F41, F44, G15

*I am very grateful for comments and suggestions by Michael Burda, Grzegorz Długoszek, Jean Imbs, Keith Küster, Giovanni Lombardo, Alexander Meyer-Gohde, Felix Strobel, Tommy Sveen, Lutz Weinke and Leopold Zessner-Spitzenberg. All errors are mine.
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1 Introduction

A classical question in international macro and finance is how the openness of financial markets affects the propagation of shocks between countries. Early contributions analyzing the transmission of technology shocks come to the conclusion that financial integration and output synchronization *correlate negatively* (e.g., Heathcote and Perri, 2004). With the experience of the Great Financial Crisis (GFC) of 2007-2008 and the subsequent Great Recession, the focus has shifted to the role of financial frictions. It has been shown that financial integration and output synchronization *correlate positively* when financial shocks drive the business cycle or when financially constrained intermediaries hold the assets (e.g., Kalemli-Ozcan et al., 2013a; Trani, 2015; Yao, 2019).

In this article, I argue that the distinction between supply and demand shocks is an important, yet overlooked, determinant of the sign of the correlation between financial integration and output synchronization. In particular, financial integration and business cycle synchronization correlate negatively in the presence of country-specific supply shocks and positively in the presence of country-specific demand shocks. Considering that technology shocks are supply side shocks, whereas financial shocks usually have stronger demand side effects, my results encompass previous findings.

My results are based on a standard two-country DSGE model, which features agents who hold risky claims on home and foreign capital.[1] Financial market integration is defined as the share of foreign assets in home agents' portfolios. Households consume home and foreign goods but preferences are biased towards home goods. In response to an adverse home supply shock,[2] the terms of trade appreciate as home producer prices increase relative to foreign producer prices. Therefore, real returns on foreign assets relative to real returns on home assets decrease, implying negative demand effects at home which are increasing in the share of foreign assets in the home portfolio. Because of home bias in consumption, negative demand effects amplify the initial drop in home output. At the same time, in the foreign economy, portfolio returns increase with financial integration, boosting demand for foreign goods and foreign output. Therefore, a higher share of foreign assets in a country's portfolio leads home and foreign output to diverge further. Contrary, in response to ad-

[1] In the benchmark version, the agents holding the portfolio are leverage-constrained financial intermediaries while in the alternative version they are standard households.

[2] As common in the literature, I distinguish supply and demand shocks by the cyclicality of inflation: supply shocks trigger a negative correlation between output and inflation while demand shocks trigger a positive correlation between the two variables. The supply shock I use is a technology shock.

verse home demand shocks,[3] real returns from foreign asset holdings exceed real returns from home asset holdings. Therefore, a larger share of foreign asset holdings causes a larger positive demand effect in the home economy, which attenuates the initial drop in home output. The opposite is true for the foreign economy. Hence, in the context of demand shocks, a higher share of foreign assets in a country's portfolio leads home and foreign output to be more correlated. In this model, the effect of financial integration on output comovement essentially hinges on income transfers between the home and the foreign economy, evoking terms of trade movements which either amplify (supply shock) or dampen (demand shock) the initial disturbance. This mechanism resembles the famous "Transfer Problem" discussed by Keynes (1929).

The effect of financial integration on the cross-country correlations of financial variables, such as net wealth and leverage, is also negative in the context of the supply shock. In the context of demand shocks, it depends on the nature of the specific demand shock, in particular, its repercussions in the home financial sector, whether financial integration has a positive, a negative or a non-monotonous effect on financial synchronization. Hence, in the model, the effects of financial integration on international business cycle comovement are not just reflecting its effects on financial sector comovement

With respect to the transmission channel I point out, I follow a well-trodden path in the macro-finance literature. However, to the best of my knowledge, I am the first to show that due to the terms-of-trade effect, financial integration and business cycle synchronization correlate negatively in the presence of supply shocks and positively in the presence of demand shocks. Notable examples of multiple-country DSGE models featuring this channel are Cole and Obstfeld (1991), who show that terms of trade movements provide an important insurance mechanism against supply shocks and, hence, explain very limited gains from risk-sharing through financial integration. Pavlova and Rigobon (2007) enrich this literature by demand shocks, showing that in the presence of the latter, terms of trade movements no longer provide full insurance against country-specific shocks, presenting a motive for international portfolio diversification. In Coeurdacier et al. (2010) and Khalil (2019) terms of trade effects play a role for cross-border portfolio diversification with respect to bond versus equity holdings. Pavlova and Rigobon (2008) show that constraints on international portfolio diversification increase cross-country comovement in stock prices when the latter are subject to country-specific shocks. Closest to my analysis is the study by Yao (2019) on the role of leveraged financial institutions for the international transmission of shocks. Here, opposing terms of trade movements explain the

[3] The model contains a variety of demand shocks, in particular, government spending, preference, monetary policy, net wealth (financial) and capital quality shocks.

different transmission of financial versus non-financial shocks.

Empirical studies on the relationship between financial integration and international synchronization are abundant and come to very different results regarding the sign of the correlation and the transmission channels at work, depending on the countries in the sample, the time period which is analyzed, the measurement of financial integration and the empirical methodology. [4] In an influential contribution, Kalemli-Ozcan et al. (2013a) split their sample into the subperiods 1978:q1 to 2007:q2 and 2007:q2 to 2009:q4 and find a significant negative association between cross-border banking linkages and output synchronization in the first subsample and a significant positive association in the second subsample. They conclude that financial integration increases business cycle correlations during financial crises. Considering that demand side disturbances where prevalent during the Great Recession (see, e.g., Mian and Sufi, 2014; Benguria and Taylor, 2020), my results suggest, that terms of trade effects also contributed to the positive correlation between financial integration and output synchronization during this episode. Direct support for the relevance of terms of trade effects in the context of international financial integration and business cycle synchronization comes from a study by Fidora et al. (2007). They show that about 20% of cross-country differences in bilateral portfolio holdings can be explained with differences in real exchange rate volatility.

My results deemphasize the role of financial frictions in the relationship between financial integration and sychronization. Accordingly, they challenge the widespread view that macroprudential measures aimed at internationally active financial institutions are well suited to tame the risks associated with financial integration (see, e.g., Rey, 2013). This is relevant, as the share of non-financial holders in total private international portfolio holdings has doubled over the last twenty years (see figure 1, graph (a)). This has been mainly driven by an increasing share of non-financial holders in total private equity holdings (graph (b)). In the EU this share has risen to almost 20%, and if we only consider integration within the EU, i.e., holder and issuer within the EU (not shown), it has increased even more, to over 30%.

The paper is organized as follows. The next section develops the model. Sec-

[4] E.g., Kose et al. (2003) conclude that more integration leads to more synchronization in industrialized countries whereas the opposite ist true in developing countries. Imbs (2010) supports the findings of Kose et al. (2003) for industrialized countries. However, Kalemli-Ozcan et al. (2013b) show that financial integration leads to a decoupling of business cycles when accounting for country-pair-fixed-effects. Davis (2014) finds opposing effects of financial integration on business cycle synchronization depending on whether debt market integration or equity market integration is considered. Cesa-Bianchi et al. (2018) show that financial integration promotes synchronization in the presence of country-specific shocks but lowers synchronization in the presence of common shocks (with heterogenous effects).

tion 3 provides the calibration. In section 4, I present and discuss the results. The final section concludes and gives an outlook.

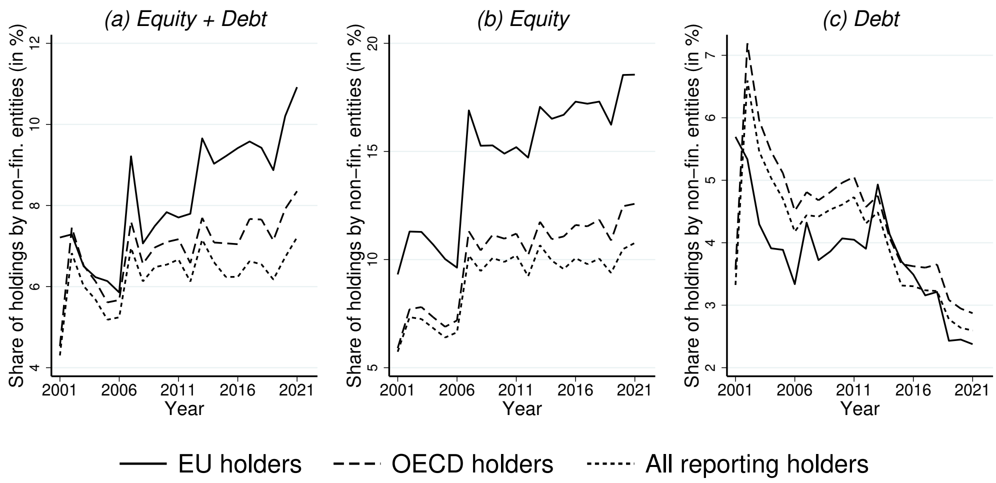

Figure 1: *Share of international portfolio holdings by households and non-financial corporations in total private holdings. The data comes from the Coordinated Portfolio Investment Survey (CPIS) by the International Monetary Fund (IMF). The sample includes all reporting holders which reported equity and debt holdings for the entire period, 2001-2021 and with a sectoral breakdown, which excludes the US. "All reporting holders" are 57 countries, "EU holders" are 23 countries and "OECD holders" are 33 countries. There are 243 issuing countries in the sample.*

2 Model

2.1 Overview

I assume that the world consists of two countries with symmetric structures, each inhabited by a continuum of agents of equal size. Each country features a financial intermediation sector which is modeled as in Dedola et al. (2013), which itself is an open economy version of Gertler and Karadi (2011). The role of intermediaries is to transfer funds between households and intermediate goods producers who use these funds to finance investment into physical capital. Intermediaries face an endogenously determined constraint on their leverage ratio, motivated by a simple agency problem which drives a wedge between saving and borrowing rates. This or slightly modified setups of the banking sector have been used in various accounts of the GFC (e.g., Devereux and Yetman, 2010; Kalemli-Ozcan et al., 2013a; Yao, 2019). Following this practice ensures comparability with existing literature.

The two-country version of the model developed in this paper features final goods market integration as well as asset and deposit market integration. Allowing the net foreign asset position to be adjusted via two margins - asset and bond trade - might imply two unit roots in a first-order approximation of the model (see, e.g., Schmitt-Grohé and Uribe, 2003). Hence, I introduce two stationarity inducing features, an endogenous discount factor, which dates back to Uzawa (1968), and a debt-elastic interest rate yield.

Integration of asset markets is modeled by assuming that financial intermediaries can channel funds to intermediate goods producing firms at home and abroad as in Dedola et al. (2013) and Carniti (2012). This introduces an endogenous portfolio choice problem as returns to assets are subject to country-specific risk. I address this problem using the procedure proposed by Devereux and Sutherland (2007; 2008; 2011). In the version without financial intermediaries, households directly hold the financial claims on intermediate goods producing firms at home and abroad. In order to motivate different degrees of portfolio diversification, I assume a second-order cost associated with the trade in risky assets. Therefore, international consumption risk sharing is, in general, incomplete, even if households hold the portfolio[5] and the number of shocks equals the number of tradable assets.

Each country produces a final good which is consumed by households in both countries and the domestic government. Furthermore, the final good is used in the production of domestic capital goods. Home bias in consumption leads to deviations from purchasing power parity and fluctuations in the real exchange rate.

The final good is costlessly assembled from a domestic intermediate good. The pricing of the final good is subject to a Calvo (1983) friction.

For simplicity only home country equations will be displayed. Foreign variables will be denoted with an asterisk.

2.2 Households

Within each household, there are two member types, workers and bankers. While the worker supplies work to final goods firms and deposits to banks, the banker manages a financial intermediary and transfers retained earnings back to her household when the lifetime of the bank ends. Within the family, there is perfect consumption risk sharing, which allows to maintain the representative agent framework. As in Gertler and Karadi (2011), it is assumed that a fraction

[5] In Krenz (2016) I show that that a portfolio chosen by financial intermediaries instead of households, in general, does not yield the highest possible degree of international consumption risk-sharing. A similar point is made by Maggiori (2017) on the basis of a continuous time model.

$1-f$ of household members are depositors, while a fraction f are bankers. Between periods there is a random turnover between the two groups: with probability θ_b a banker will stay a banker and with probability $1-\theta_b$ she will become a depositor. The relative proportions are kept fixed. New bankers are provided with some start-up funds from their respective households.

The lifetime utility of a representative home worker, who draws utility from consumption C_t and disutility from labor L_t, is given by

$$E_t \sum_{k=0}^{\infty} \Theta_{t+k} \zeta_{C,t} \frac{\left(C_{t+k} - \chi \frac{L_{t+k}^{1+\phi}}{1+\phi}\right)^{1-\gamma} - 1}{1-\gamma},$$

with γ, χ, $\phi > 0$. Variable Θ_t is the endogenous discount factor of households chosen to ensure stationarity as explained below. Variable $\zeta_{C,t}$ denotes a preference shock. A positive innovation in $\zeta_{C,t}$ reflects a temporary increase in the subjective discount factor of the household and, hence, a negative shock to private demand. The functional form of utility follows Greenwood et al. (1988) and implies non-separability between consumption and leisure. As can be directly seen from first-order condition (1), under this assumption, the marginal rate of substitution between consumption and labor is independent of consumption. This eliminates the wealth effect on labor supply, i.e., labor becomes independent of the consumption dynamics. These so-called GHH (Greenwood-Hercowitz-Huffman) preferences are commonly used in the open economy business cycle literature, at first, mostly for technical reasons, however, Schmitt-Grohé and Uribe (2012) show that GHH preferences are also supported by the data over other forms of preferences.

Households save by depositing funds at domestic and foreign banks (see 2.3 for details). Total deposits held between $t-1$ and t, denoted by D_{t-1}, are equivalent to one-period riskless real bonds paying the gross real rate of return R_{t-1}. Furthermore, households provide labor to final goods firms and receive the real wage w_t. Hence, the home household's budget constraint is given by

$$C_t + D_t = R_{t-1} D_{t-1} + w_t L_t + NP_t + T_t,$$

where NP_t denotes net profits from the ownership of firms (financial and non-financial) and T_t are lump-sum taxes.

Households consume home and foreign final goods. Their CES composite of consumption, C_t, is given by

$$C_t = \left(\mu_c^{\frac{1}{\iota}} C_{H,t}^{\frac{\iota-1}{\iota}} + (1-\mu_c)^{\frac{1}{\iota}} C_{F,t}^{\frac{\iota-1}{\iota}}\right)^{\frac{\iota}{\iota-1}},$$

with $C_{H,t}$ and $C_{F,t}$ denoting consumption of the home and the foreign final goods, respectively. Parameter $0 < \mu_c < 1$ denotes the degree of home bias in consumption and $\iota > 0$ the elasticity of substitution between home and foreign goods. The assumption of home bias in consumption is a common shortcut of accounting for the presence of non-tradable goods. The corresponding consumer price index takes the following form:

$$P_t = \left(\mu_c P_{H,t}^{1-\iota} + (1-\mu_c) P_{F,t}^{1-\iota}\right)^{\frac{1}{1-\iota}},$$

where $P_{H,t}$ denotes the price of the home good in the home country and $P_{F,t}$ denotes the price of the foreign good in the home country.

