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The Integration of Imperfect Financial Markets: Implications for Business Cycle Volatility

by

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Abstract

During the last two decades, the degree of openness of national financial systems has increased substantially. At the same time, asymmetries in information and other financial market frictions have remain prevalent. We study both empirically and theoretically the implications of the opening up of national financial systems in the presence of financial market frictions for business cycle volatility. In our empirical analysis, we demonstrate that stylised facts suggest that countries with more developed financial systems have lower business cycle volatility. Financial openness has no strong impact on business cycle volatility, in contrast. In our theoretical analysis, we use a dynamic general equilibrium model to study the implications of the opening up of national financial markets and of financial market frictions for business cycle volatility. We find that the implications of opening up national financial markets for business cycle volatility are largely unaffected by the presence of financial market frictions.

Keywords: Business cycle volatility; Financial frictions; Financial market integration

JEL classification: F31, F32, F36, F41, E44

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1 Motivation

During the last decades, international financial markets have become more integrated, and international capital flows have grown rapidly. At the same time, financial market frictions in the form of information and transaction costs remain prevalent, as evidenced, for instance, by recent debates on weaknesses in corporate governance systems.[1] In this environment, international financial market integration may not only bring benefits by allowing for a better risk sharing among households and a better allocation of capital across countries. Rather, financial market integration may also increase business cycle volatility by magnifying the effects of existing distortions beleaguering national financial markets. If international financial market integration leads to increased instability in the form of greater business cycle volatility, policy makers may thus be tempted to slow down the process of international financial market integration.

Finding an answer to the question of how international financial market integration and financial market frictions interact in shaping business cycle volatility is therefore important. In this paper, we seek to answer this question by studying the interaction between international financial market integration, national financial market frictions, and business cycle volatility in the framework of a 'New Open Economy Macroeconomics' (NOEM) model of the type recently developed by Obstfeld and Rogoff (1995). The model we use in our analysis merges elements of the literature emphasizing the role of financial market integration for business cycle volatility (Sutherland 1996, Senay 1998) with elements of recent literature stressing the role of financial market frictions and 'financial accelerator'

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[1] The financial crises of Asia in the later 1990s, for instance, have been attributed to weak corporate governance systems by many observers. Also, fraud in US companies has

effects for macroeconomic fluctuations (Aghion et al. 1999, Bacchetta and Caminal 2000, Faia 2001a, 2001b, Gilchrist et al. 2002).

The basic building blocks of our model are the same as those in the NOEM model recently developed by Faia (2001a). Faia has built a financial accelerator mechanism à la Bernanke et al. (2000) into an otherwise standard NOEM model. Her NOEM model combines many of the elements that have been stressed in recent literature to be important for the general equilibrium modeling of the implications of financial market frictions for macroeconomic fluctuations. In addition, the structure of her model closely corresponds to other recent contributions analyzing the financial accelerator in open economies (see, among others, Gilchrist et al. 2002). Thus, using the model developed by Faia as a starting point for our analysis guarantees that we use a model with many features that are commonly used in the literature, implying that the results we derive do not hinge upon uncommon and arbitrary assumptions.

Our model differs from the model developed by Faia (2001a) with regard to the structure of international financial markets. Faia assumes that international financial markets are complete in an Arrow-Debreu sense and that there are no costs of trading financial assets internationally. In contrast, we model a bond economy with incomplete financial markets as in Obstfeld and Rogoff (1996). Moreover, we follow Sutherland (1996) and Senay (1998) in assuming that households incur transaction costs when undertaking positions in international financial markets. This implies that internationally traded domestic and foreign financial assets become imperfect substitutes. By varying the transaction costs for undertaking cross-border financial transactions, we can analyze how the integration of international financial markets affects macroeconomic fluctuations in the presence of financial market frictions.

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spurred debates on reforms of corporate governance systems. See Becht et al. (2002) for an extensive survey.

By combining the assumptions of incomplete financial market integration and financial market frictions, our model addresses two key features of real-world financial markets. First, our model assumes that international bond markets are integrated to a greater degree than international bank lending markets, which we consider to be perfectly segmented. Second, we focus on debt markets. This acknowledges the fact that international capital flows are dominated by debt rather than equity (see, e.g. Kraay et al. 2000).

We calibrate our model to study how financial market integration and financial market frictions affect the impact of exogenous monetary policy and productivity shocks on business cycle volatility. We find that the implications of financial market integration for business cycle volatility are largely unaffected by the presence of financial market frictions.

We organize the remainder of this paper as follows. In Section 2, we discuss some stylized facts of international financial market integration and present empirical evidence on the degree of financial frictions on national financial markets. Using cross-section regressions, we study how financial market integration and financial market frictions affect business cycle volatility. In Section 3, we provide a non-technical overview of the NOEM model we use to derive the results we report in this paper. In Section 4, we calibrate and simulate our NOEM model in order to analyze the implications for business cycle volatility of the opening up of national financial markets in the presence credit market frictions. In Section 4, we conclude and discuss the policy implications of our research. We provide technical details concerning the structure of our model at the end of the paper (Technical Appendix).

2 Financial Integration and Financial Frictions: Empirical Evidence

Because the model we present in Section 3 will focus on the impact of the integration of international financial markets and of credit market frictions on business cycle volatility, this section presents descriptive statistics as well as regression-based evidence on these variables.

2.1 Stylised Facts

The theoretical model that we use in Section 3 makes certain assumptions on the degree of international integration of different segments of financial markets and on the importance of financial frictions. More specifically, the model focuses on debt markets, and it assumes that bond markets are integrated to a greater degree than bank lending markets. Banking markets are perfectly segmented across countries whereas trading in bonds is possible internationally, albeit at certain costs. Moreover, domestic credit markets are assumed to be characterized by asymmetries in information, which make the costs of external debt finance a function of firms' net worth. Before we turn to a more detailed analysis of the link between these financial market structures and business cycle volatility, it is useful to review the relevant empirical evidence.

We consider the degree of international integration of different financial market segments first. Generally, barriers to integration can be either direct, taking the form of outright restrictions on capital flows, or indirect, taking the form of transaction and information costs. Because these indirect barriers to integration are difficult to measure, the empirical analysis below will use information on the presence of capital controls as proxies for the openness of financial systems. We use a 0/1-dummy that captures the fact whether countries maintain controls on cross-border capital flows. We measure capital controls in the mid-1990s, using a data set kindly provided by Gian-Maria Milesi-Ferretti. This data set is based on the IMF's surveys of exchange rate restrictions.

The summary statistics provided in Table 1 show that OECD countries have lower capital controls than non-OECD countries. This confirms that quite significant advances have been made towards increased financial integration, in particular in OECD countries.

— Insert Table 1 about here. —

At the same time, indirect barriers to integration in the form of transaction and information costs differ considerably among different financial market segments. While comprehensive and comparable indicators on the degree of financial integration of individual market segments across countries are difficult to obtain, the introduction of the euro has spurred research into the degree of integration of different financial market segments across Europe. Hence, the evidence obtained for European markets can serve as a case study for integration trends in OECD countries.

With regard to the degree of financial integration in general, evidence suggests an increasing openness of European financial markets that has been promoted by the Single Market program in 1992 as well as by the introduction of the euro in 1999 (Fratzscher 2002, Lemmen 1998). At the same time, the degree of integration of different financial market segments differs considerably. With regard to banking markets, studies find a general trend towards interest rate convergence across Europe, in particular for money markets, while retail interest rates still show relatively high degrees of dispersion across countries (Kleimeier and Sander 2000, Centeno and Mello 1999). Essentially, the interbank and the corporate bond market in Europe show a relatively large degree of integration already while the collaterized money market and equity markets are still largely national in scope (BIS 2001).

The model we use in Section 3 not only assumes that the degrees of integration of bond and banking markets differ, it also assumes that credit market frictions in the form of asymmetries in information between firms and banks persist on a domestic level. Again, it is difficult to obtain direct measures of the severity of information problems. Therefore, our empirical model will use the actual importance of credit markets in an economy, measured as the ratio of credit granted by commercial banks and by other financial institutions over GDP, as a

proxy. We have obtained these data from the database on financial structures around the world, which has been compiled by the World Bank.[2] We again use data for the mid-1990s.

As evidenced by Table 1, credit markets tend to be more important in OECD than in non-OECD countries. Similar cross-countries differences can be found for other financial market segments. In the EU, for instance, the importance of stock markets, measured in terms of market capitalization over GDP, varies between 184% in Luxembourg and 33% in Italy (Giannetti et al. 2002).

2.2 Regression Results

To what extent does the degree of financial openness and of financial market frictions have an impact on business cycle volatility across countries? Before we use our model to study this question, we provide a first, regression-based answer to this question. To setup our regression-based analysis, we proceed as follows. We use the standard deviation of the growth of real GNP (measured in 1995 US-Dollars) as a proxy for business cycle volatility.[3] Data are available for a sample of 76 countries. To analyze the determinants of business-cycle volatility in our cross-section of countries, we regress our measure of business cycle volatility on the volatility (i.e., standard deviation) of a number of control variables. To compute the standard deviations of the control variables, we use annual data for the 1990s. We have obtained the data from the CD-Rom *World Development Indicators 2002* of the World Bank. In addition to the volatility of the main variables of interest, i.e., the financial market variables that have been described above, we control for the volatility of government spending

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[2] The data can be downloaded from http://econ.worldbank.org/programs/finance/topic/finstructures/.