Assuming producer currency pricing, the law of one price holds i.e., $P_{H,t} = s_t P^*_{H,t}$ and $P_{F,t} = s_t P^*_{F,t}$, where s_t is the nominal exchange rate. However, as long as households prefer domestically produced goods over foreign goods, i.e., $\mu_c > 0.5$, Purchasing Power Parity does not hold and the real exchange rate, defined as $\text{RER}_t = \frac{s_t P^*_t}{P_t}$, fluctuates. The terms of trade, defined as the price of foreign consumption goods relative to the price of home consumption goods, are given by $\text{ToT}_t = \frac{P_{F,t}}{P_{H,t}}$. Given the assumed production structure, real exchange rate movements are generally proportional to terms of trade movements.[6]

The endogenous discount factor is determined as follows

$$\begin{aligned} \Theta_{t+1} &= \Theta_t \beta(C_{A,t}), \\ \Theta_0 &= 1, \end{aligned}$$

where $C_{A,t}$ is aggregate home consumption. Using aggregate consumption in the endogenous discount factor ensures that the household does not internalize the effect of her consumption decision on the discount factor, which simplifies calculations considerably (cf. Schmitt-Grohé and Uribe, 2003). As in Schmitt-Grohé and Uribe (2003) and Devereux and Yetman (2010) the following functional form of the endogenous discount factor is assumed

$$\beta(C_{A,t}) = \omega_c (1 + C_{A,t})^{-\eta_c}.$$

Parameter η_c drives the elasticity of the discount factor with respect to consumption. It is chosen to be small, to keep the effects of this purely technical feature on the results of the model negligible. Parameter ω_c captures the steady state savings propensity. Note that the discount factor decreases in $C_{A,t}$, i.e.,

[6] In particular, real exchange rate movements are positively proportional to terms of trade movements if $0.5 < \mu_c < 1$ and negatively proportional if $0 < \mu_c < 0.5$ (for a derivation of this relationship see, e.g. Heathcote and Perri, 2002).

whenever a country has relatively higher consumption in the present, it discounts future consumption more heavily and, hence, saves less. The latter implies lower consumption in the future and, therefore, the economy returns to the initial state.

Hence, the household's first-order conditions for the optimal choice of labor and consumption are given by

$$w_t = \chi L_t^{\phi}, \tag{1}$$

and

$$1 = \beta(C_{A,t})\zeta_{C,t} E_t \lambda_{t,t+1} R_t,$$

with the household's real stochastic discount factor defined as

$$\lambda_{t,t+1} \equiv \frac{\lambda_{t+1}}{\lambda_t},$$

where λ_t denotes the marginal utility of consumption given by

$$\lambda_t = \left(C_t - \chi \frac{L_t^{1+\phi}}{1+\phi} \right)^{-\gamma}.$$

2.3 International Intermediaries

To simplify matters, I implicitly assume that households hold their deposits with savings banks which – according to the needs in the financial system – channel the funds to home and foreign banks via international intermediaries. It should be noted, that these intermediaries are not a maximizing agent, but a means to motivate the given setup of the deposit market. Total deposits of home households are given by $D_t = D_{H,t} + D_{F,t}$.

Allowing deposits to freely flow between countries, would induce a unit root. Therefore, it is assumed that home deposits can only be channeled to foreign banks by purchasing one-period bonds from international intermediaries. The latter charge a small interest rate premium on the real interest rate, hence, home and foreign deposits rates are only imperfectly correlated. The premium depends on the real net foreign bond position of the respective country (see, e.g., Hjortsoe, 2016). It reflects that a country's default risk increases in its external debt. This assumption adds realism to the model and ensures stationarity (see, e.g., Schmitt-Grohé and Uribe, 2003). As in Hjortsoe (2016), I assume

$$R_t = \frac{\mathrm{RER}_{t+1}}{\mathrm{RER}_t} R_t^* \Phi(D_{F,t}), \tag{2}$$

where R^*_t is the foreign real riskless rate of return. It is assumed that the country-specific rate charged by international intermediaries is increasing in the deviation of the external household debt position (real debt is given by $-D_{F,t}$) from its steady state, i.e., $\Phi(\cdot)' < 0$ and $\Phi(0) = 0$. As in Hjortsoe (2016), the following functional form is chosen for the debt-elastic interest rate premium

$$\Phi(D_{F,t}) = (1 - \omega_d D_{F,t}).$$

Parameter ω_d, the yield sensitivity of debt, is chosen to be small, to keep the effects of this feature on the results of the model small. For technical reasons, profits of international intermediaries are redistributed lump-sum to households in the current account surplus country.

2.4 Banks

The setup of the banking sector closely follows Dedola et al. (2013). In the model economy, home financial intermediaries channel funds from home and foreign households to home and foreign intermediate goods producers, fulfilling the double role of investment as well as commercial banks. In addition to obtaining funds from households, banks also raise funds internally by accumulating retained earnings. The balance sheet of home bank i is given by

$$Q_t S_{iH,t} + \mathrm{RER}_t Q^*_t S_{iF,t} = D^B_{i,t} + N_{i,t},$$

where Q_t ($\mathrm{RER}_t Q^*_t$) denotes the price of the home (foreign) capital asset in terms of home consumption. Deposits at bank i, stemming from home and foreign households, are denoted by $D^B_{i,t} = D_{iH,t} + D^*_{iH,t}$. Variables $S_{iH,t}$ and $S_{iF,t}$ denote state-contingent claims on future returns of a unit of capital used in final goods production in the home or foreign country, respectively. Both claims are expressed in terms of the home consumption good. The corresponding gross real rates of return are given by $R_{k,t}$ and $\mathrm{RER}_t R^*_{k,t}$, respectively. Intermediary i's net worth is given by $N_{i,t}$. It evolves according to the following equation:

$$N_{it} = R_{k,t} Q_{t-1} S_{iH,t-1} + \mathrm{RER}_t R^*_{k,t} Q^*_{t-1} S_{iF,t-1} - R_{t-1} D^B_{i,t-1}.$$

As can be seen from the equation above, any growth in banks' equity capital above the riskless rate depends on the premia $R_{k,t} - R_{t-1}$ and $\frac{\mathrm{RER}_t}{\mathrm{RER}_{t-1}} R^*_{k,t} - R_{t-1}$ and on the quantity of assets. Financial intermediaries cannot fund assets with an expected discounted premium below zero. In a frictionless financial market, risk-adjusted premia would always be zero. In this model, due to the presence of a leverage constraint, the spread is positive. As will be seen later, it covaries negatively with GDP, as banks' inability to obtain funds increases during bad states of the economy.

As it is assumed that each period a fraction 1-θ_b of bankers exits the business with i.i.d. probability and pays out accumulated earnings to their respective households,[7] a banker maximizes the terminal value of her net worth given by

$$V_t = \max\ E_t \sum_{k=0}^{\infty} (1-\theta_b)\theta_b^k \Theta_{t+k} \Lambda_{t,t+k+1} N_{i,t+k+1}.$$

To motivate the requirement to build up net worth, the following moral hazard problem is assumed: At the beginning of each period, before the shocks realize and any other transactions take place, the banker can choose to divert the fraction λ_b of available funds back to the household. The cost associated with this fraud is that the depositors recover the remaining fraction $1-\lambda_b$ and force the banker into bankruptcy. Therefore, for households to be willing to deposit funds with the bank, the following incentive constraint must hold

$$V_{i,t} \geq \lambda_b B_{i,t},$$

with $B_{i,t} \equiv Q_t S_{iH,t} + \mathrm{RER}_t Q_t^* S_{iF,t}$ denoting total bank assets. To solve the banker's maximization problem define the objective of the bank recursively as

$$V_{i,t} = \max\ E_t \beta(C_{A,t}) \Lambda_{t,t+1} [(1-\theta_b) N_{i,t+1} + \theta_b V_{i,t+1}],$$

and conjecture that the value function is linear in assets and net worth:

$$V_{i,t} = \nu_{iH,t} Q_t S_{iH,t} + \nu_{iF,t} \mathrm{RER}_t Q_t^* S_{iF,t} + \eta_{i,t} N_{i,t}.$$

The banker's problem consists in choosing the amount of home assets, $S_{iH,t}$, foreign assets, $S_{iF,t}$ and deposits $D_{i,t}^B$ such that terminal net worth is maximized and the incentive constraint holds. It can be solved using the Lagrange method.

The solutions for the coefficients are given by

$$\begin{aligned}
\nu_{H,t} &= E_t \Omega_{t+1} (R_{k,t+1} - R_t) \\
\nu_{F,t} &= E_t \Omega_{t+1} \left(\frac{\mathrm{RER}_{t+1}}{\mathrm{RER}_t} R_{kt+1}^* - R_t \right) \\
\eta_t &= E_t \Omega_{t+1} R_t,
\end{aligned}$$

where

$$\Omega_{t+1} = \beta(C_{A,t}) \zeta_{C,t} \Lambda_{t,t+1} \left[(1-\theta_b) + \theta_b \left(\eta_{t+1} + \nu_{t+1} \phi_{t+1} \right) \right],$$

[7] This arrangement precludes bankers from aggregating so much net worth that the incentive constraint becomes irrelevant for them.

which can be interpreted as the stochastic discount factor of the banker. It differs from the household's stochastic discount factor due to the presence of financial frictions (cf. Maggiori, 2017). Note that the subscript i was dropped as the coefficients exclusively depend on aggregate variables.

A further first-order condition is given by

$$\nu_{H,t} = \nu_{F,t} \equiv \nu_t \quad \Leftrightarrow \quad E_t \Omega_{t+1} R_{k,t+1} = E_t \Omega_{t+1} \frac{\mathrm{RER}_{t+1}}{\mathrm{RER}_t} R^*_{k,t+1}. \tag{3}$$

It is the first-order condition relevant for optimal portfolio choice and implies an alignment of capital return in the two countries, as will be explained further in section 2.12.

Assuming that the incentive constraint binds,[8] it can be expressed in terms of the coefficients of the value function

$$B_t = \frac{\eta_t}{\lambda_b - \nu_t} N_t = \phi_t N_t,$$

where $B_t \equiv Q_t S_{H,t} + \mathrm{RER}_t Q^*_t S_{F,t}$ are banks' assets and ϕ_t is the ratio of intermediated assets to net worth, which can be referred to as the leverage ratio. Note that it is determined endogenously in this model.

Finally, the law of motion for aggregate net worth can be derived as

$$\begin{aligned}
&N_t = N_{n,t} + N_{e,t}\,\varepsilon_{N,t}, \text{ with}\\
&N_{e,t} = \theta_b \left[\left((R_{k,t} - R_{t-1}) - \frac{\mathrm{RER}_{t-1} Q^*_{t-1} S_{F,t-1}}{B_{t-1}} (R_{k,t} - \frac{\mathrm{RER}_t}{\mathrm{RER}_{t-1}} R^*_{k,t}) \right) \phi_{t-1} + R_{t-1} \right] N_{t-1},\\
&N_{n,t} = \omega_b [Q_{t-1} S_{H,t-1} + \mathrm{RER}_{t-1} Q^*_{t-1} S_{F,t-1}],
\end{aligned}$$

where $N_{e,t}$ denotes existing bankers' net worth, $N_{n,t}$ denotes new bankers' net worth and ω_b is the fraction of the assets given to new bankers by their households. Variable $\varepsilon_{N,t}$ denotes an exogenous disturbance to the net worth of existing bankers.

2.5 Intermediate Goods Firms

Intermediate goods firms sell their products to final goods producers in the same country. The Cobb-Douglas production function of the representative intermediate goods firm is given by

$$Y_{m,t} \quad = \quad A_t (\Psi_t K_{t-1})^{\alpha} L_t^{1-\alpha}, \tag{4}$$

[8]Parameters and steady state values are chosen such that the incentive constraint binds in the steady state. Holding the variance of shocks small enough guarantees that the incentive constraint also binds in a stochastic environment.

where $Y_{m,t}$ denotes intermediate output and A_t exogenous technology. Parameter α denotes the output elasticity of capital. Labor L_t is provided by households in the same country only. Capital K_{t-1} was bought from capital goods producers in the same country in the previous period at price Q_{t-1}. To finance capital purchases, the firm issues state-contingent securities to obtain funds from home and foreign intermediaries at the same price. Each period, after being productive, the firm has to pay back capital returns on the securities issued in the previous period. As originally introduced by Gertler and Kiyotaki (2010), I assume that there exists a shock to the quality of capital, denoted by Ψ_t. It can be interpreted as the sudden realization that much of the capital installed is of lower quality than previously thought. The law of motion for capital is given by

$$K_t = I_t + (1-\delta)\Psi_t K_{t-1}, \tag{5}$$

where I_t is aggregate investment and δ denotes physical depreciation.

As can be seen from equations (4) and (5), a shock to the quality of capital affects the model in various ways: Firstly, it has an effect on production similar to a technology shock. Secondly, through the law of motion for capital, it is a source for exogenous variations in the price of capital. Thirdly, as the capital stock is equal to the capital claims issued to banks, banks' balance sheets contract in response to a negative capital quality shock. In the latter sense, the capital quality shock resembles a financial shock. In the model version without banks, where households hold the capital claims, it is a shock to household wealth.

The first-order conditions of the intermediate goods producer's profit maximization problem are, therefore, given by[9]

$$R_{k,t+1} = \frac{\alpha \frac{P_{M,t+1} Y_{m,t+1}}{K_t} + (Q_{t+1}-\delta)\Psi_{t+1}}{Q_t},$$

and

$$w_t = (1-\alpha)\frac{P_{M,t} Y_{m,t}}{L_t},$$

where $P_{M,t}$ is the price of intermediate goods output in terms of final goods output. The firm earns zero profits state-by-state, hence, it simply pays out the ex post return to capital, $R_{k,t}$, to financial intermediaries.

[9]As in Gertler and Karadi (2011), I assume that the replacement price of depreciated capital is unity. Therefore, the value of the capital stock which is left over is given by $(Q_{t+1}-\delta)\Psi_{t+1}K_t$.

2.6 Capital Goods Firms

Competitive capital goods firms produce new capital only for the domestic market using national final output as input, facing investment adjustment costs (in consumption units). I follow the approach used by Gertler and Karadi (2011) and assume that adjustment costs are on net investment so that the capital utilization decision is independent of the market price of capital. Their functional form is given by

$$f\left(\frac{I_{n,t}+I}{I_{n,t-1}+I}\right) = \frac{\eta_I}{2}\left(\frac{I_{n,t}+I}{I_{n,t-1}+I}-1\right)^2,$$

with $\eta_I > 0$, denoting the inverse elasticity of net investment with respect to price of capital, I denoting steady-state investment and net investment being defined as $I_{n,t} \equiv I_t - \delta(U_t)\Psi_t K_{t-1}$. The capital goods producer chooses I_t to maximize lifetime profits given by

$$E_t \sum_{k=0}^{\infty} \Theta_k \zeta_{C,t} \Lambda_{t,t+k}\left\{(Q_{t+k}-1)I_{n,t+k} - f\left(\frac{I_{n,t+k+1}+I}{I_{n,t+k}+I}\right)(I_{n,t+k}+I)\right\}.$$

From the first order conditions, the real price of one unit of capital is obtained,

$$Q_t = 1 + f(\cdot) + \frac{I_{n,t}+I}{I_{n,t-1}+I} f'(\cdot) - E_t \beta(C_{A,t})\zeta_{C,t}\Lambda_{t,t+1}\left(\frac{I_{n,t+1}+I}{I_{n,t}+I}\right)^2 f'(\cdot).$$

Due to flow investment costs, capital goods firms can earn profits outside the steady state. These profits are distributed lump-sum to the households.

2.7 Final Goods Firms

Final output produced by home firms and purchased by consumers at home and abroad, Y_t, is assumed to be a CES composite of mass unity of differentiated final products,

$$Y_t = \left(\int_0^1 Y_t(h)^{\frac{\epsilon-1}{\epsilon}} dh\right)^{\frac{\epsilon}{\epsilon-1}},$$

with $0 < \epsilon$. $Y_t(h)$ denotes output by retailer h. The corresponding home producer price index is given by

$$P_{H,t} = \left(\int_0^1 P_{H,t}(h)^{1-\epsilon} dh\right)^{\frac{1}{1-\epsilon}}$$

Given that consumers allocate consumption expenditures optimally between varieties, home final goods firm h faces the following demand by home and foreign consumers[10]

$$Y_t(h) = \left(\frac{P_{H,t}(h)}{P_{H,t}}\right)^{-\epsilon} Y_t,$$

i.e., its share in total home final goods production, Y_t, depends on its relative price.

It is assumed that each unit of final output is assembled costlessly from one unit of intermediate output. Real marginal cost is therefore given by the intermediate output price $P_{m,t}$. It is further assumed that firms face a positive probability, σ, each period that they are not able to reset their price (Calvo-style pricing). Hence, the optimal price of firm h, $\tilde{P}_{H,t}$ is given by

$$\tilde{P}_{H,t} = \frac{\epsilon}{\epsilon - 1} \frac{E_t \sum_{k=0}^{\infty} \sigma^k \Theta_k \lambda_{t+k} \Pi^{\epsilon}_{H,t,t+k} Y_{t+k}}{E_t \sum_{k=0}^{\infty} \sigma^k \Theta_k \lambda_{t+k} \Pi^{\epsilon-1}_{H,t,t+k} Y_{t+k} p_{H,t+k}} P_{H,t},$$

where $\Pi_{H,t} \equiv \frac{P_{H,t}}{P_{H,t-1}}$ denotes home producer price inflation between $t-1$ and t and $p_{H,t} \equiv \frac{P_{H,t}}{P_t}$ is the relative price of home goods. The dynamics of the home price index are given by

$$P_{H,t} = \left(\sigma P^{1-\epsilon}_{H,t-1} + (1-\sigma) \tilde{P}^{1-\epsilon}_{H,t}\right)^{\frac{1}{1-\epsilon}}.$$

2.8 Monetary Policy

Monetary policy is specified by a simple and standard Taylor rule. It is assumed that the home central bank reacts to variations in the home output gap and home consumer price inflation (CPI). CPI targeting is chosen, because it represents a better description of actual Taylor rules used in central banks following inflation targeting strategies (Devereux et al., 2014). The particular Taylor rule of the home country's central bank is given by

$$i_t = (\beta^{-1} \Pi_t^{\gamma_\Pi} \hat{y}_t^{\gamma_y})^{(1-\rho_r)} i_{t-1}^{\rho_r} \varepsilon_{M,t},$$

where i_t denotes the nominal policy rate, $\hat{y}_t$ denotes the output gap, defined as the difference between flexible price output and sticky price output. The output gap is approximated by the inverse of the markup gap. Consumer price inflation between periods $t-1$ and t is denoted by $\Pi_t \equiv \frac{P_t}{P_{t-1}}$ and $\varepsilon_{M,t}$ is an exogenous disturbance to monetary policy. Parameter ρ_r denotes the degree of interest rate smoothing and γ_y and γ_Π denote the reaction coefficients with respect to output gap and inflation, respectively.

[10]Under the assumption of producer currency pricing (law of one price holds), a distinction between home and foreign demand is not necessary.

The following Fisher equation establishes the link between the policy rate and the real interest rate

$$i_t = R_t E_t \Pi_{t+1}.$$

2.9 Government

For the sake of introducing an additional demand shock, I assume wasteful government consumption. It has to hold that government spending is equal to lump-sum taxes at all times, i.e., $G_t = T_t$. It is assumed that government spending, G_t, follows a stochastic process, fluctuating around its steady state value, $G = gY$, where g denotes the steady state government spending share.

2.10 Further Equilibrium Conditions

The model equilibrium is further characterized by the international capital market clearing condition, an international goods market clearing condition and the home and foreign aggregate resource constraints.

The international capital market clearing condition states that the current value of total capital installed in both countries has to be equal to the total value of state contingent claims on future returns of capital held by home and foreign banks

$$Q_t K_t + \mathrm{RER}_t Q_t^* K_t^* = Q_t (S_{H,t} + S_{H,t}^*) + \mathrm{RER}_t Q_t^* (S_{F,t} + S_{F,t}^*).$$

Final goods market clearing in the home economy is given by

$$Y_t = G_t + C_{H,t} + C_{H,t}^* + \frac{P_t}{P_{H,t}} \left(I_t + f\left(\frac{I_{n,t} + I}{I_{n,t-1} + I}\right)(I_{n,t} + I) \right).$$

The home aggregate resource constraint is derived from the aggregation of the budget constraint over home households, considering profits from the ownership of non-financial firms, retained earnings from exiting bankers and the transfer to new bankers

$$\begin{aligned}
&\frac{P_{H,t}}{P_t} Y_t + Q_{t-1}^* S_{F,t-1} R_{k,t}^* - Q_{t-1} S_{H,t-1}^* R_{k,t} + D_{F,t-1} R_{t-1} + \Upsilon_t^{\mathrm{IFI}} \\
&\quad = C_t + D_{F,t} + I_t + f\left(\frac{I_{n,t} + I}{I_{n,t-1} + I}\right)(I_{n,t} + I) + Q_t^* S_{F,t} - Q_t S_{H,t}^*,
\end{aligned}$$

where $\Upsilon_t^{\mathrm{IFI}} = \left(\frac{\mathrm{RER}_{t+1}}{\mathrm{RER}_t} R_t^* - R_t\right) D_{F,t}$ denotes international intermediaries' profits.

Furthermore, the relationship between final goods production and intermediate goods production characterizes the equilibrium

$$Y_{m,t} = Y_t \Delta_{p,t},$$

with $\Delta_{p,t}$ denoting price dispersion which arises in a model with a two-stage production process with intermediate and final good producers and sticky prices. It can be written in terms of producer price inflation,

$$\Delta_{p,t} = \sigma \Delta_{p,t-1} \Pi_{H,t}^{\epsilon} + (1-\sigma) \left(\frac{1-\sigma \Pi_{H,t}^{\epsilon-1}}{1-\sigma} \right)^{\frac{\epsilon}{\epsilon-1}}.$$

2.11 Model Version Without Banks

To be able to analyze the role of financial frictions for the cross-country transmission of shocks, I need a version of the model without financial frictions. In this version, I assume that households can directly hold capital assets at home and abroad. This assumption also gives rise to a portfolio choice problem and a similar portfolio choice equation emerges as in the problem with banks,

$$E_t \Lambda_{t+1} R_{k,t+1} = E_t \Lambda_{t+1} \frac{\text{RER}_{t+1}}{\text{RER}_t} R_{k,t+1}^*, \tag{3'}$$

the only difference to equation (3) being the stochastic discount factor, which is now the one of the household.

Without a financial friction, by arbitrage, $R_{k,t}$ is equalized to R_t and $R_{k,t}^*$ is equalized to R_t^*. Hence, for technical reasons, the model without financial intermediaries does not feature deposit market integration.

The remaining parts of the model are the same as in the model with banks.

2.12 Determination of International Portfolio Holdings

I define the degree of international financial integration as

$$\alpha_t^P \equiv \frac{\text{RER}_t Q_t^* S_{F,t}}{Q_t S_{H,t} + \text{RER}_t Q_t^* S_{F,t}},$$

i.e., the share of foreign capital holdings in home banks' portfolios. Recall home banks' first-order condition for the choice of home and foreign assets,

$$E_t \Omega_{t+1} R_{k,t+1} = E_t \Omega_{t+1} \frac{\text{RER}_{t+1}}{\text{RER}_t} R_{k,t+1}^*. \tag{3}$$

Evaluated in the non-stochastic steady state, this equation becomes

$$R_k = R_k^*,$$

and, approximated up to first order,

$$E_t R_{k,t+1} \approx E_t(\mathrm{RER}_{t+1} - \mathrm{RER}_t + R_{k,t+1}^*).$$

Hence, in the steady state and evaluated up to first-order, both assets pay the same return when expressed in terms of the same consumption good. This implies that all possible compositions of banks' portfolios, i.e., all possible values of α_t^P, pay the same return in the non-stochastic steady state and in expectations, evaluated up to first order. Therefore, international portfolio choice is indeterminate up to first-order accuracy. The economic intuition behind this indeterminacy problem is that the two capital assets are only distinguishable in terms of their risk characteristics which can only be captured with an approximation of second-order or higher (Devereux and Sutherland 2007; 2008; 2011). However, it can be shown that only the steady state portfolio share, i.e., α^P, matters for the (first-order) dynamics of the remaining variables (Devereux and Sutherland 2007; 2008; 2011). Note that, due to symmetry, in the steady state $\alpha^P = \alpha^{P*}$, i.e., the share of foreign capital holdings in home banks' portfolios is equal to the share of home capital holdings in foreign banks' portfolios. Using these insights, the model can be solved at first-order accuracy. In practice, this can be done by, first, rewriting the relevant equations in terms of α_t^P and α_t^{P*} and such that α_t^P and α_t^{P*} always appear in a product with excess returns, $R_{k,t} - \frac{RER_t}{RER_{t-1}} R_{k,t}^*$, and then replacing α_t^P and α_t^{P*} by α^P.

Various local and global methods have been proposed to solve for the *optimal*[11] steady state portfolio. Optimal steady state portfolio shares depend very much on specific model features (for a good overview see, e.g., Coeurdacier and Rey, 2012) and the calibration of the model, especially the calibration of the stochastic environment. For example, changing the ratio between the variances of different shocks within an empirically plausible range or adding an additional shock might imply a very different portfolio composition. As I am interested in the question how the degree of financial integration affects international shock transmission I refrain from setting up the model in a way that it generates optimal portfolio holdings which match realistic values on international portfolio holdings. Instead, I follow another path to target values of α^P in the range of 0 and 1,[12] which is quite common in the literature. In particu-

[11]In this context, "optimal" refers to the portfolio composition which maximizes international consumption-risk-sharing.

[12]Note that mathematically α^P can take on values < 0 or > 1, whenever $Q^* S_F$, QS_H, $Q^* S_F^*$ or QS_H^* take on very large values or values < 0. Such values, however, would be economically meaningless and are therefore excluded.

lar, I assume that agents face a cost when trading assets internationally. Such costs reflect, e.g., transaction costs, regulatory policies or differences in taxation. Note that they affect the first-order dynamics of the model only insofar as they affect the portfolio composition and, thus, are not explicitly modeled (cf. e.g., Trani, 2015; Tille and van Wincoop, 2010; Devereux and Sutherland, 2011).

3 Calibration

Table 1 reports the baseline calibration and its sources. The time unit is one quarter. Most parameters are quite standard and will not be discussed.

The weight of labor in the utility function, χ, was set to 2.633 in the model with banks and to 2.737 in the model without banks to ensure that, in either model, a household devotes one third of its time to work.

Home bias in consumption, μ_c, is set to 0.9 which yields a steady state share of imports in aggregate output of approximately 7%. This is in line with Corsetti et al. (2008) who report that between 1960 and 2002 the ratio of U.S. imports from their main trading partners Europe, Canada and Japan averaged 5% of aggregate output. The trade elasticity of $\iota = 0.9$ is in the range of values typically reported in empirical analysis, which reaches from 0.1 to 2 (cf. Corsetti et al., 2008).[13]

The parameters of the banking system, λ_b, the divertable fraction of assets, θ_b, the average lifetime of banks, and ω_b, the transfer to entering bankers, are set to similar values as in Gertler and Karadi (2011). The three parameters jointly determine a steady state interest rate spread of 115 basis points, a steady state leverage ratio of 4.1 and an average lifetime of a bank of 8.2 years.

Parameter η_c in the endogenous discount factor was taken from Devereux and Sutherland (2009). In general, this parameter can have considerable implications for the international transmission of shocks. Hence, it should be set to a small value. However, choosing it to be too small induces a unit root in a first-order approximation of the model. The same is true for ω_d, the yield sensitivity to debt, which is calibrated as in Hjortsoe (2016). Given $\eta_c = 0.01$ and the steady state value of consumption, parameter ω_c was chosen as to guarantee an annual steady state interest rate of 4%, i.e., a steady state value of $\beta(C_A)$ of 0.99.

The exogenous variables $\zeta_{C,t}$, G_t A_t and Ψ_t are assumed to follow AR(1) processes. For simplicity, I assume the same standard deviation for all shocks. It is assumed that all shocks are uncorrelated between each other, i.e., also between the home and the foreign economy.

[13] My results are robust to changes of the trade elasticity within that range.

Parameter	Description	Value	Source/Target
Households			
γ	risk aversion	2	standard RBC value
ϕ	inverse of Frisch elasticity	0.276	Gertler and Karadi (2011)
χ	utility weight of labor	2.633* / 2.737**	steady state labor share of 33%
η_c	parameter from discount factor	0.01	Devereux and Sutherland (2009)
ω_c	parameter capturing steady state savings propensity	0.996	steady state discount factor of 0.99
ω_d	yield sensitivity to debt	0.0001	small value
μ_c	home bias in consumption	0.9	import-to-output share of 7%
ι	substitution elasticity between H and F goods	0.9	standard value
Capital goods firms			
η_I	inverse elasticity of investment with respect to price of capital	1.728	Gertler and Karadi (2011)
Intermediate goods firms			
α	capital share	0.33	standard value
δ	depreciation rate	0.025	standard value
Final goods firms			
σ	probability of not being able to change price	0.78	Gertler and Karadi (2011)
ϵ	substitution elasticity between varieties	4.17	Gertler and Karadi (2011)
Financial intermediaries			
λ_b	fraction of divertable assets	0.39	st. st. leverage ratio of 4.1
ω_b	transfer to entering banks	0.002	st. st. spread of 115bps.
θ_b	quarterly survival rate of banks	0.97	average banker lifetime of 8.2 years
Government			
g	steady state government spending share	0.1	relatively small value
Monetary policy			
γ_y	feedback coefficient on output gap	0.125	Gertler and Karadi (2011)
γ_π	feedback coefficient on inflation	1.5	Gertler and Karadi (2011)
ρ_r	interest smoothing coefficient	0.8	Gertler and Karadi (2011)
Exogenous processes			
ρ_ψ	persistence of capital quality shock	0.66	Gertler and Karadi (2011)
ρ_A	persistence of technology schock	0.95	Gertler and Karadi (2011)
ρ_G	persistence of gov. spend. shock	0.95	Bernanke et al. (1999)
ρ_C	persistence of preference shock	0.9	Jiang (2017)
$\gamma_\psi, \gamma_A, \gamma_N$ $\gamma_G, \gamma_C, \gamma_M$	standard deviation of shocks	0.01	

*model with banks; **model without banks

Table 1: *Parameters*

4 Results

4.1 Portfolio Exposure and Business Cycle Synchronization

In this section, I will discuss the response of the *real sector* to various shocks and for different degrees of balance sheet exposure. I consider technology shocks (ε_A), preference shocks (ε_C), government spending shocks (ε_G), capital quality shocks (ε_Ψ) and net wealth shocks (ε_N). Using the cyclicality of producer price inflation to distinguish between demand and supply shocks, the technology shock is classified as a supply shock, while all other shocks are demand shocks. The most important finding is, that in the presence of demand shocks, higher financial integration leads to a higher cross-country correlation of GDP and that in the presence of the supply shock (technology shock), higher financial integration leads to a lower cross-country correlation of GDP. This results holds regardless of whether financial intermediaries or households hold the foreign asset portfolio. The result is mainly driven by the response of the terms of trade, as I will show in the later discussion of the impulse response functions.

In figure 2, the cross-country correlation of GDP growth is plotted against all different degrees of portfolio exposure between full home bias ($\alpha^P = 0$) and full foreign bias ($\alpha^P = 1$). The first row contains the statistics from the model with a banking sector, the second row the corresponding statistics from the model without a banking sector. The cross-country correlations of GDP growth for a specific shock were calculated by setting the shock variance of the corresponding shock to 0.01 and all other shock variances to zero.[14] It should be noted, that the analysis is not meant to be a quantitative exercise. To obtain empirically plausible cross-country correlations, further bells and whistles would have to be added to the model. Furthermore, in reality, business cycles are driven by a combination of shocks and these shocks are usually correlated between countries. For the sake of understanding the relevant transmission mechanisms, I refrain from adding further model features or adding a more realistic stochastic environment with non-zero cross-country shock correlations. Therefore, the absolute size of the correlations is not very informative. What is of utmost importance for answering the research question is the slope of the graphs. And in this regard, a general pattern emerges: Increasing the degree of portfolio exposure leads to significantly lower business cycle comovement conditional on supply shocks and to significantly higher business cycle comovement conditional on demand shocks. This result holds for both models – the model with

[14]Note that, even though, in each case, the number of shocks (two) equals the number of tradable assets (two), international consumption risk sharing is still incomplete as α^P is not at its optimal value.

and the model without financial frictions.