(standard deviation of the growth of general government final consumption expenditure in constant (1995) US-Dollars), and the volatility of monetary policy (coefficient of variation, i.e., standard deviation divided by the mean, of lending rates). We also use the volatility of real exchange rates as a proxy for productivity shocks (standard deviation of the growth of the real effective exchange rates index, 1990 = 100).

Table 1 gives the summary statistics of the data that we use. Generally, business cycle volatility and the volatility of our control variables are higher in non-OECD than in OECD countries. This holds for the volatility of GDP as well as for government spending. Interestingly though, the volatility of interest rates in OECD and non-OECD countries is fairly similar, the non-OECD countries being slightly more heterogeneous.

Equipped with these control variables, we estimate an equation of the form

$$\sigma_i^{cycle} = \alpha_0 + \sum_{i=1}^{m} \beta_i \sigma_t^{control} + u_i ,$$

where business cycle volatility (σ_i^{cycle}) depends on a constant intercept term, α_0, the volatility of the control variables ($\sigma_{i,t}^{control}$), and on a country-specific stochastic disturbance term, u_i.

Table 2 presents the regression results. To capture differences between OECD and non-OECD countries in business cycle volatility, we include a dummy variable which is set equal to one for OECD countries. The negative and significant sign that we obtain for this dummy variable suggests that economic development lowers business cycle volatility. We obtain qualitatively similar results when we use GDP per capita as an alternative proxy for economic development (results not reported). However, in contrast to the OECD-dummy, GDP per capita is less significant.

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[3] While it would be preferable to use more sophisticated filtering techniques such as Band-Pass- or HP-filters to isolate the cyclical component of the data, sample sizes have been too small for the developing countries to implement these methods.

— Insert Table 2 about here. —

Generally, higher volatility of lending rates and of government spending increases business cycle volatility. While volatility of government spending is generally significant at least at the 10 percent level, interest rate volatility becomes insignificant if credit over GDP is entered as an additional control variable. Moreover, results in column (7) of Table 2 show that higher volatility of the real exchange rates, which we use as a proxy for terms of trade and, thus, productivity shocks, has no significant impact on business cycle volatility in our cross-country regression.

As regards the effects of financial market conditions on business cycle volatility, our results suggest that larger credit markets are associated with lower business cycle volatility. However, this effect is not significant unless we enter the credit market variable separately for countries at different states of development (column 4). This specification shows that a higher volume of credit over GDP is associated with lower volatility of GDP in high-income countries only. Because, in this specification, the OECD dummy becomes insignificant, we cannot isolate the effect of economic development in general from the effects of the development of the financial system. Openness for foreign capital, as measured through the intensity of capital controls, has no significant impact on business cycle volatility. This result does not change if we split up the sample by income level.

Because work by, for instance, Aghion et al. (1999) suggests that the link between financial openness and business cycle volatility depends on the degree of development of the domestic financial system, we additionally include an interaction term between the size of credit markets and openness (see column 6 of Table 2). This interaction term is insignificant though. If we additionally include the proxies for openness and development (not reported), all variables become insignificant, and there is substantial multicollinearity in the data.

One interesting question is whether OECD and non-OECD countries differ only with regard to the level of business cycle volatility or also with regard to the impact of the control variables we use. We use two different methodologies to test for structural differences between these groups of countries (results not reported). First, we interact the OECD dummy with the remaining regressors. Second, we split the sample into the two sub-groups and estimate the equations separately. Both methods yield the same qualitative results. The interaction terms are insignificant. This suggests that differences between the OECD and the non-OECD countries do not work through the channels that we control for in our regressions, i.e., they are not systematically linked to differences in monetary and fiscal policy volatility or differences in financial systems. Moreover, some of the variables that we find to be significant determinants of business cycle volatility in the full sample are insignificant in the sub-samples (OECD versus non-OECD). Hence, the results that we obtain partly stem from the heterogeneity between these two country groups.

To sum up, in regression-based empirical analysis we have established the following three main stylized facts that our theoretical model must be compatible with:

- Business cycle volatility tends to be lower in more developed countries with more developed domestic credit markets.
- There is no evidence that business cycle volatility is linked significantly to the openness of the financial system.
- The implications of financial market openness and of credit market frictions for business cycle volatility tend to be largely independent of each other.

3 Overview of the Model

We now lay out a theoretical model that helps explain the results of our regression-based empirical analysis reported in Section 2. Here, we provide an overview of the structure of the

model. The main building blocks of the model are commonly used in the open-economy macroeconomics and international finance literature, so our discussion can be relatively brief. We give details concerning the mathematical specification of the various building blocks of the model at the end of the paper (Technical Appendix).

3.1 The Household and Production Sectors

Our model is a dynamic stochastic general equilibrium 'New Open Economy Macroeconmic' (NOEM) model. The basic structure of our model is identical to the structure of the model developed by Obstfeld and Rogoff (1996). As in their model, the world is made up of two countries. The countries are of equal size. Each country is inhabited by infinitely-lived identical households. Households form rational expectations and maximize their expected lifetime utility. Households save, invest in domestic and foreign nominal one-period bonds, make deposits at domestic financial intermediaries, and supply labor. Hence, with respect to the asset allocation choices of households, we depart from the workhorse NOEM model by allowing for the possibility that households hold deposits in addition to bonds. Also note that, while households may invest in either domestic or foreign bonds, they can only hold deposits with domestic financial intermediaries. As argued in Section 2, this assumption is consistent with the stylized facts on the different degrees of international integration of financial market segments.

In addition, each country features a production sector. As in Bernanke et al. (2000) and Faia (2001a), the production sector is made up of three types of firms: entrepreneurs, capital producers, and retailers. The entrepreneurs act in a competitive environment. Using a constant-returns-to-scale production function, they combine the labor supplied by households with physical capital to produce a wholesale good. The entrepreneurs hire labor in a perfectly competitive labor market. They buy physical capital from capital producers who act in a

competitive environment as well. Capital producers, in turn, use a production technology that embeds adjustment costs to produce capital goods (see Kiyotaki and Moore, 1997). The assumption that the production of capital goods involves adjustment costs adds variability to the real of price of capital (Tobins *Q*). This, in turn, contributes to the variability of the net worth of entrepreneurs and, as discussed below, reinforces the effects of the financial friction on macroeconomic fluctuations and, thereby, gives rise to a so-called 'financial accelerator' mechanism.

Retailers buy the wholesale good and differentiate it at no costs. They sell the differentiated good they produce in a monopolistically competitive goods market. The goods produced by retailers can be used as consumption goods and as investment goods. Each retailer has monopoly power on the market for its differentiated product. The retailers, therefore, treat the prices they charge for their products as a choice variable. In consequence, one has to specify a price setting mechanism. We follow McCallum and Nelson (2000) and Bernanke and Gertler (1999) in assuming that retailers behave according to a price-setting mechanism similar to the one introduced by Fuhrer and Moore (1995). This price-setting mechanism renders it possible that firms combine forward-looking and backward-looking elements when setting the prices of their products. Such a behavior is in line with recent empirical evidence (Gali et al. 2001).

3.2 The Domestic Credit Market

Following the literature, we built a financial accelerator into the model by assuming that the risk-neutral entrepreneurs finance the acquisition of physical capital by borrowing from a competitive domestic financial intermediation sector. The financial intermediaries get the money they need to finance these loans by collecting deposits from domestic households. Due to asymmetric information problems, financial intermediaries do not supply loans at the risk-free nominal interest rate. Rather, entrepreneurs encounter an external finance premium (defined as the costs of external funds minus the opportunity costs of internal funds) when

borrowing from financial intermediaries. The external finance premium makes uncollateralized external finance more expensive then internal finance and, thereby, affects the investment decisions of firms.

To motivate the existence of the external finance premium as a reflection of credit market frictions, we follow Bernanke et al. (2000). In their model, the credit market friction arises in a world in which returns on investment are stochastic and are a function of both idiosyncratic and aggregate risk. The core credit market friction that gives rise to the external finance premium is that the financial intermediaries, in contrast to entrepreneurs, can only observe the aggregate shock. This implies that, in the case of default of the entrepreneur, the financial intermediaries must pay a fixed auditing cost in order to observe the realized returns of the entrepreneur. In consequence, an agency problem arises due to the existence of a costly state verification problem as in Townsend (1979).

The opportunity cost of the financial intermediaries when supplying loans to firms is the risk-less interest rate. The reason is that, in equilibrium, the financial intermediaries can diversify away all idiosyncratic risk of lending to entrepreneurs by holding a perfectly diversified portfolio. Because households are risk averse and entrepreneurs are risk neutral, the latter bear the entire aggregate risk of their business. The existence of aggregate risk implies that the loan rate entrepreneurs must pay when borrowing from financial intermediaries is a function of the expected return on capital and, thus, of macroeconomic conditions. The reason for this is that the lower is the realized aggregate shock to the return on capital the higher is the default probability of entrepreneurs and, as a result, the higher is the realization of the idiosyncratic shock required such that the entrepreneur is able to repay the loan. Because entrepreneurs always have to offer the financial intermediaries a contract such that the expected return on the loan is equal to the risk-free interest rate, a higher required realization of the idiosyncratic shock implies that the external finance premium and, thus, the

costs of external finance increase. If entrepreneurs face a negative aggregate shock and their balance sheet worsens, they must compensate financial intermediaries for the increased probability of default. Because the entrepreneur balances in equilibrium the returns to capital and the marginal cost of external finance, this implies that, when choosing the amount of investment, the entrepreneur is constrained by the existence of the higher external finance premium.