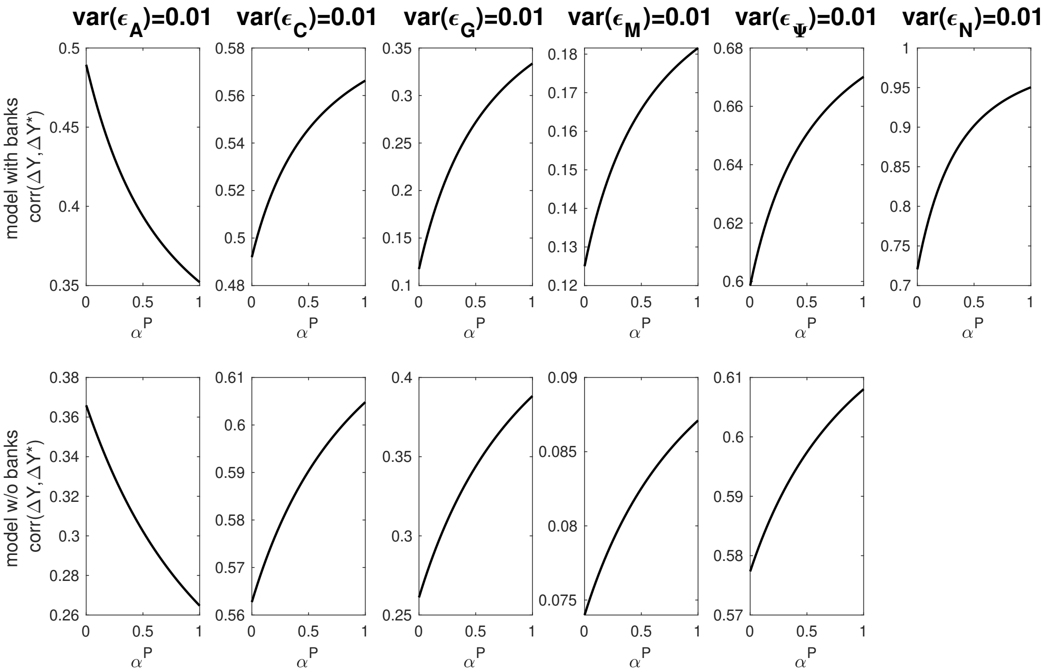

Figure 2: *Cross-country correlations of GDP growth (corr($\Delta Y, \Delta Y^*$)) for different degrees of portfolio exposure (α^P) in the presence of country-specific technology shocks (ε_A), preference shocks (ε_C), government spending shocks (ε_G), monetary policy shocks (ε_M), capital quality shocks (ε_Ψ) and net wealth shocks (ε_N)*

Since the result holds regardless of the assumption of financial frictions, balance sheet effects can be ruled out as dominant transmission channel. By using GHH preferences, wealth effects on labor, which are the relevant transmission mechanism, e.g., in Heathcote and Perri (2004), also have been ruled out by assumption. Instead, the result is driven by the assumption of home bias in consumption and the resulting fluctuations in the terms of trade, or, equivalently, the real exchange rate. This can be seen from comparing the graphs in figure 2 to the graphs in figure 23 in the appendix. The latter displays the same cross-country correlations under the assumption of $\mu_c = 0.5$, i.e., in the absence of real exchange rate fluctuations. Figure 23 shows that the effect of portfolio exposure on international business cycle comovement is negligible (model with banks) or non-existent (model without banks) under the assumption of equal preferences for home and foreign consumption goods. The very small effect of portfolio exposure on international business cycle comovement we observe in the model with banks, presumably reflects balance sheet effects, however, quantitatively these effects are negligible compared to the effects observed in the model with real exchange rate movements.

To better understand the driving forces between the results displayed in figure 2, I will now turn to a discussion of the impulse responses of certain variables to the individual shocks. Impulse responses of further variables can be found in the appendix. All impulse responses displayed in the following figures are generated by the model with financial frictions. The repercussions in the real sector are qualitatively the same in the model without frictions (see the appendix for impulse responses generated by the model without frictions).

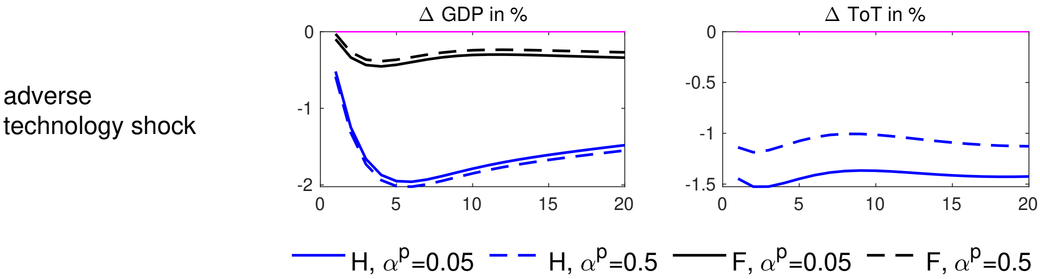

Figure 3: *Impulse responses to an adverse 1% home technology shock, ε_A*

Figure 3 displays the responses of home (H, blue lines) and foreign (F, black lines) GDP and the terms of trade to a negative 1% technology shock in the home economy. The shock directly hits home production, leading to a drop in the supply of home goods and an increase in the price of home goods. This causes the terms of trade to appreciate (ToT_t drops). Due to home bias in consumption, the home consumption basket appreciates relative to the foreign consumption basket. This induces an appreciation of the real exchange rate (RER_t drops) proportional to the appreciation of the terms of trade. In the given model, foreign GDP drops in response to the negative home technology shock. It should be noted, however, that this positive comovement of home and foreign GDP in response to technology shocks results from model-specific assumptions, i.e., the production structure, the assumption of deposit market integration and the assumption of non-separable preferences, and is not a general result.

The figure also displays impulse responses for different degrees of portfolio exposure. While the solid lines reflect the impulse responses of an economy displaying a large home bias in portfolio holdings (95% of the portfolio consists of home assets), the dashed lines reflect the impulse responses of an economy with a balanced portfolio of home and foreign assets (50% of the portfolio consists of home assets). The impulse responses show that in reaction to the adverse home supply shock, the fall in home GDP is larger when the degree of portfolio diversification is larger, i.e., when home households hold a larger degree of foreign assets in their portfolio. The reason is that the appreciation of the terms of trade induces a relative depreciation of foreign real assets. If home investors (households or banks) hold more of these assets in their portfolio, revenues from international portfolio holdings are lower, which has a negative effect on home demand and – due to home bias in consumption – on home production. The negative demand effect from larger foreign portfolio holdings associated with smaller portfolio revenues is also reflected by a slightly smaller appreciation of the terms of trade. These effects correspond to the ones observed by Keynes (1929) in his famous discussion of the "Transfer Problem". Note that the foreign economy displays the same reaction but with an opposite sign: Revenues from international portfolio holdings are higher when foreign investors hold more home assets, which has a positive effect on foreign demand and production.

Figure 4 displays the impulse responses to three demand side disturbances, in particular, to a positive 1% shock to the discount factor of the home household sector (adverse preference shock), to a negative 1% shock to home government spending and to a negative 1% shock to the home banking sector's net wealth., i.e., a negative financial shock. The fall in home demand in combination with home bias in consumption leads to a relative decrease in home prices, reflected in the depreciations of the terms of trade (ToT_t increases). Considering again the differences between the impulse responses for different degrees of international financial integration, we can observe the opposite effects compared to supply shocks: With the terms of trade depreciating, in the home economy, a larger share of foreign assets in the portfolio is associated with larger revenues from international portfolio holdings. This attenuates the initial negative demand effect in the home economy, leading to a smaller exchange rate depreciation and a smaller initial fall in home GDP. Correspondingly, the increase in foreign GDP is less pronounced when foreign agents hold more home assets, which depreciate in value.

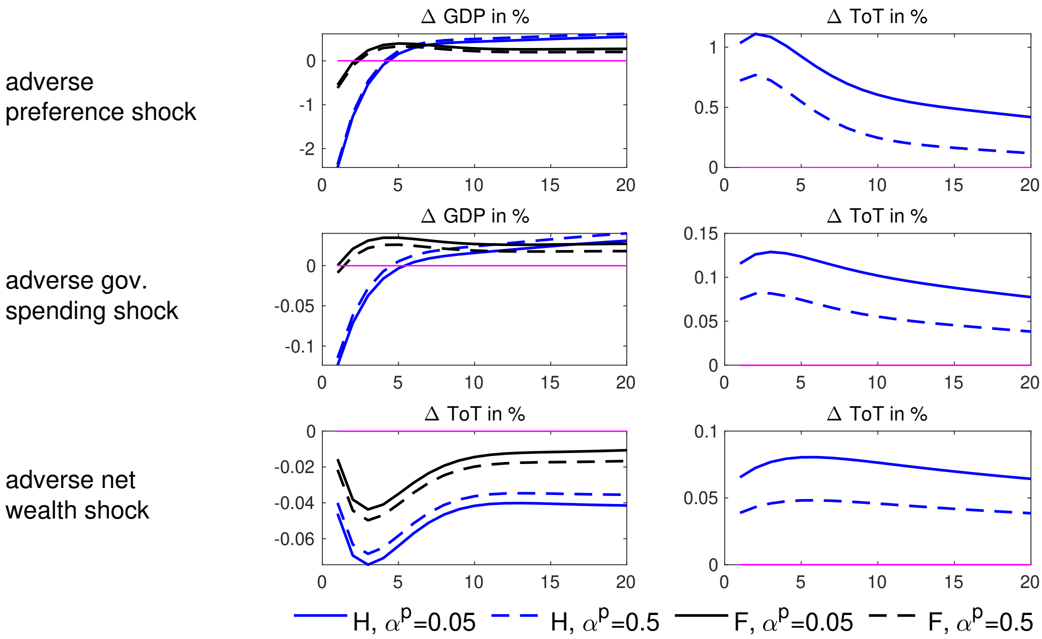

Figure 4: *Impulse responses to adverse 1% home demand shocks (preference shock, ε_C, government spending shock, ε_G, net wealth shock, ε_N)*

For monetary policy shocks and capital quality shocks the transmission mechanisms is slightly different (see impulse responses in the appendix). Both shocks lead to procyclical responses of producer price inflation and are therefore considered as demand shocks. However, in both cases the real exchange rate appreciates in response to an adverse shock which is due to a large nominal appreciation. Despite the real appreciation, home excess returns ($R_{k,t} - \frac{\text{RER}_t}{\text{RER}_{t-1}} R^*_{k,t}$) drop, as it is the case for the other demand shocks. Therefore, by decreasing the share of domestic assets in their portfolio, home agents can reduce the adverse demand side effects. This is reflected in an even larger appreciation of the real exchange rate and a smaller fall in home GDP when the portfolio is more diversified ($\alpha^P = 0.5$). Correspondingly, the drop in foreign GDP is more pronounced, when foreign agents hold more of the adversely affected home assets.

4.2 Portfolio Exposure and Financial Synchronization

In the previous section it was shown that in the context of demand shocks financial integration promotes GDP comovement while in the context of supply shocks the opposite is true. We now turn to the question under which conditions financial integration promotes the comovement of *financial* variables.

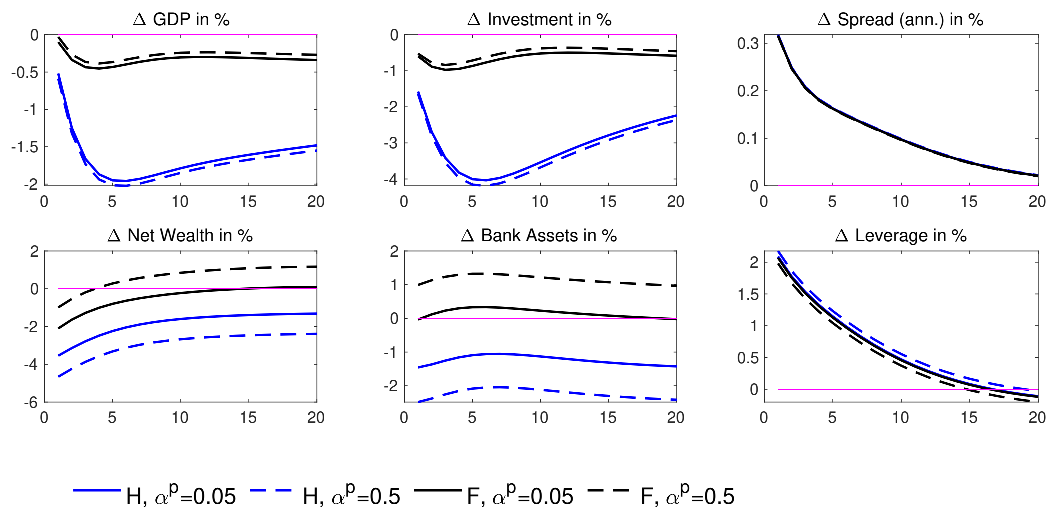

Figure 5: *Impulse responses of real and financial variables to an adverse 1% home technology shock, ε_A*

Figure 5 contains impulse responses to an adverse home technology shock. As a direct effect, the return to home capital and home investment demand are reduced. This exerts downward pressure on the price of home capital, Q_t and thereby affects banks' balance sheets negatively. Net wealth drops considerably and leverage increases. Note that this shock transmits from the real to the financial sector primarily via prices. Under financial market integration, capital prices are nearly equalized due to the equalization of expected returns. Therefore, this shock also reaches foreign banks balance sheets mainly via asset price equalization. Foreign banks' net wealth drops as well and leverage also increases. Foreign banks' assets increase slightly as they take over some of the intermediation activities of home banks. As discussed in the previous section, the adverse technology shock in the home economy causes an appreciation of the real exchange rate. Therefore, a higher share of foreign assets in home banks' portfolios leads to an even larger adverse effect on home banks' balance sheets as foreign real assets loose in value relative to home assets. Analogously, the decrease in foreign banks' net wealth is somewhat alleviated when foreign banks hold more home assets in their portfolio, as home assets gain in value relative to foreign assets due to the real exchange rate appreciation.

The next two figures contain impulse responses to an adverse preference shock and and adverse government spending shock, i.e., non-financial demand shocks. As the impulse responses are qualitatively very similar they will be discussed together. As opposed to the supply shock discussed above, the adverse demand shocks have positive effects on the banking sector: the drop in private (ε_C shock) or public demand (ε_G shock) leaves room for higher investment demand. This has a direct positive effect on the return to home capital and the capital price leading to an increase in home banks' net wealth. Via asset price equalization the foreign banking sector's net wealth is also positively affected, however, to a lesser extend. In reaction to these demand shocks the real exchange rate depreciates. Therefore an increase in financial market integration ($\alpha^P \uparrow$) enhances the increase in home banks' net wealth and lowers the increase in foreign banks' net wealth.