The external finance premium is inversely linked to the strength of the net worth of entrepreneurs. This assumption introduces the 'financial accelerator' into the model. The net worth of entrepreneurs is defined as the sum of their liquid assets and the collateral value of illiquid assets minus outstanding obligations. Because entrepreneurs' net worth is pro-cyclical, the external finance premium is counter-cyclical. Due to the counter-cyclical behavior of the external finance premium, the credit market friction magnifies cyclical fluctuations. This is what Bernanke et al. (2000) call the 'financial accelerator' mechanism.

Finally, to prevent entrepreneurs from accumulating enough wealth to become fully self-financing, the assumption that entrepreneurs have finite lives is needed. Thus, in every period a certain number of entrepreneurs leave the model and new entrepreneurs enter the market for the production of the wholesale good.

3.3 International Financial Markets

The markets for deposits and loans are not the only financial markets in the model. In addition to the deposit and loans markets, which are perfectly segmented across countries, there is also a market for domestic and foreign nominal one-period bonds. Thus, households allocate their financial wealth across domestic deposits and domestic bonds as well as foreign bonds. While domestic bonds and deposits are perfect substitutes, domestic and foreign bonds are imperfect substitutes.

We introduce this feature into the model by assuming that households incur transaction costs when undertaking positions in the international bond market. Thus, when choosing the optimal allocation of their wealth, households have to take into account that international bond markets are not perfectly integrated. Whereas domestic (foreign) households have free access to the home (foreign) bond market, they incur transaction costs when undertaking positions in the international bond market. To model the transaction costs for undertaking positions in the international bond market, we follow Sutherland (1996), Senay (1998), and Benigno (2000) in assuming that the real transaction costs for cross-border capital movements are a convex function of the flow of funds transferred from the domestic to the foreign bond market.

The introduction of the assumption that domestic and foreign bonds are imperfect substitutes implies that the no-arbitrage condition of uncovered interest rate parity does not hold anymore in its most basic form. In its basic form, the condition of uncovered interest rate parity stipulates that, in a frictionless economy in which domestic and foreign interest bearing securities are perfect substitutes, the interest accrued from holding domestic securities must be identical to the expected return from holding foreign securities. The expected return from holding foreign securities is given by the sum of the yield on foreign securities and the expected rate of change of the nominal exchange rate.

In our model, this basic version of the condition of uncovered interest rate parity does not hold. Rather, a modified version of this no-arbitrage condition for international bonds markets applies. The modification of the condition of uncovered interest rate parity we have to make reflects that the transaction costs for undertaking positions in the international bond market drive a wedge between the returns on domestic and the returns on foreign bonds. Because the transaction costs are a function of the flow of funds involved in cross-border financial transactions (i.e., international capital flows), the wedge between the return on domestic and

the return on foreign bonds is a function of this variable as well. Only in the limiting case of no transactions costs, in which international bond markets become fully integrated, does the basic form of the condition of uncovered interest rate parity hold in our model. (See also the Appendix, Equation (A.8).)

3.4 The Government Sector

Finally, in order to close our model, we have to specify the government sector. We abstract from government purchases of consumption goods. This implies that the integral of lump-sum transfers taken over all households in the domestic and foreign economy, respectively, is zero. With respect to monetary policy, we assume that the short-term interest rate is the instrument used by the central bank. To formalize this notion, we model the interest-rate setting of the central bank by means of a simple central bank reaction function similar to the one used by Taylor (1993). The version of the Taylor rule we use has also been used by Bernanke et al. (2000) and Faia (2001). It stipulates that the central bank sets the nominal interest rate in response to deviations of inflation from a target level of inflation. In addition, the central bank reaction function we use captures the interest-rate smoothing objective of central banks (Goodfriend 1991).

4 Financial Market Integration, Financial Market Frictions, and Business Cycle Volatility

In this section, we use our model to analyze how the integration of international financial markets affects business cycle volatility in the presence of a 'financial accelerator' mechanism. In contrast to the previous NOEM literature studying the implications of financial market integration for business cycle volatility (Sutherland 1996, Senay 1998), we ask whether, and if so, how the effects of exogenous shocks differ in a world with financial integration from those in a world without financial integration if we additionally consider the

effects of frictions in domestic financial markets that give rise to a 'financial accelerator' mechanism.

To answer this question, we simulate our model numerically. To code up our numerical simulations, we take three steps. (1) We follow Obstfeld and Rogoff (1995) and many others and log-linearize the model around a symmetric monopolistic competition flexible-price steady state equilibrium in which the domestic and foreign asset positions are zero. (2) We then calibrate the model. The calibration of the model is given in Table 1 and closely follows Bernanke et al. (2000) and Faia (2001a) who use calibrated parameters that are consistent with U.S. and European data. We take the parameter describing the transactions costs for taking position in international bond markets from Sutherland (1996) and Senay (1998). Using the parameter values that are fairly standard in the literature assures that our results can be compared to those reported in the previous literature. It also assures that the results that drop out of our simulations do not depend upon arbitrary and empirically unreasonable numerical values for the structural parameters of our model. (3) We use the solution algorithm developed by Klein (2000) to solve our log-linearized model numerically.[4]

The remainder of this section comes in two parts. In the first part, we use impulse response functions to discuss how financial market integration affects the way exogenous shocks propagate through the economy. To illustrate how the model works, we discuss in some detail how a monetary policy shock propagates through the economy. We also analyze how financial market integration affects the macro-dynamic consequences of productivity shocks. In the second part, we analyze in detail how the presence of the financial accelerator

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[4] We use Paul Klein"s algorithm "solve.k" in Matlab to solve the model numerically. In our simulations of the model, we neglect the variation in terms that have no perceptible impact on dynamics (e.g., the terms capturing the consumption of entrepreneurs). See also the discussion in Bernanke et al. (1999).

mechanism affects the implications of the integration of financial markets for business cycle volatility.

4.1 Financial Market Integration and Macroeconomic Fluctuations

To analyze how the integration of international bond markets affects the way in which exogenous shocks propagate through the economy, we plot in Figures 1 and 2 impulse response functions to visualize the dynamic response of a number of key domestic variables to such exogenous shocks. The time units on the figures are quarters. The unanticipated, temporary exogenous shocks we consider are monetary policy and productivity shocks. For both monetary policy and productivity shocks we plot impulse response functions for a version of our model in which international capital mobility is low (dashed lines) and a version of our model in which international capital mobility is high (solid lines). If capital mobility is low, the transaction costs for undertaking positions in international financial markets are relatively high.

To analyze how the model works, consider the impulse response functions that summarize the macro-dynamic implications of a unit domestic monetary policy shock (Figure 1). The monetary policy shock implies that the domestic central bank raises the short-term nominal interest rate. Because the result is a rise in the domestic real interest rate, consumption decreases. Also, the domestic monetary policy shock implies that domestic bonds become more attractive relative to foreign bonds and the nominal exchange rate appreciates.

Because the prices of the differentiated goods produced in the retail sector adjust sluggishly, the nominal appreciation results in an appreciation of the domestic terms of trade, defined as the domestic currency price of foreign goods in terms of the home currency price of domestic goods. The appreciation of the terms of trade, in turn, makes domestic goods more expensive relative to foreign goods and leads, thereby, to a decline in home output and

to a deterioration of the trade balance. The deterioration of the trade balance implies that the foreign asset position of the domestic economy starts declining.

— Insert Figure 1 about here. —

Why does the degree of international financial market integration matter for the dynamics of the model in the aftermath of a monetary policy shock? With international financial markets being imperfectly integrated, the impact of the monetary policy shock on the dynamics of the foreign asset position is directly reflected in the condition of uncovered interest rate parity. As detailed in the Appendix (see equation (A.8)), this condition stipulates that, at any point in time, the international nominal interest rate differential is proportional to the sum of the expected rate of change of the nominal exchange rate and the expected rate of change of the cross-border flow of funds. This direct effect of the change in the foreign asset position on the international nominal yield differential does not arise in a world of perfect international capital mobility.

It follows from the dynamics of the trade balance discussed above that the expected rate of change of the cross-border flow of funds is *positive* in the aftermath of a monetary policy shock, i.e., the domestic country starts exporting financial capital. To see this, note that the trade balance deficit realized in the immediate aftermath of the monetary policy shock gradually turns into a surplus as the domestic currency starts depreciating again. From this it immediately follows that the *expected rate of change* of the cross-border flow of funds is positive. This, in turn, implies that, for any given interest rate differential, the expected rate of depreciation of the domestic currency must be smaller with segmented international financial markets. As a result, the initial appreciation of the Home currency is less pronounced when international financial markets are segmented.

From this argument it follows that the output effect of the monetary policy shock is larger in the case of high capital mobility than in the case of low capital mobility. Thus, as in workhorse model of international macroeconomists, the by now classic Mundell-Fleming model (Fleming 1962, Mundell 1963), switching from a world of low to a world of high international capital mobility increases business cycle volatility. This result is in line with the results derived in a similar NOEM model by Sutherland (1996).