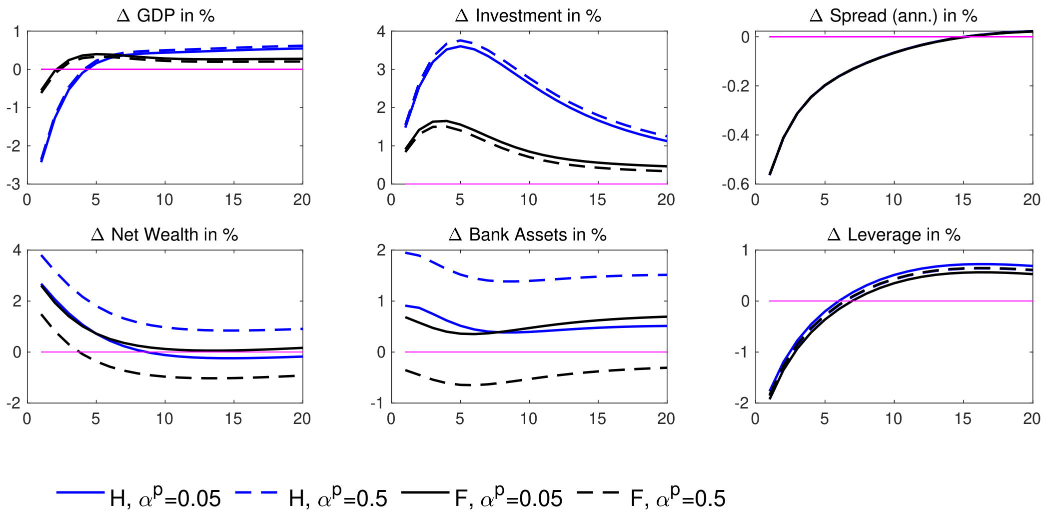

Figure 6: *Impulse responses of real and financial variables to an adverse 1% home preference shock, ε_C*

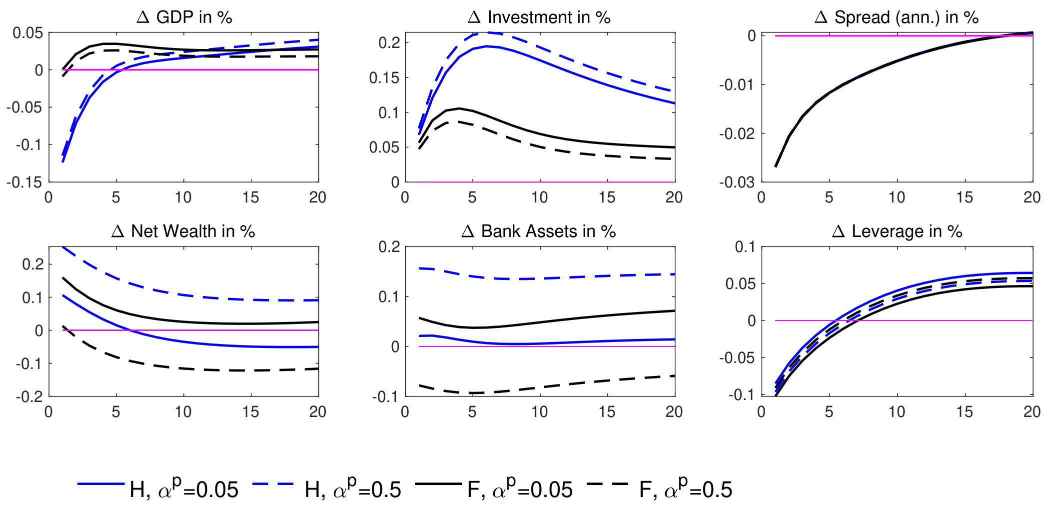

Figure 7: *Impulse responses of real and financial variables to an adverse 1% home government spending shock, ε_G*

Therefore, in the case of shocks which do not directly affect the financial sector – demand and supply shocks – it holds that an increase in portfolio exposure lowers the comovement of financial variables, however, for different reasons. In the case of the adverse supply shock, the reason is that through the real exchange rate appreciation the adverse effects on the home financial sector are amplified through financial integration. In the case of the adverse government spending and preference shocks, the positive effects on the home financial sector are amplified through financial integration, because the real exchange rate depreciates.

We next turn to an analysis of those shocks which directly affect the size of the financial frictions – net wealth, capital quality and monetary policy shocks. Figure 8 shows impulse responses to an adverse net wealth shock to the home banking sector. This shock decreases the intermediation capacity of the respective banks. Thereby, home banks' leverage increases which forces them to reduce their lending to firms, hence, investment drops. At the same time the spread falls, which reduces banks' profits, further contributing to the fall in net worth. Due to return equalization, the foreign banking sector also suffers from the decrease in the spread and, hence, from a reduction in net worth. If foreign banks hold more home assets, which loose in value due to the depreciation of the real exchange rate, the drop in foreign net worth is more pronounced while the drop in home net wealth is somewhat alleviated. We can conclude that with respect to this financial shock, the adverse affects on the financial sector are diversified through financial integration. Therefore, higher financial integration leads to higher financial comovement.

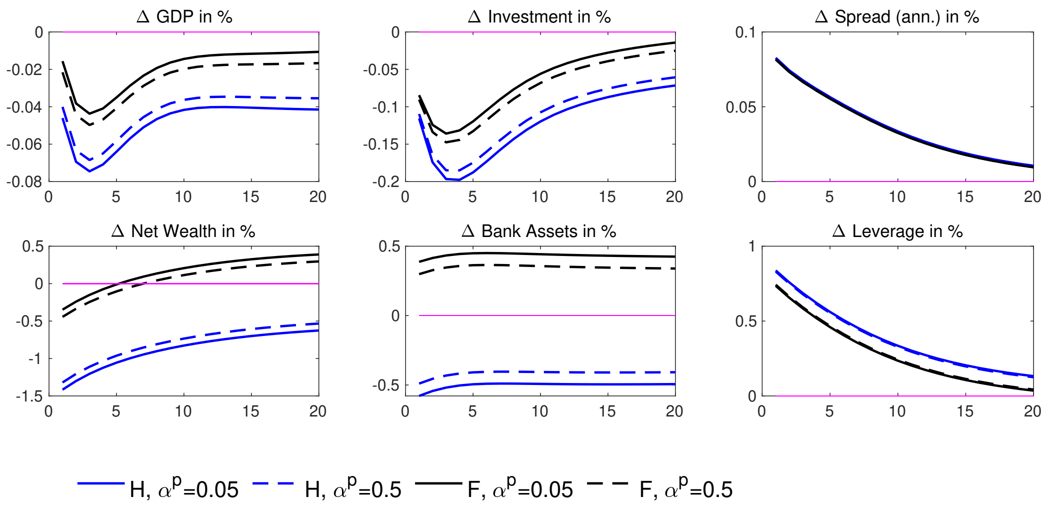

Figure 8: *Impulse responses of real and financial variables to an adverse 1% home net wealth shock,* ε_N

As discussed above, the capital quality shock shares similarities with demand and supply shocks and in the model with financial frictions it can furthermore be considered a financial shock. Recall that the capital quality shock not only hits the production function, but also destroys part of the capital stock. As the capital stock is equal to the capital claims issued to banks, the decline in home capital quality causes a devaluation of home capital assets, i.e., of $S_{H,t}$ and $S^*_{H,t}$. The foreign bank suffers from this decline in asset values proportionately to its home asset holdings. The direct devaluation effects of the shock outweigh the appreciation effects of home assets coming from a fall in the real exchange rate. Therefore, higher financial integration leads to higher financial comovement after capital quality shocks.

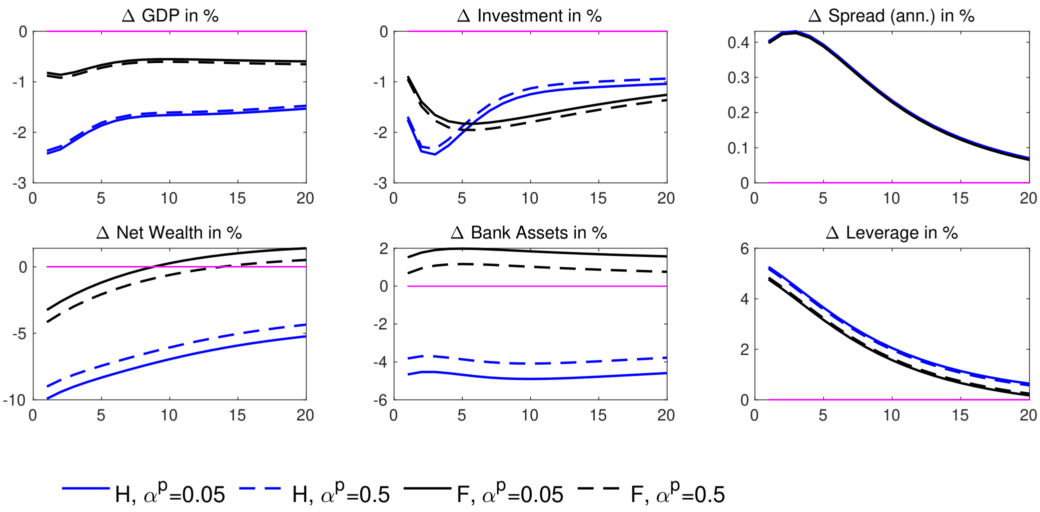

Figure 9: *Impulse responses of real and financial variables to an adverse 1% home capital quality shock,* ε_Ψ

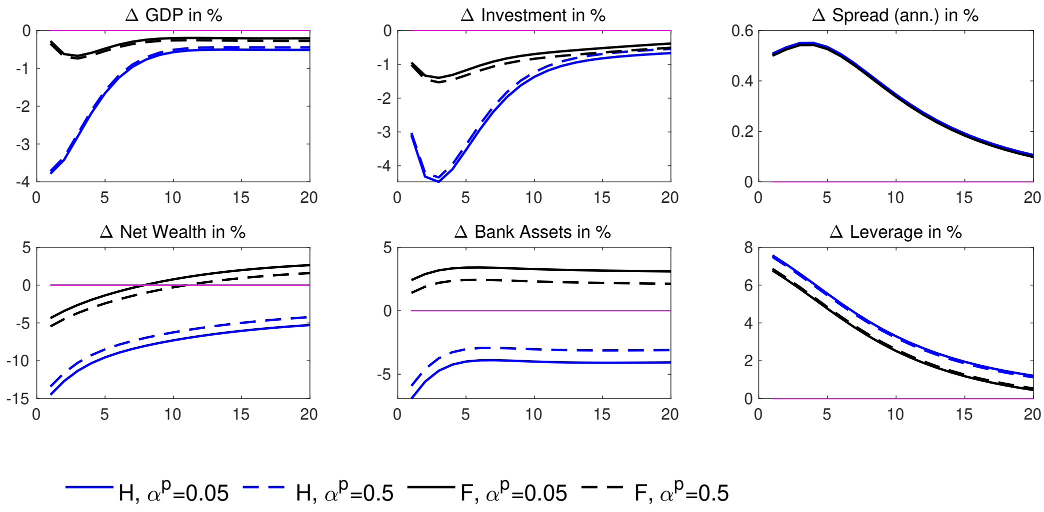

Figure 10: *Impulse responses of real and financial variables to an adverse 1% home monetary policy shock, ε_M*

The impulse responses of the financial variables to the monetary policy shock are qualitatively very similar to those of the net wealth and the capital quality shock. The monetary policy shock has a relatively large negative effect on investment and asset prices which triggers a substantial financial accelerator effect. As for the capital quality shock the direct devaluation effects of the shock coming from the financial accelerator outweigh the appreciation effects from a fall in the real exchange rate. Therefore, higher foreign asset holdings alleviate the effects of the shock on the home economy.

In the following figure, figure 11, the cross-country correlations of net wealth growth, leverage and spreads are plotted against all different degrees of portfolio exposure between full home bias ($\alpha^P = 0$) and full foreign bias ($\alpha^P = 1$). Results are displayed for technology shocks (ε_A), preference shocks (ε_C), government spending shocks (ε_G), monetary policy shocks (ε_M), net wealth shocks (ε_N) and capital quality shocks (ε_Ψ). The graphs confirm our results from the discussion of the impulse responses: in the case of technology, preference and government spending shocks, for empirically plausible calibrations of α^P ($0 < \alpha^P < 0.5$), financial integration has a negative effect on the international comovement in financial variables, while in a context of financial shocks (net wealth shocks, capital quality shocks) financial integration fosters international comovement in financial variables.

Note that there is very little variation in the correlation of the external finance premia, $\text{corr}\left(\frac{R_{kt+1}}{R_t}, \frac{R^*_{kt+1}}{R^*_t}\right)$, it is close to one for all portfolio compositions. This equalization of spreads in a first-order approximation of the model comes about by construction of the model, in particular, by assuming endogenous portfolio choice (cf. equation (3)) and deposit market integration (cf. equation (2)).

As discussed above, the result that in the presence of government spending and preference shocks, financial integration actually leads to lower cross-country correlations of financial variables is due to the fact that these two shocks have opposite effects on the real and the financial sector in the context of this particular setup of the financial intermediation sector. It can be expected that in a model in which financial sector variables evolve procyclically in the presence of government spending and preference shocks (e.g., Bernanke et al., 1999), financial integration actually leads to higher cross-country correlations of financial variables. This issue is left for further research.

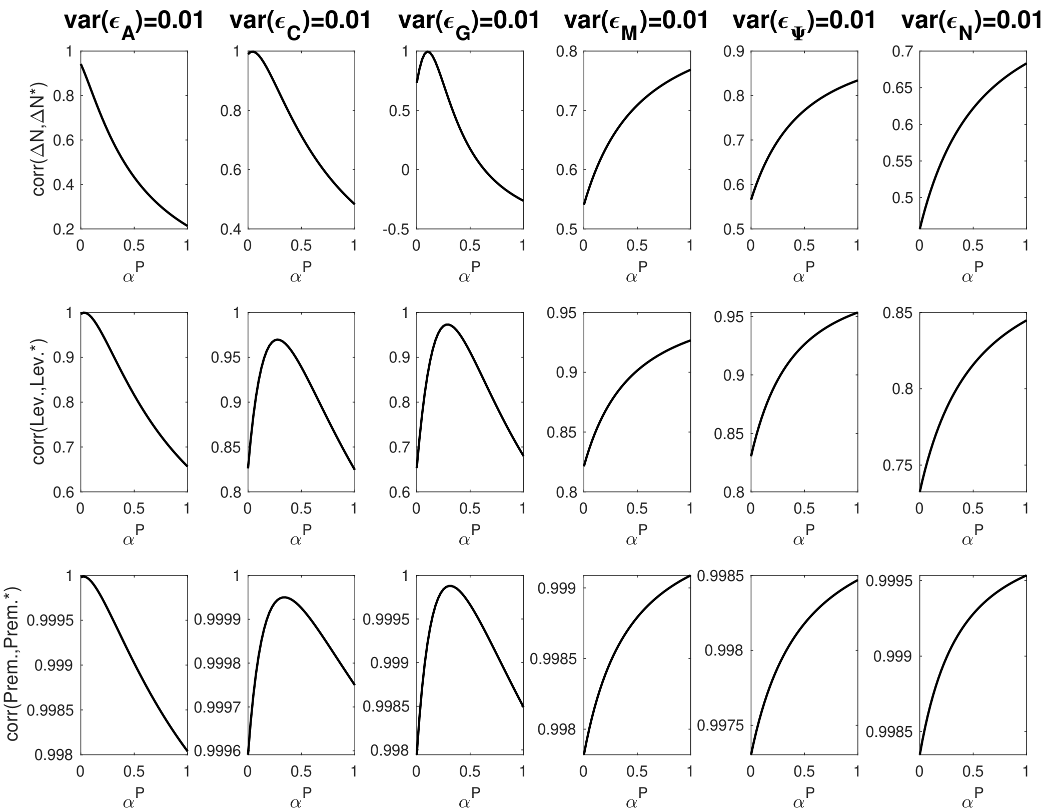

Figure 11: *Financial cycle correlations for different degrees of portfolio exposure (α^P) in the presence of country-specific technology shocks (ε_A), preference shocks (ε_C), government spending shocks (ε_G), monetary policy shocks (ε_M), capital quality shocks (ε_Ψ) and net wealth shocks (ε_N)*

5 Conclusion

I develop a standard international business cycle model augmented by a commonly used financial friction and show that the distinction between supply and demand shocks is an important determinant of the sign of the correlation between financial integration and output synchronization. The presence of a financial friction or of financial shocks are neither necessary nor sufficient conditions for a positive effect of international portfolio exposure on business cycle synchronization.

In the given setup of the financial sector, financial shocks act as demand side shocks, therefore, they give rise to a positive relationship between financial integration and the cross-country output correlation. In this regard, my study nests the results of previous studies, showing that financial integration and output comovement correlate positively in the presence of financial shocks. However, there are also contributions which model the financial sector in a way that financial shocks are supply shocks (e.g., Meh and Moran, 2010; Fiore and Tristani, 2013). My results suggest, that in this case, financial shocks might not trigger a positive correlation between financial integration and business cycle synchronization.

The result that the presence of leveraged financial intermediaries is irrelevant for the effects of foreign asset exposure on business cycle comovement stands in contrast with ample empirical evidence – mainly from the debt crises of the 1990s – which establishes that financial crises can spread quickly from the country of origin via linkages between financial institutions (e.g., Kaminsky and Reinhart, 2000; Kaminsky et al., 2003). This irrelevance result is driven by (almost) perfect return equalization (cf. Dedola and Lombardo, 2012), which is a common feature of two-country DSGE models with international portfolio choice solved with perturbation methods. Hence, to analyze the potential contagion effects of financial integration through financial intermediaries a different type of model needs to be considered.

It was further shown, that financial integration only leads to higher cross-country correlations of certain financial variables in the context of shocks which directly affect the size of the financial friction. The result that in the presence of non-financial demand shocks financial integration can actually lead to lower cross-country correlations of financial variables is specific to the given setup of the financial sector. It will be worthwhile to analyze whether in a model with a different financial friction government spending and preference shocks are also among those shocks causing higher financial comovement in the face of higher portfolio exposure.

The results are important for an evaluation of the advantages and risks emanating from cross-country asset holdings and derived policy implications. I show that potential contagion risks associated with cross-country asset holdings do not depend on whether the holders are financially constrained or not. And, as figure 1 shows, the share of international portfolio holdings traded by non-financial actors is steadily increasing. Furthermore, there is evidence, that the role of demand side disturbances is growing. Therefore, my model suggests, that we can expect an increase in the correlation between financial integration and business cycle comovement and that potential measures employed to tame contagion risks should also consider the role of non-financial actors in international asset trade.

Last but not least, my analyses suggest that in order to make empirical progress on the question of whether higher exposure to foreign assets leads to more business cycle comovement, it is necessary to analyze this relationship conditional on different kinds of shocks, in particular demand versus supply shocks.

A Appendix

A.1 Further Impulse Responses from Model with Banks

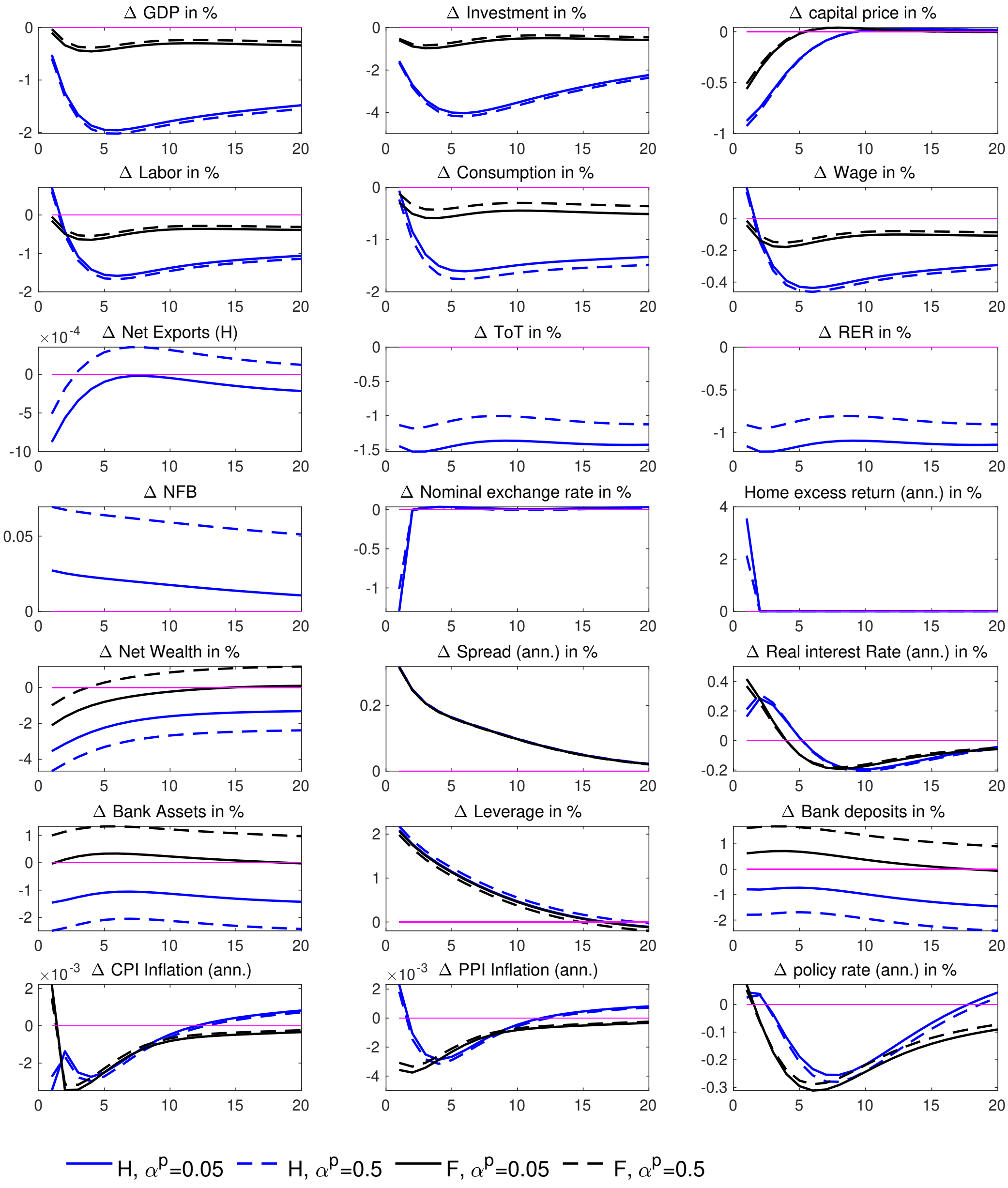

Figure 12: *Impulse responses to an adverse 1% home technology shock, ε_A*

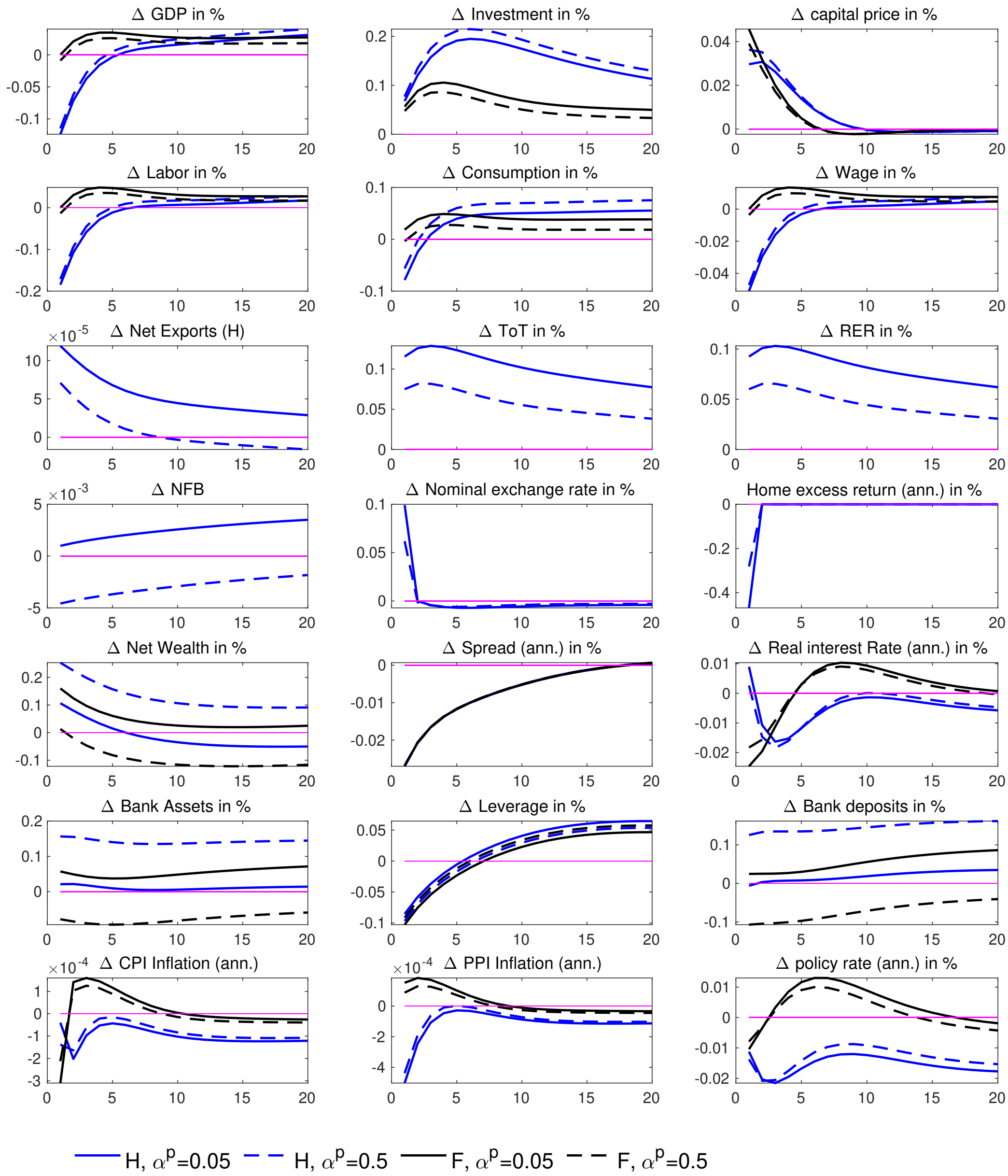

Figure 13: *Impulse responses to an adverse 1% home government spending shock,* ε_G