The traditional Mundell-Fleming mechanism is not the only mechanism through which monetary policy shocks affect macroeconomic dynamics. A further mechanism that has to be taken into consideration when analyzing how a monetary policy shock propagates through our model economy is the 'financial accelerator' mechanism. To see more clearly how the financial accelerator works, it is useful to realize that the increase in the nominal and the real interest rate brought about by the monetary policy shock deteriorates the financing conditions for investment and, thus, slows down capital accumulation. As investment declines, the price of capital (Tobin's Q) declines as well. The decline in the price of capital worsens entrepeneurs' balance sheets and gives rise to an increase in the external finance premium. Any rise in the external finance premium increases entrepeneurs' costs of loans and this, in turn, reinforces the decrease in the demand for investment goods. This spiral of a deterioration of investment conditions, a decrease in the net worth of entrepeneurs, and a rise in the external finance premium is what is known in the literature as the 'financial accelerator' mechanism (see Bernanke et al. 2000).

The 'financial accelerator' mechanism is also at work if a domestic productivity shock hits the economy. As revealed by Figure 2, a productivity shock results in an output boom and, as reflected in the increase in consumption, leads to a decline in the real interest rate. The decline in the real interest rate, in turn, spurs investment and results in an increase in the real price of

capital. This improves entrepreneurs' balance sheets and reduces the external finance premium, which, in turn, provides a further stimulus for investment.

— Insert Figure 2 about here. —

It is also worth noting that the effect of the productivity shock on the real price of capital and on investment is less pronounced if capital mobility is high.[5] The reason is that, if capital mobility is high, the productivity shock exerts a relatively strong effect on the nominal exchange rate and, thus, on the terms of trade. Movements in the terms of trade, in turn, have a direct effect on the real value of the net worth of entrepreneurs and, thus, on the external finance premium. From this argument it follows that the investment boom triggered by the productivity shock must be less strong if capital mobility is high.

4.2 Financial Market Integration, the Financial Accelerator, and Business Cycle Volatility

So far, our discussion has centered on the question how the integration of international financial markets may effect the propagation of a given exogenous (monetary policy or productivity) shock. In this discussion, we implicitly assumed that the parameter capturing the strength of the 'financial accelerator' mechanism in credit markets (the elasticity of the external finance premium with respect to the leverage ratio) is fixed at a certain level. We now turn to the question how the integration of international financial markets shapes the effects of exogenous shocks under alternative assumptions regarding the numerical value of the parameter capturing the prevalence of the 'financial accelerator' mechanism. This discussion allows tracing out whether there are significant interdependencies between

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[5] Similar arguments apply in the case of a monetary policy shock.

financial market integration and financial market frictions in terms of their effects on business cycle volatility.

To start our discussion, we plot in Figures 3 and 4 the amplitude of the impulse response functions as observed during a time interval of twenty periods following a unit domestic monetary policy shock and a unit domestic productivity shock, respectively, on the vertical axis. The elasticity of the external finance premium with respect to the leverage ratio is plotted on the horizontal axis.[6] Thus, when moving from the left to the right on the horizontal axis, the severity of the friction in the credit market increases.

— Insert Figures 3 and 4 about here. —

Figures 3 and 4 show that the magnitude of the effects of domestic monetary policy and productivity shocks depends upon the degree of international capital mobility and on the severity of the friction in the credit market. For example, the figures reveal that the impact of monetary policy and productivity shocks on output is increasing in the severity of the friction in the credit market as measured in terms of the elasticity of the external finance premium with respect to the leverage ratio. This result is in line with the results of the regression-based analysis presented in Section 2, which have shown that business cycle volatility tends to be an inverse function of the degree of development of the domestic credit market.

The figures also depict that switching from low to high capital mobility in general results in an increase in the effect of monetary and productivity shocks on output and the nominal exchange rate. Thus, business cycle volatility tends to be higher the higher is the degree of

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[6] We use the amplitude of the impulse response function rather than its variance to measure the magnitude of the effects of the exogenous shock because the foreign bond holdings of private households are not stationary. It would be straightforward to add to our model a modelling device that would make the foreign asset position of private households and, thus, the initial steady state around which the model is log-linearized stationary (Schmitt-Grohe und Uribe 2002).

capital mobility. In this respect it is also worth noting from Figures 3 and 4, but also from Figures 1 and 2, that this effect tends to be relatively small in quantitative terms. This result is also in line with the result of the regression-based analysis presented in Section 2 that the link between business cycle volatility and financial openness tends to be not very strong.

A further result depicted in Figures 3 and 4 is that the changes in the magnitude of the output effects of monetary policy and productivity shocks and, thus, changes in business cycle volatility resulting from switching from low to high capital mobility are largely independent of the severity of the friction in the credit market. This result follows from the fact that in the case of output the dashed lines plotted in the figures more or less parallel the solid lines. Thus, in line with the empirical evidence reported in Section 2, the implications of financial market integration and of financial market frictions for business cycle volatility are largely independent of each other.[7]

5 Concluding Remarks

In this paper, we documented three stylized fact concerning the linkage between international financial market integration, financial market frictions, and business cycle volatility and have suggested a theoretical model that helps explaining these stylized facts. The three stylized facts we established are: (i) Empirically, the link between business cycle volatility and the openness of the financial system is not very strong. (ii) Business cycle volatility tends to be lower in more developed countries with more develop domestic credit markets. (iii) The implications of financial market openness and of credit market frictions for business cycle volatility tend to be largely independent of each other. To explain these facts, we used a

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[7] This result indicates that the results reported by Sutherland (1996) and Senay (1998), who do not consider the effects of financial market frictions when analysing the link between

dynamic, stochastic NOEM model that features credit market frictions and transaction costs for undertaking positions in international bond markets. Our simulations of the model revealed that this model is broadly consistent with the three stylized facts our empirical analysis has revealed: financial openness has only a small impact on business cycle volatility, a reduction of domestic financial market frictions lowers business cycle volatility, and the impact of financial development and financial openness is largely unrelated.

The result of this paper that the impact of financial opening on business cycle volatility seems to be largely independent from the state of development of the domestic financial system seems to be at odds both with recent theoretical literature and with current policy discussions. Recent theoretical work by Aghion et al. (1999), for instance, shows that financial opening might be harmful for countries at medium levels of financial market development as it may aggravate instabilities. Recent episodes of currency and banking sector crises seem to have shown that these interaction effects are in fact empirically important. In many instances, the severity of currency crises has been linked to weaknesses in domestic financial systems. These experiences have revived an old debate on the appropriate sequencing of internal and external financial liberalization and, in fact, many observers conclude that financial systems should open up for foreign capital only if domestic financial systems have been reformed sufficiently.

The focus of this paper differed from the discussion on the appropriate sequencing of financial liberalization in two main regards. The first main difference between our paper and the literature dealing with the optimal sequencing of external and internal financial liberalization is that we did not analyse countries that are facing the risk of an acute financial crisis. Rather, we described the longer-term linkages between financial openness and financial development, on the one hand, and the volatility of the real economy, on the other hand. Most

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financial market integration and macroeconomic volatility, tend to be robust with respect

importantly, we ruled out fixed exchange rates or other forms of exchange rate management. Therefore, we cannot use the paper to draw conclusions with regard to policy responses that are appropriate if speculative pressure on a currency is building up.

The second main difference between this paper and the sequencing literature is that we considered countries that can use their own currency when contracting with foreign counter parties. We did not, in other words, study cases in which the currency of denomination of domestic transactions is that of the foreign country, as is the case for many developing countries and emerging markets. Hence, our analysis is applicable in a strict sense only to relatively mature market economies.

Despite these obvious differences to the literature on the optimal sequencing of internal and external financial liberalization, our paper holds some interesting implications. Perhaps the most important message is that often articulated fears that the ongoing international integration of financial markets may amplify the effects of distortions in national financial markets and may, thereby, lead to greater economic instability may not be justified. While both the empirical and theoretical framework in principle allow for the interaction between frictions on domestic financial markets and financial openness, these effects do not seem to be important in quantitative terms. In our theoretical model, feedback effects between financial openness and financial development would work through the impact of financial openness on Tobin's Q and the real exchange rates. However, under plausible parameter constellations, these feedback channels do not seem to be important quantitatively.

In our empirical model, we likewise did not detect significant interaction effects between financial openness (i.e., the presence of controls on cross-border financial credits) and the size of the domestic credit market, which we used as a proxy for the state of development of the domestic financial system. Yet, while the degree of openness of countries does not seem to be

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to the specification of the credit market.

of empirical significance in explaining volatility, a higher degree of development of the domestic financial system seems to be associated with lower volatility. Through this channel, financial openness might indirectly impact upon volatility. This is because there is evidence that the state of financial development is endogenously related to the degree of financial openness of countries (see, e.g, Kaminsky and Schmukler 2001, Rajan and Zingales 2001).

The expected enlargement of the European Union is one policy area for which the results of this paper are important. The accession states of Central and Eastern Europe are expected to join the EU in the year 2004. Inter alia, accession will imply the full abolition of remaining controls on the free flow of capital across borders as well as further development of the domestic financial system through participation in the Single Market for capital. Our results suggest that the benefits of financial integration are likely to outweigh the risks in terms of increased instabilities.

However, more research into the links between financial openness, financial sector development, and business cycle volatility will be required to test the robustness of these results. This research should address two main issues. First, the accession states of Central and Eastern Europe are required to participate in the European Exchange Rate Mechanism (ERM2) before being considered to participate in the euro. Fixing the exchange rate, in turn, is likely to introduce instabilities and speculative dynamics, an issue we did not address in this paper. Second, future research should pay more attention to the potential causes of differences between the business cycle characteristics of emerging markets and industrialized countries. Research into the growth effects of capital account liberalization shows that countries that are at different stages of their development process benefit from financial liberalization to quite different degrees (for recent evidence see Klein 2003), and there is also evidence that business cycle volatility in emerging markets shows patterns different from business cycle volatility in

developed countries (Kose et al. 2002). Exploring the causes for these differences both in theoretical and empirical work will be a challenging task for future research.

6 References

Aghion, P., P. Bacchetta, and A. Banerjee (1999). Capital Markets and the Instability of Open Economics. In: P.R. Agenor, M. Miller, D. Vines, and A Weber (eds.). *The Asian Financial Crisis: Causes, Contagion, and Consequences*. Cambridge University Press. Forthcoming.

Bacchetta, P., and R. Caminal (2000). Do capital market imperfections exacerbate output fluctuations? *European Economic Review* 44 (3): 449–468.

Bank for International Settlements (BIS) (2001). *70th Annual Report*. Basle.

Becht, M., P. Bolton, and A. Röell (2002). Corporate Governance and Control. National Bureau of Economic Research (NBER). Working Paper 9371. Cambridge, MA.

Bernanke, B.S., and A.S. Blinder (1988). Credit, Money, and Aggregate Demand. *American Economic Review* 78(2): 435–439.

Bernanke, B.S., M. Gertler, and S. Gilchrist (2000). The Financial Accelerator in a Quantitative Business Cycle Framework. In: Taylor, J., and M. Woodford (eds.), *Handbook of Macroeconomics*, Amsterdam: North Holland, chapter 21.

Centeno, M., and A.S. Mello (1999). How Integrated are the Money Market and the Bank Loans Market Within the European Union? *Journal of International Money and Finance* 18: 75–106.

Faia, E. (2001a). Stabilization Policy in a Two Country Model and the Role of Financial Frictions. Working Paper No. 56. European Central Bank. Frankfurt am Main, Germany.

Faia, E. (2001b). Monetary Policy in a World with Different Financial Systems. New York University. October. mimeo.

Fleming, J.M. (1962). Domestic financial policies under fixed and under floating exchange rates. *I.M.F. Staff Papers* 9: 369 – 379.

Fratzscher, M. (2002). Financial Market Integration in Europe: On the Effects of EMU on Stock Markets. *International Journal of Finance and Economics* 7: 165-193

Fuhrer, Jeffrey C. and George R. Moore (1995). Inflation Persistence. *Quarterly Journal of Economics* 110: 127 – 159.

Gali, Jordi, Mark Gertler, and David Lopez-Salido (2001). European Inflation Dynamics. *European Economic Review* 45: 1237-1270.

Giannetti, M, L. Guiso, T. Jappelli, M. Padula, and M. Pagano (2002). Financial Market Integration, Corporate Financing and Economic Growth. European Commission. Economic Papers 179. November. Brussels.

Gilchrist, Haircault, and Kempf (2002). Financial Integration in a Monetary Union. Working Paper No. 175. European Central Bank. Frankfurt am Main, Germany.

Goodfriend, M.S. (1991). Interest rates and the conduct of monetary policy. *Carnegie-Rochester Conference Series on Public Policy* 34: 7-30.

Kaminsky, G.L., and S.L. Schmukler (2001). On Booms and Crashes: Financial Liberalization and Stock Market Cycles. George Washington University and The World Bank. mimeo.

Kiyotaki, N. and J. Moore (1997). Credit cycles. *Journal of Political Economy* 105: 211 – 248.

Kleimeier, S., and H. Sander (2000). Regionalisation versus Globalisation in European Financial Market Integration: Evidence from co-integration analyses. *Journal of Banking and Finance* 24: 1005–1043.

Klein, Michael W. (2003). The Variety of Experience of the Effect of Capital Account Openness on Growth. Fletcher School, Tufts University, and NBER. Mimeo.

Klein, Paul (2000). Using the Generalized Schur Form to Solve a Multivariate Linear Rational Expectations Model. *Journal of Economic Dynamics and Control* 24: 1405 – 1423.

Kose, M.A., E.S. Prasad, and M. Terrones, 2002, Financial Integration and Macroeconomic Volatility, International Monetary Fund, Washington D.C. mimeo.

Lemmen, J. (1998). *Integrating Financial Markets in the European Union.* Cheltenham and Northhampton (Edward Elgar).

McCallum, B. and E. Nelson (2000). Monetary policy for an open economy: an alternative framework with optimizing agents and sticky prices. *Oxford Review of Economic Policy* 16: 74 – 91.

Mundell, R.A., 1963. Capital mobility and stabilization policy under fixed and flexible exchange rates. *Canadian Journal of Economics and Political Science* 29: 475 – 485.

Obstfeld, Maurice and Kenneth Rogoff (1995). Exchange Rate Dynamics Redux. *Journal of Political Economy* 103: 624 – 660.

Rajan, R.G., and L. Zingales (2001). The Great Reversals: The Politics of Financial Development in the 20th Century. National Bureau of Economic Research. NBER Working Paper 8178. Cambridge, MA..

Schmitt-Grohe, S. and M. Uribe (2002). Closing Small Open Economy Models. *Journal of International Economics* (forthcoming)

Senay, O. (1998). The Effects of Goods and Financial Market Integration on Macroeconomic Volatility. *The Manchester School Supplement* 66: 39–61.

Sutherland, A. (1996). Financial Market Integration and Macroeconomic Volatility. *Scandinavian Journal of Economics* 98: 129–539.

Taylor, John B. (1993). Discretion versus Policy Rules in Practice. *Carnegie-Rochester Conference Series on Public Policy* 39: 195 – 214.

Townsend, R.M. (1979). Optimal contracts and competitive markets with costly state verification. *Journal of Economic Theory* 21: 265 – 293.

7 Technical Appendix

In this Technical Appendix, we briefly sketch the basic building blocks of our model. Many elements of our model are as in Bernanke et al. (2000) and Faia (2001). In particular, we draw on their work to model the production and financial intermediation sector of our economy. The main difference between their models and our model is that we follow Sutherland (1996) and Senay (1998) in assuming that international bonds markets are segmented due to transaction costs for undertaking positions in international asset markets. This implies that in our model the domestic and foreign bond holdings of households are additional state variables and that the no-arbitrage condition of uncovered interest rate parity has to be modified to account for the transaction costs.

7.1 Households

Home and Foreign households have identical preferences and maximize the present value of their expected lifetime utility. The expected lifetime utility of a Home household is defined as $U_t = \mathbb{E}_t \sum_{s=t}^{\infty} \beta^{s-t} u_s$, with $0 < \beta < 1$ being the households' subjective discount factor and $\mathbb{E}_t$ denoting the conditional expectations operator. For simplicity, we assume that the period-utility function, u_t, is logarithmic in its arguments consumption and hours worked: $u_t = \ln(C_t) - \ln(N_t)$, where C_t denotes a real consumption index and N_t is the households' labor supply (i.e., hours worked). The aggregate consumption index, C_t, is an aggregate of an index of Home consumption goods, C_t^h, and of an index of Foreign consumption goods, C_t^f:

$$C_t = \left[(1-\gamma)^{1/\eta} (C_t^h)^{(\eta-1)/\eta} + \gamma^{1/\eta} (C_t^f)^{(\eta-1)/\eta}\right]^{\eta/(\eta-1)}, \qquad \text{(A.1)}$$

where $\eta > 0$ denotes the elasticity of substitution between the Home and Foreign consumption index. The index C_t^h (C_t^f) is defined as a CES aggregate over a continuum of

differentiated, perishable Home (Foreign) consumption goods. The parameter γ captures the degree of openness of the economy. Home and Foreign retailers sell the consumption goods in a monopolistically competitive goods market. The indices C_t^h and C_t^f can be expressed as

$$C_t^h = \left[\int_0^1 \{c_t^h(z)\}^{(\varepsilon-1)/\varepsilon} dz\right]^{\varepsilon/(\varepsilon-1)} \quad \text{and} \quad C_t^f = \left[\int_0^1 \{c_t^f(z)\}^{(\varepsilon-1)/\varepsilon} dz\right]^{\varepsilon/(\varepsilon-1)}, \qquad \text{(A.2)},$$

where $c^j(z)$, $j = h, f$ denotes consumption of good z and $\varepsilon > 1$ denotes the elasticity of substitution between consumption goods produced within the same country. The optimal consumption allocation is standard:

$$C_t^h(z) = \left[p_t^h(z)/P_t^h\right]^{-\varepsilon} C_t^h \quad \text{and} \quad C_t^f(z) = \left[p_t^f(z)/P_t^f\right]^{-\varepsilon} C_t^f, \qquad \text{(A.3)}$$

where $p_t^h(z)$ denotes the Home currency price of a good produced at Home and $p_t^f(z)$ denotes the Home currency price of a good produced abroad. The price index P_t^h (P_t^f) is defined as the minimum expenditure required for buying one unit of the index of Home (Foreign) consumption goods, C_t^h (C_t^f). The aggregate Home price index is of the form:

$$P_t = \left[(1-\gamma)(P_t^h)^{1-\eta} + \gamma(P_t^f)^{1-\eta}\right]^{1/(1-\eta)}. \qquad \text{(A.4)}$$

Preferences are identical at Home and abroad, the law-of-one-price holds for each differentiated good, and purchasing power parity holds: $P_t = E_t P_t^*$, where P_t^* denotes the aggregate Foreign price index measured in terms of the Foreign currency, given by a formula similar to that given in (A4).