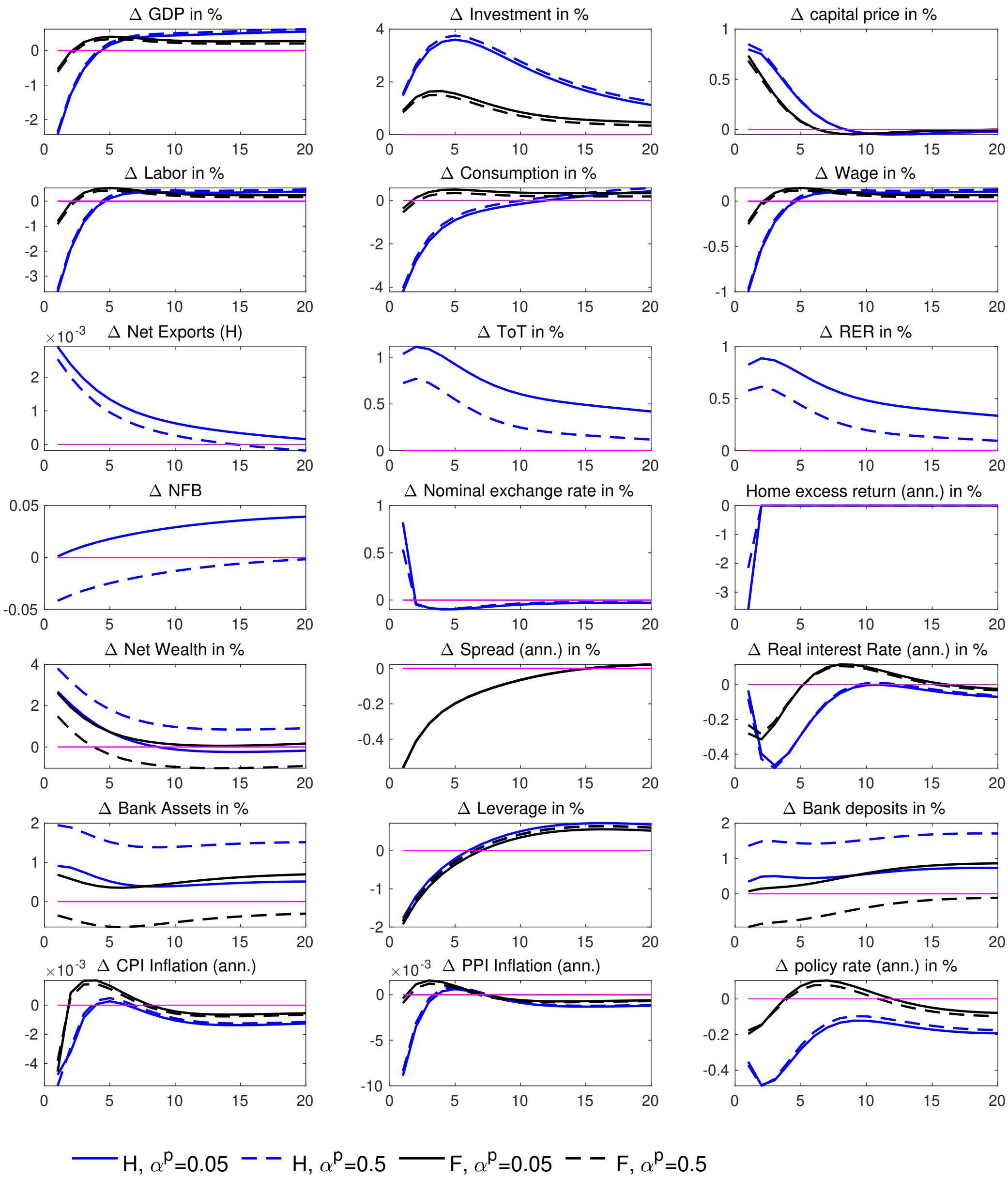

Figure 14: *Impulse responses to an adverse 1% home preference shock, ε_C*

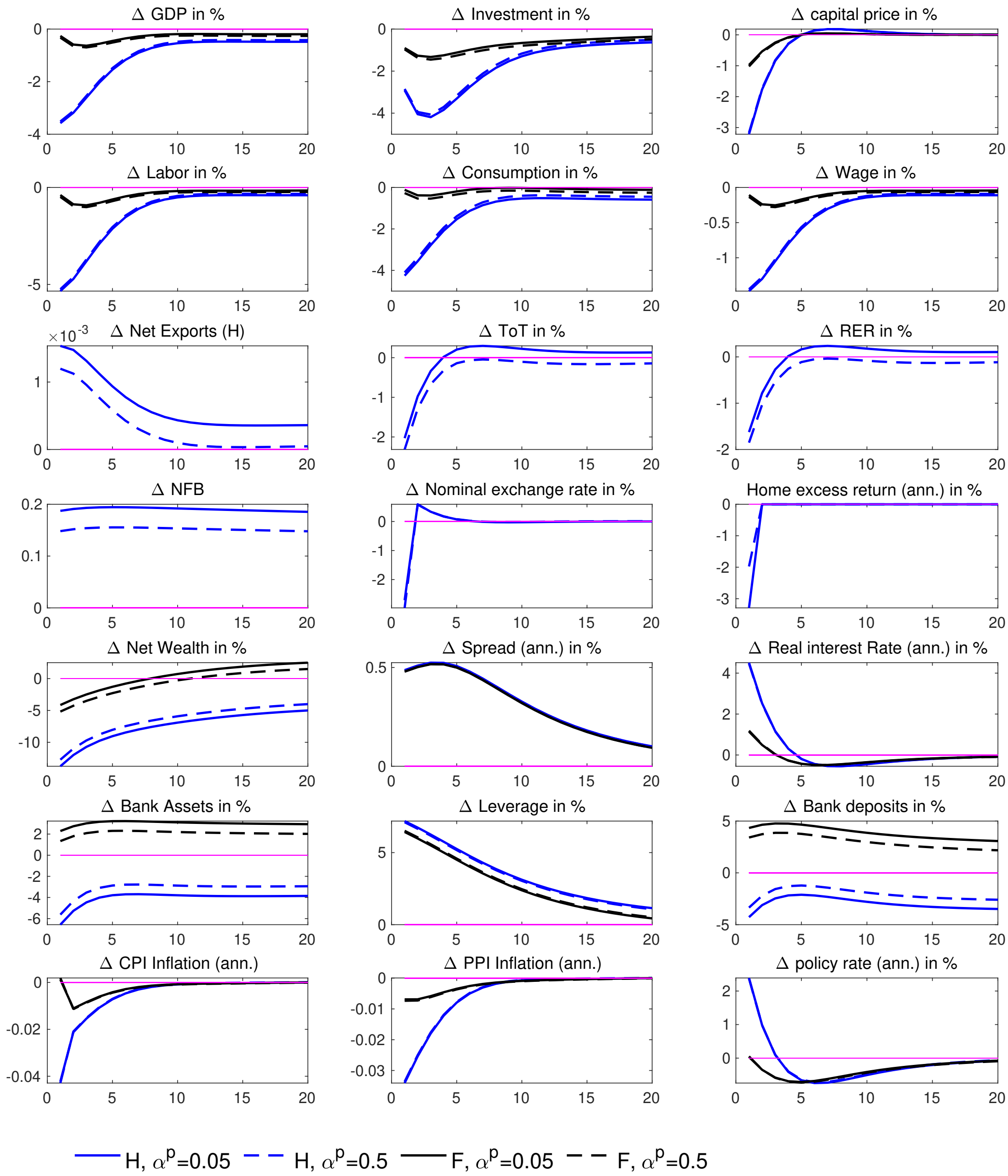

Figure 15: *Impulse responses to an adverse 1% home monetary policy shock, ε_M*

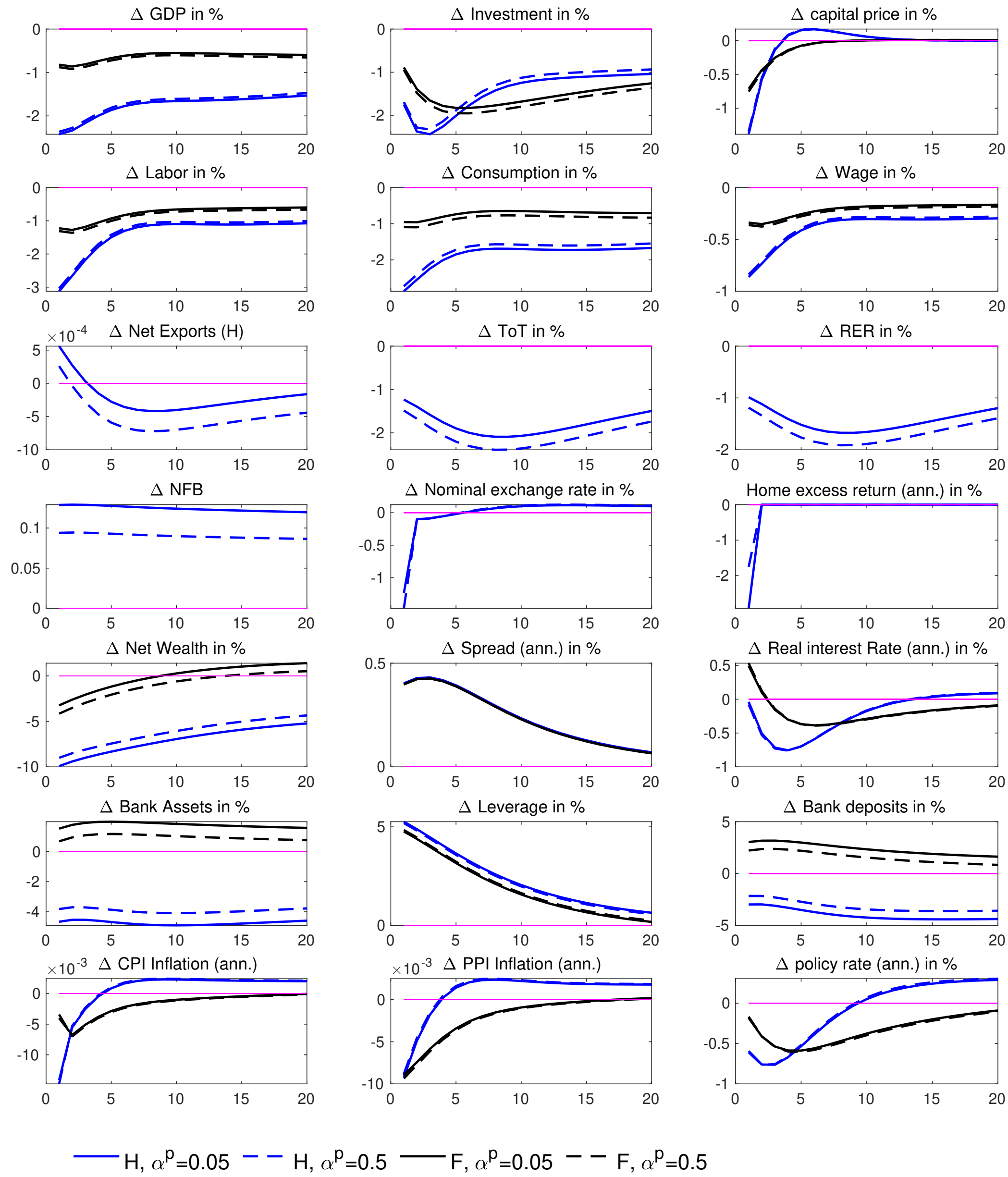

Figure 16: *Impulse responses to an adverse 1% home capital quality shock, ε_Ψ*

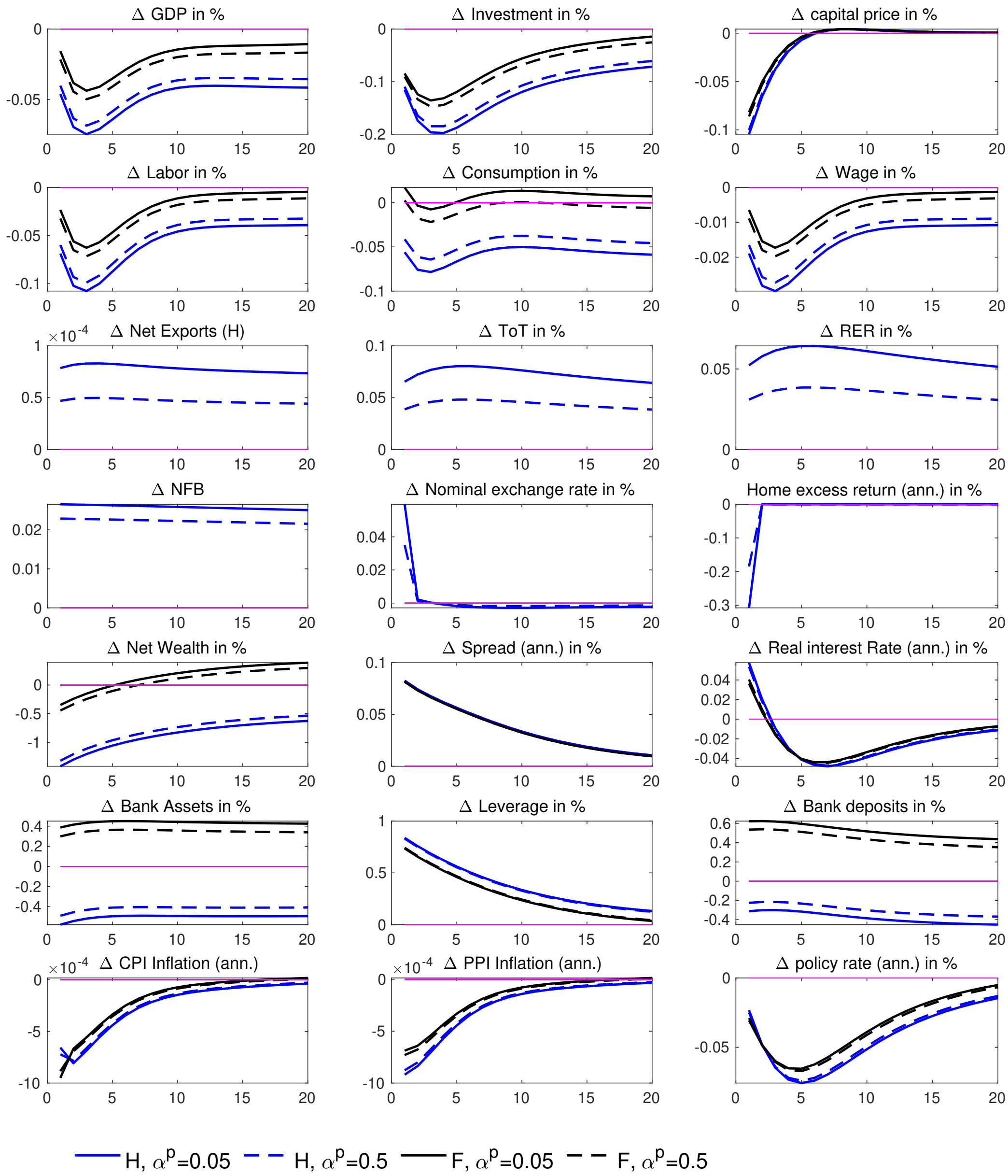

Figure 17: *Impulse responses to an adverse 1% home net wealth shock, ε_N*

A.2 Further Impulse Responses from Model without Banks

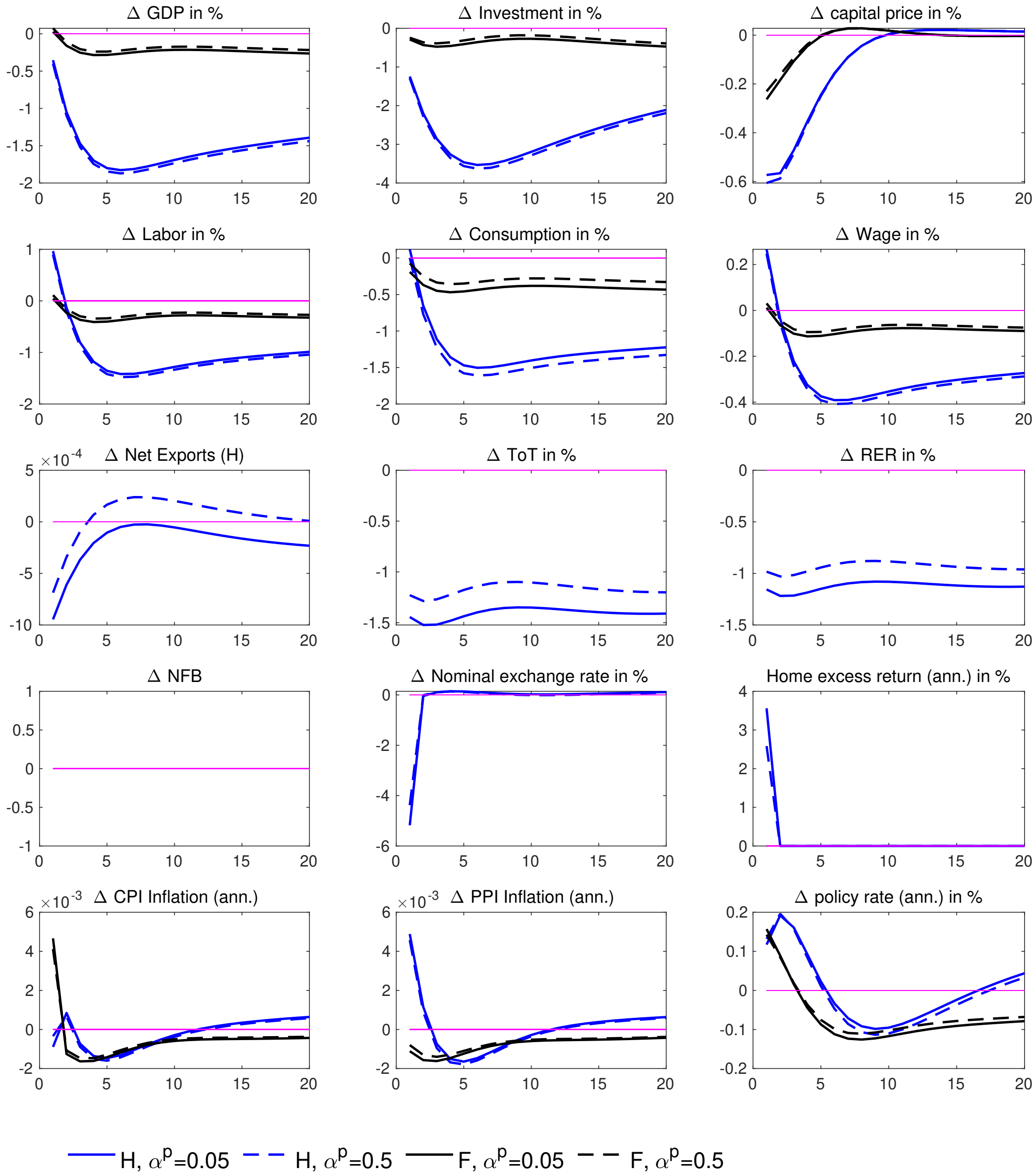

Figure 18: *Impulse responses to an adverse 1% home technology shock, ε_A*

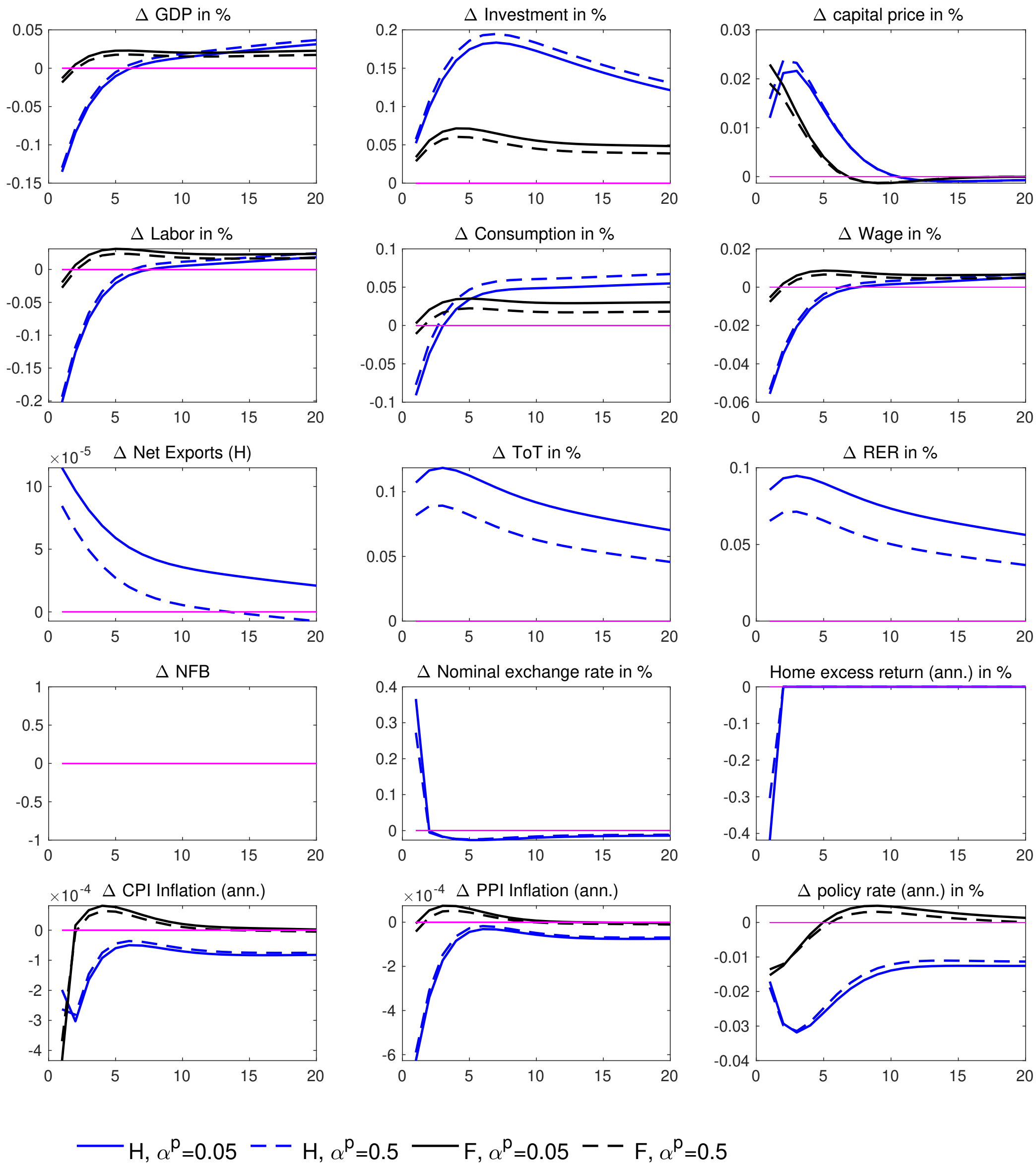

Figure 19: *Impulse responses to an adverse 1% home government spending shock,* ε_G