7.2 The Structure of International Financial Markets

Households allocate their wealth across domestic deposits and Home and Foreign nominal risk-free one-period bonds. When choosing the optimal allocation of their wealth, households have to take into account that international financial markets are imperfectly integrated. Home (Foreign) households have free access to the Home (Foreign) bond market but incur

transaction costs when undertaking positions in the international bond market. The transaction costs, Z_t, of undertaking positions in the international asset market incurred by Home households are given by (see also Sutherland 1996)

$$Z_t = 0.5\psi G_t^2, \tag{A.5}$$

where $\psi > 0$ is a positive constant, and G_t denotes the level of real funds transferred by Home households from the Home to the Foreign bond market. Both Z_t and G_t are denominated in terms of the aggregator for Home consumption goods.

Total income received by Home households consists of the yield on their holdings of Home and Foreign bonds, the interest accrued upon making deposits at Home financial intermediaries, the profit income for the ownership of Home firms, and the labor income. Given total income, households determine their optimal consumption and decide on their preferred deposit and bond holdings. In addition, they receive transfers from the government and incur the transaction costs for undertaking positions in the international bond market. The dynamics of Home households' domestic bond holdings are, therefore, given by

$$\begin{aligned} D_{t+1} + I\!E_t d_{t+1} B_{t+1} = B_t + w_t N_t - \int_0^1 \left(p_t^h(z) c_t^h(z) - p_t^f(z) c_t^f(z) \right) dz \\ - P_t^H Z_t - P_t^H G_t + R_{t-1} D_t + \Pi_t + T_t, \end{aligned} \tag{A.6}$$

where B_t denotes for the quantity of Home currency denominated nominal bonds with price d_t, R_t denotes the nominal interest rate on Home deposits, D_t, and T_t denotes for the lump-sum transfers the household receives from the Home government. The variable w_t denotes the nominal wage rate earned in a perfectly competitive domestic labor market, and Π_t denotes the nominal profit income the household receives from the Home production sector. The dynamics of the Home households' Foreign bond holdings are given by

$$I\!E_t d_{t+1}^* F_{t+1} = F_t + (P_t^h / E_t) G_t, \tag{A.7}$$

where d_t^* denotes the Foreign currency price of one unit of the Foreign bond. Whereas Home (Foreign) bonds and Home (Foreign) deposits are perfect substitutes, so that $R_t = 1/I\!E_t(d_{t+1})$ ($R_t^* = 1/I\!E_t(d_{t+1}^*)$), the transaction costs for undertaking positions in international bond markets imply that Home and Foreign bonds are imperfect substitutes. Specifically, the transaction cost function given in (A.5) implies that, from the optimization of Home households, the following log-linear version of the no-arbitrage condition of uncovered interest rate parity applies:

$$I\!E_t(\hat{E}_{t+1} - \hat{E}_t) = (\hat{R}_t - \hat{R}_t^*) - \tilde{\psi} I\!E_t(\hat{G}_{t+1} - \hat{G}_t), \tag{A.8}$$

where $\tilde{\psi} \equiv \psi \overline{C}$ ($\overline{C}$ denotes steady-state consumption) and a variable with a hat denotes the percentage deviation from the steady state. A similar equation applies for Foreign households.

Financial market equilibrium requires that the Home and Foreign credit markets and that the markets for Home and Foreign bonds clear. In the case of the bond markets, this requires $B_t + F_t^* = 0$ and $B_t^* + F_t = 0$.

7.3 The Production Sector

Entrepreneurs hire labor and buy capital to produce a wholesale good according to the following Cobb-Douglas production function:

$$y_t = A_t K_{t-1}^{\alpha} N_t^{1-\alpha}. \tag{A.9}$$

The term A_t denotes a stochastic productivity shock that follows an autoregressive process of order one. The term K_{t-1} is the capital stock produced in period $t-1$ and used in production in period t. Competitive capital producers produce the capital stock. They buy retail goods and combine them according to the aggregator given in (A.2) to form investment goods. The law of motion of the capital stock is given by

$$K_{t+1} = \phi(I_t / K_t)K_t + (1-\delta)K_{t-1}, \tag{A.10}$$

where δ denotes the depreciation rate, I_t denotes investment, and the positive, increasing, concave, and twice-differentiable function $\phi(\cdot)$ is a production function for capital goods that embeds adjustment costs. Profit maximization of capital producers implies that the real price of capital, Q_t, is determined by:

$$Q_t = 1/\phi'(I_t / K_t). \tag{A.11}$$

The aggregate demand for capital from entrepreneurs is determined by computing the total expected real return on capital, $I\!E_t(R^K_{t+1})$ as:

$$I\!E_t(R^K_{t+1}) = I\!E_t\{(mc_t \alpha Y_t / K_t + Q_{t+1}(1-\delta))/Q_t\}, \tag{A.12}$$

where mc_t denotes real marginal costs.

We complete our description of the production sector by specifying an aggregate supply schedule. To this end, we assume that retailers set prices according to a price-setting mechanism similar to the one introduced by Fuhrer and Moore (1995). We assume that retailers' price setting decisions can be described as a function of the weighted arithmetic average of lagged and expected inflation and of marginal costs. The price setting equation for a Home firm can be expressed as:

$$d\hat{p}^h_t(z) = 0.5[d\hat{p}^h_{t-1}(z) + I\!E_t d\hat{p}^h_{t+1}(z)] + \Psi \hat{mc}_t, \tag{A.13}$$

where Ψ is a positive constant. Given the price of the differentiated good, the quantity produced by the firm can be derived from the demand function for this good:

$$Y^H_t = (p^h_t(i)/P^h_t)^{-\varepsilon}(C^h_t + C^{h*}_t + I^h_t + Z_t). \tag{A.14}$$

7.4 Financial Intermediation

Financial intermediaries collect deposits from Households and give loans to entrepreneurs. Due to the existence of the agency problem described in Section 3, entrepreneurs face an

external finance premium when borrowing from financial intermediaries to finance their investment. Bernanke et al. (2000) derive the optimal financial contract for this agency problem and Faia (2001a) shows how their solution can be applied in an open economy model. Drawing on their results, we assume that the external finance premium encountered by entrepreneurs when borrowing from financial intermediaries is given by:

$$I\!E_t(R^K_{t+1})/(R^r_t P_t / P^h_t) = -\varphi(\Pi_{t+1} / Q_t K_{t+1}), \tag{A.15}$$

where R^r_t denotes the Home real interest rate and the function φ describes the functional form of the link between entrepreneurs balance sheets and the external finance premium. This equation states that the external finance premium (expressed in terms of the Home consumption good) is an inverse function of the ratio of the net wealth, Π_t, of entrepreneurs and capital valued at the real price of capital, Q_t. The law of motion of the (aggregate) net worth of entrepreneurs is determined by the difference between the return on capital and the cost of loans:

$$\Pi_{t+1} = \xi\left(R^K_t Q_{t-1} K_t - (1+LL)(1+R_{t-1}P_t / P^h_t)(Q_{t-1}K_t - \Pi_t)\right), \tag{A.16}$$

where LL is the *ex post* cost of loans and ξ is the survival probability of entrepreneurs. The assumption that entrepreneurs have a finite live assures that they do not accumulate enough wealth to be fully self-financing.

7.5 The Government Sector

As regards fiscal policy, we abstract from government purchases of consumption goods. This implies that $\int_0^1 T(z)dz = 0$. With respect to monetary policy, we rely on a relatively simple central bank reaction function (see also Bernanke et al. 2000, Faia 2001a). According to our reaction function, the central bank sets the nominal interest rate in response to deviations of inflation from a target level:

$$\hat{R}_t = \mu_1(d\hat{P}_{t-1} - \overline{\pi})] + \mu_2 \hat{R}_{t-1} + \varepsilon_{R,t}\,, \tag{A.17}$$

where $\varepsilon_{R,t}$ is a serially uncorrelated stochastic disturbance term, $\overline{\pi}$ denotes the inflation target of the central bank, and μ_1 and μ_2 are parameters that capture the reaction of the central bank to deviations of the inflation rate from its target level. The interest-rate smoothing objective of the central bank is reflected in the parameter μ_2.

Figure 1 – Domestic Monetary Policy Shock and Business Cycle Volatility: The Impact of Financial Openness

The figures show the effects of a unit domestic monetary policy shock under different assumptions concerning the degree of financial openness. Results are derived for regimes of low and high capital mobility where dashed lines obtain when setting the parameter capturing the transaction costs for cross-border financial transactions equal to 5 and solid lines obtain when this parameter is set equal to 0. The calibration of the model is as given in Table 3. All variables are measured as percentage deviations from the steady state.

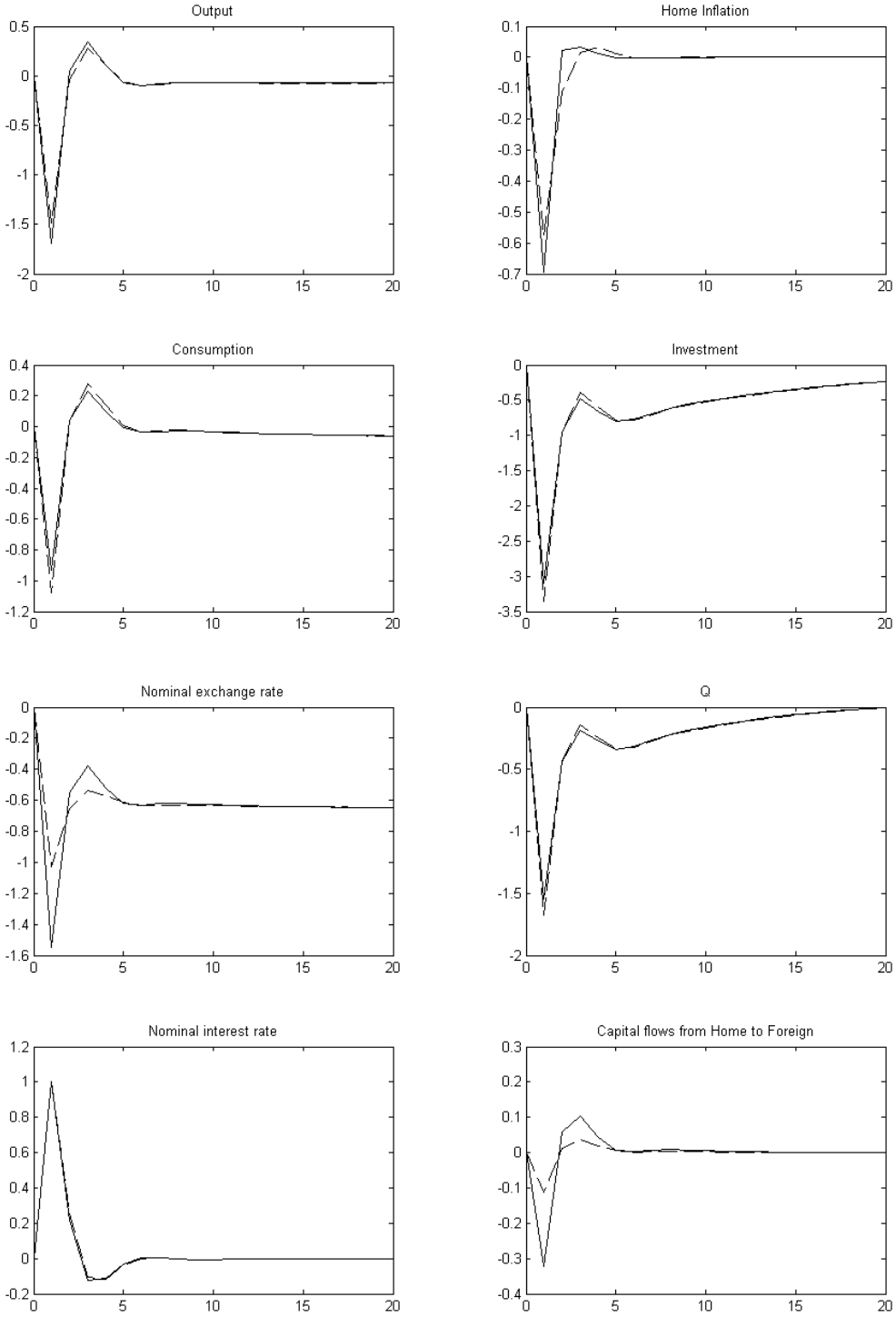

Figure 2 – Domestic Productivity Shock and Business Cycle Volatility: The Impact of Financial Openness

The figures show the effects of a unit domestic productivity shock under different assumptions concerning the degree of financial openness. Results are derived for regimes of low and high capital mobility where dashed lines obtain when setting the parameter capturing the transaction costs for cross-border financial transactions equal to 5 and solid lines obtain when this parameter is set equal to 0. All variables are measured as percentage deviations from the steady state.

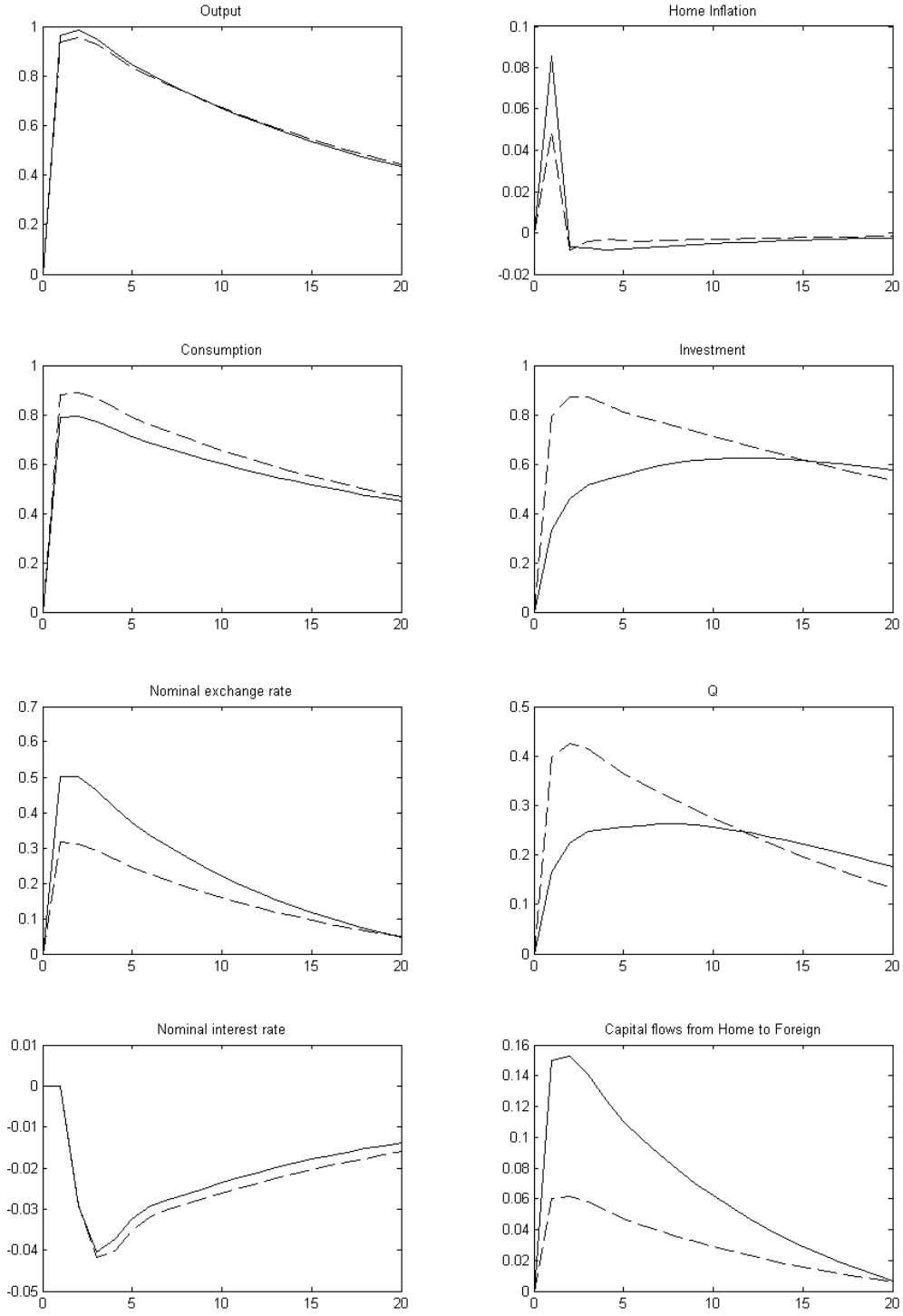

Figure 3 – Monetary Policy Shocks and Business Cycle Volatility: The Interaction Between Financial Openness and Financial Market Frictions

The figure graphs the amplitude of the impulse response function as observed during the twenty periods of time following a unit Home monetary policy shock as a function of the financial frictions parameter. The parameter capturing financial market frictions is plotted on the horizontal axis. Results are derived for regimes of low and high capital mobility where dashed lines obtain when setting the parameter capturing the transaction costs for cross-border financial transactions equal to 5 and solid lines obtain when this parameter is set equal to 0. The calibration of the model is as given in Table 3. All variables are measured as percentage deviations from the steady state.