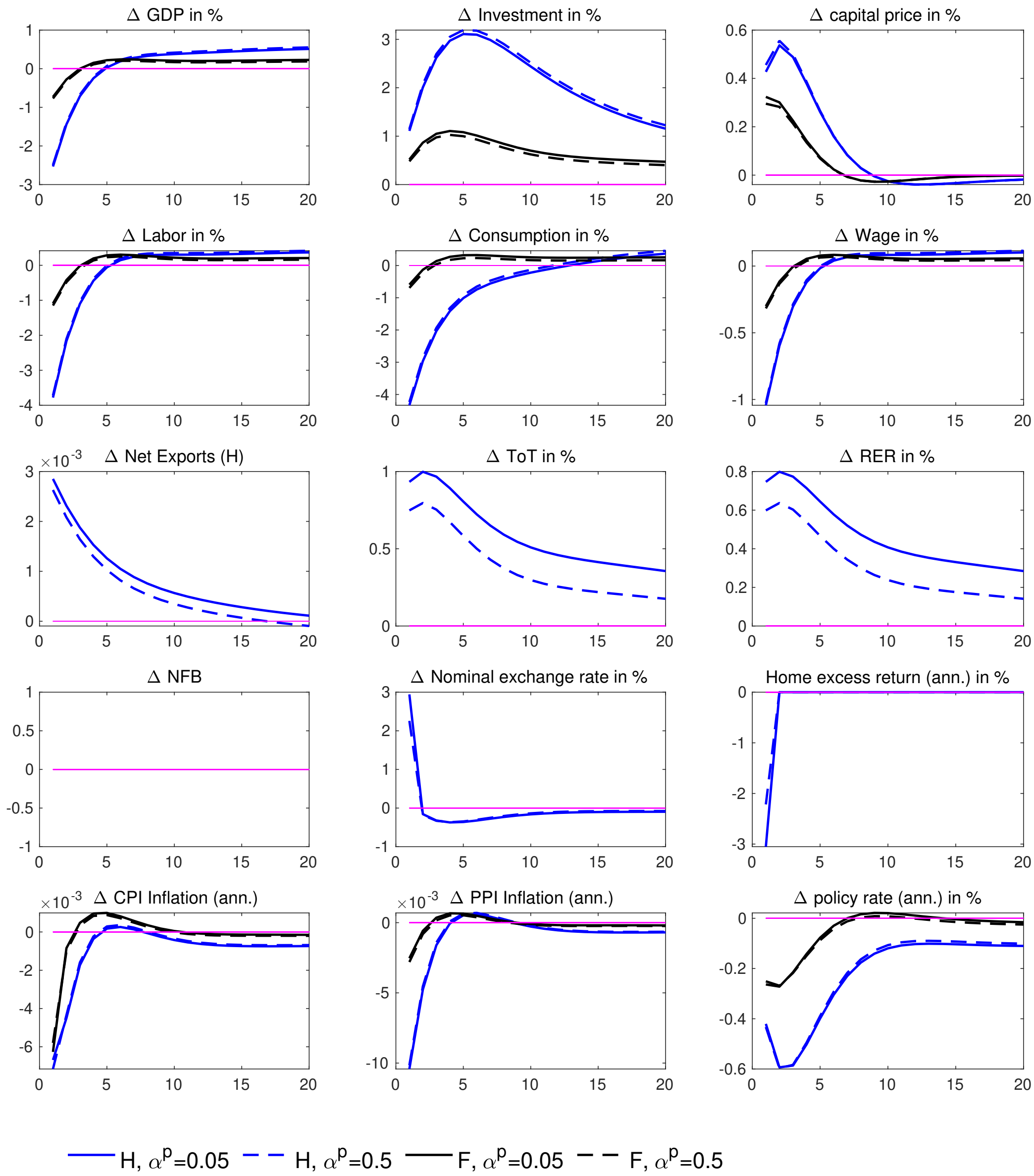

Figure 20: *Impulse responses to an adverse 1% home preference shock, ε_C*

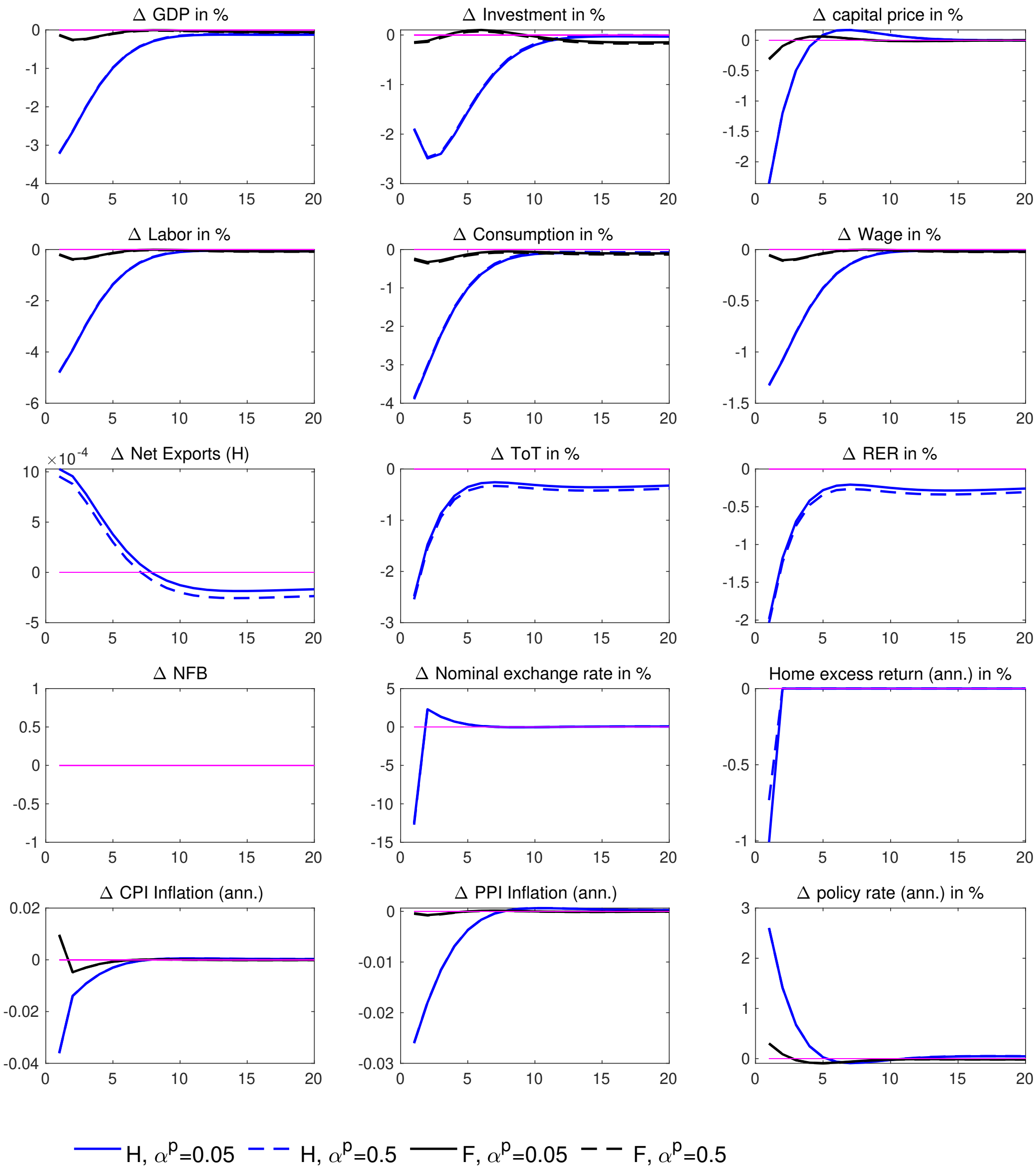

Figure 21: *Impulse responses to an adverse 1% home monetary policy shock, ε_M*

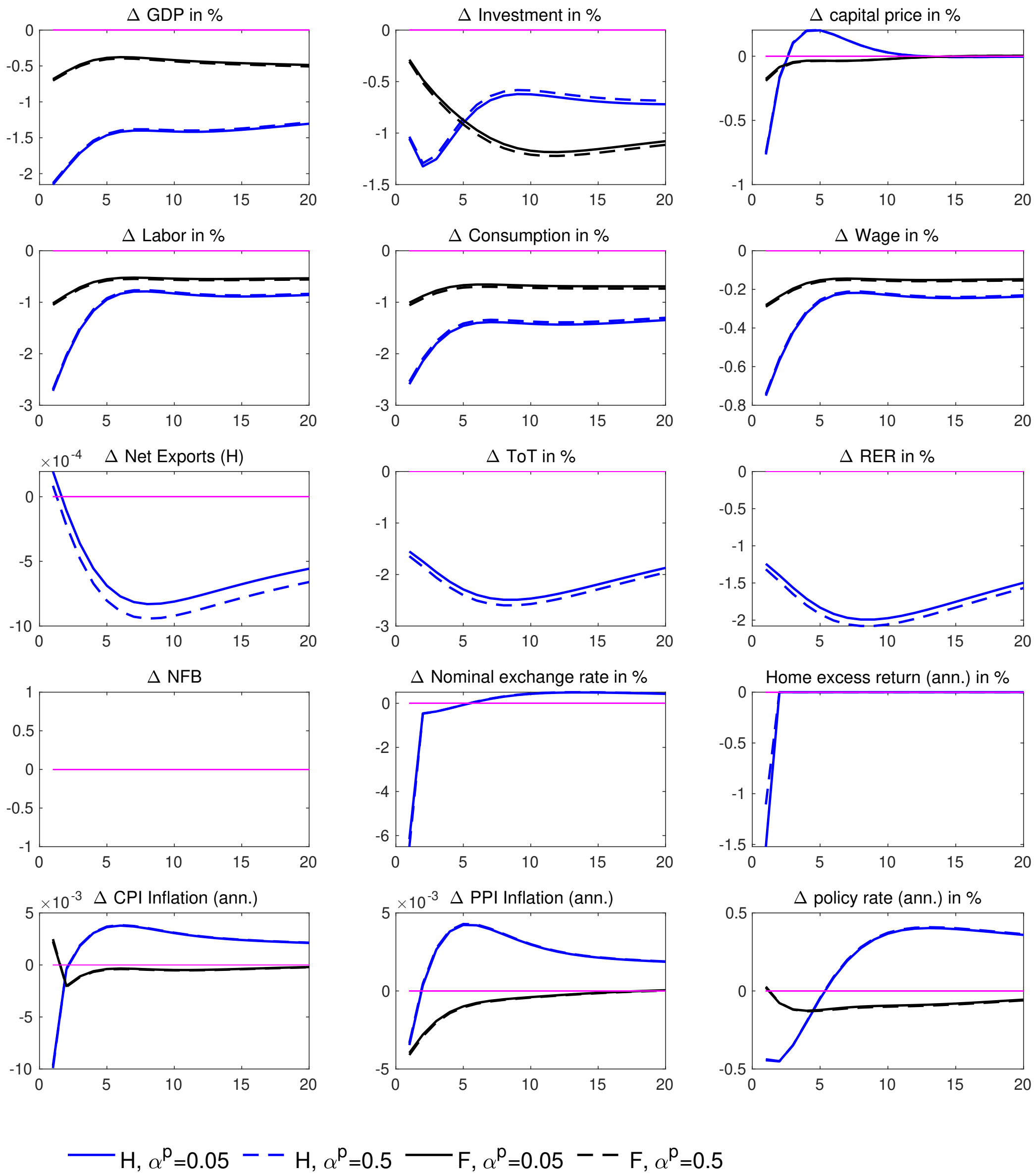

Figure 22: *Impulse responses to an adverse 1% home capital quality shock,* ε_Ψ

A.3 Additional Figures on Financial Integration and International Business Cycle Comovement

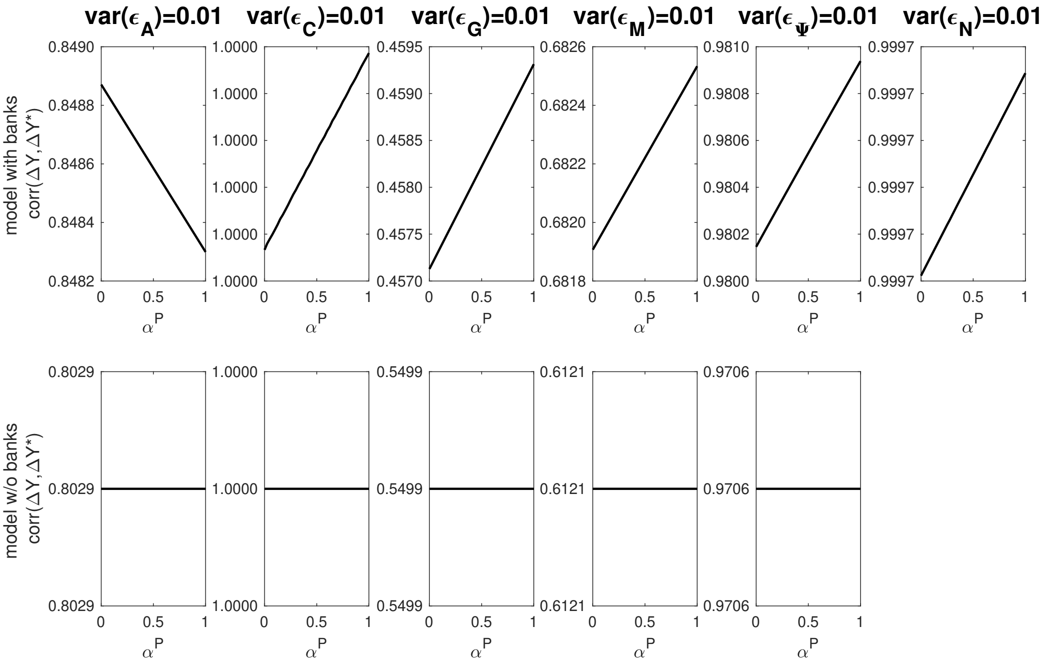

Figure 23: *Cross-country correlations of GDP growth (corr($\Delta Y, \Delta Y^*$)) for different degrees of portfolio exposure (α^P), assuming $\mu_c = 0.5$ (no RER fluctuations); in the presence of technology shocks (ε_A), preference shocks (ε_C), government spending shocks (ε_G), monetary policy shocks (ε_M), capital quality shocks (ε_Ψ) and net wealth shocks (ε_N)*

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