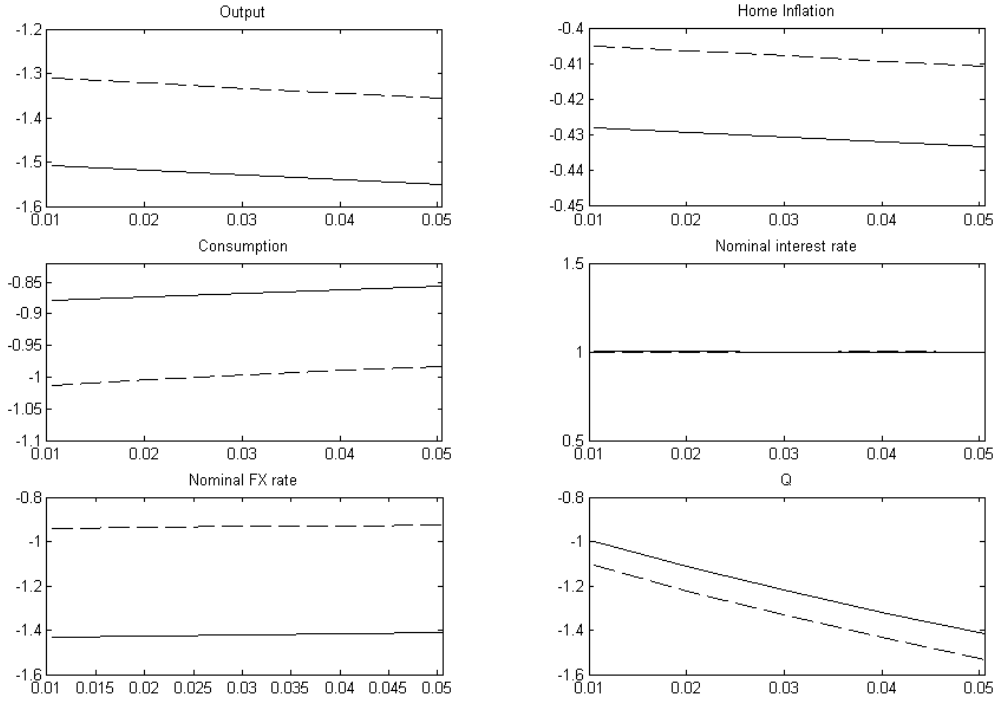

Figure 4 – Productivity Shocks and Business Cycle Volatility: The Interaction Between Financial Openness and Financial Market Frictions

The figure graphs the amplitude of the impulse response function as observed during the twenty periods of time following a unit Home monetary policy shock as a function of the financial frictions parameter. The parameter capturing financial market frictions is plotted on the horizontal axis. Results are derived for regimes of low and high capital mobility where dashed lines obtain when setting the parameter capturing the transaction costs for cross-border financial transactions equal to 5 and solid lines obtain when this parameter is set equal to 0. The calibration of the model is as given in Table 3. All variables are measured as percentage deviations from the steady state.

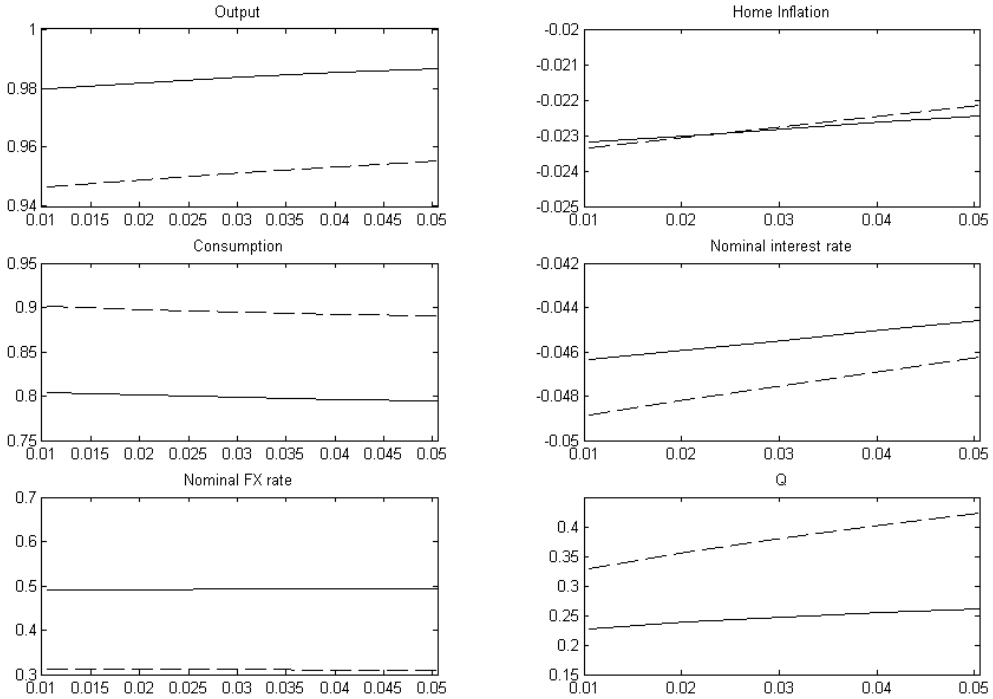

Table 1 — Summary Statistics

Capital controls is the first principal component of four 0-1-dummy variables capturing restrictions on the current and capital accounts of the balance of payments as well as foreign exchange restrictions. Volatilities are measures through the standard deviations of the respective variables, using data for the 1990s. Credit over GDP captures credit by banks and other financial institutions.

Variable	N	Mean	Standard Deviation	Minimum	Maximum
Capital controls	91	0.60	0.49	0	1
OECD	27	0.29	0.46	0	1
NON–OECD	62	0.73	0.45	0	1
Volatility of real exchange rate	60	8.32	7.83	1.28	34.03
OECD	25	5.23	3.42	1.28	17.83
NON–OECD	34	10.55	9.43	2.02	34.03
Domestic credit / GDP	83	55.76	46.36	1.53	217.21
OECD	28	84.33	52.17	10.72	217.21
NON–OECD	53	42.11	35.90	1.53	148.59
Volatility of GDP	92	3.89	2.59	0.68	14.76
OECD	28	2.55	1.41	1.01	5.76
NON–OECD	61	4.51	2.76	0.68	14.76
Volatility of lending rates	83	0.32	0.39	0.03	2.10
OECD	27	0.34	0.31	0.09	1.82
NON–OECD	55	0.32	0.43	0.02	2.10
Volatility of public consumption	88	6.44	6.31	0.56	35.54
OECD	28	2.38	1.83	0.55	10.26
NON–OECD	57	8.20	6.71	1.33	35.54

Table 2 — Determinants of Business Cycle Volatility

The dependent variable is the standard deviation of real GDP growth, using average annual data for the 1990s. The volatility of government consumption is the standard deviation of the growth in real government consumption. The volatility of interest rates is the coefficient of variation of nominal lending rates. Capital controls is a 0/1-dummy for controls on cross-border financial credits, i.e. greater openness implies a decline in the variable. Income dummies are defined as follows: low income: per-capita income of less than 760 USD, low-to-mid income: GDP per capita between 761 and 3000 USD, upper mid-income: between 3001 and 9300 USD, high income: above 9300 USD. *** (**, *) = significant at the 1 (5, 10) percent level. Robust t-statistics in brackets.

	(1) Baseline	(2) With capital controls	(3) With credit over GDP	(4) With credit over GDP by GDP per capita	(5) With capital controls and credit over GDP	(6) With interaction terms	(7) With standard deviation of real exchange rate
Constant	2.51***	2.65***	4.31***	3.75**	4,25***	2.75***	2.89***
	(3.81)	(3.78)	(3.11)	(2.57)	(2,84)	(3.97)	(4.60)
s.d. lending rates	1.89**	1.86**	0.93	0.93	0,98	1.30	3.47***
	(2.06)	(1.99)	(1.11)	(1.29)	(1.14)	(1.61)	(4.55)
s.d. government	0.17**	0.17*	0.16*	0.17*	0.16*	0.18*	0.06
spending	(2.08)	(1.87)	(1.85)	(1.97)	(1.72)	(1.98)	(1.19)
OECD	–1.14**	–1.29**	–0.63	–0.04	–0.82	–1.15**	–1.89***
	(–2.11)	(–2.22)	(–1.08)	(–0.07)	(–1.33)	(–2.02)	(–3.88)
capital controls		–0.04			–0.12		
		(–0.06)			(–0.17)		
log (credit/GDP)			–0.45		–0.40		
			(–1.49)		(–1.28)		
log (credit/GDP) * low _income				–0.67			
				(–1.62)			
log (credit/GDP) * low_mid_income				–0.19			
				(–0.46)			
log (credit/GDP) * high_mid_income				–0.23			
				(–0.66)			
log (credit/GDP) * high_income				–0.50*			
				(–1.70)			
log (credit/GDP) * capital controls						–0.06	
						(–0.43)	
s.d. real exchange rate							–0.01
							(–0.40)
R^2	0.36	0.36	0.36	0.41	0.36	0.35	0.56
N	76	73	75	74	71	71	53

Table 3 — The Calibrated Parameters

The parameters are as in Bernanke et al. (2000) and Faia (2001a). The parameter for the transaction costs for taking positions in international bond markets is taken from Sutherland (1996) and Senay (1998).

Description of Parameter	Numerical Value
Discount factor of households	0.98
Intertemporal elasticity of substitution	1.0
Elasticity of substitution between Home and Foreign goods	1.5
Degree of openness of the economy on the goods market	0.2
Elasticity of the external finance premium with respect to the leverage ratio	0.05
Production elasticity with respect to capital	0.3
Quarterly deprecation rate	0.025
Survival probability of entrepreneurs	0.975
Impact of marginal costs on firms' price setting	0.09
Sensitivity of the price of capital with respect to the investment-capital ratio	0.5
Impact of marginal costs on firms' price setting	0.09
Coefficient on inflation in the monetary policy rule	1.5
Interest-rate smoothing coefficient in the monetary policy rule	0.8
Persistence of productivity shocks	0.9
Steady-state mark up	1.2
Inverse of the steady-state ratio of net worth over capital	2.0
Transaction costs for taking positions in international bond markets if capital mobility is high (low)	5 (0)