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International financial market integration, asset compositions, and the falling exchange rate pass-through

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Non-technical summary

Research Question

Exchange-rate movements play an important role for economic developments, mainly via their impact on international trade and the valuation of cross-border asset positions. Key variables for both channels have changed significantly over recent decades, with the decline in the exchange rate pass-through being the most prominent observation. What drives the observed decline of the exchange rate pass-through?

Contribution

This paper proposes a new explanation of the decline in the exchange rate pass-through. Theoretically and empirically the effect of international financial integration on the exchange rate pass-through is investigated. It is argued that international financial integration, measured by the number and nature of available assets, and the resulting currency decomposition of international portfolios of domestic relative to foreign bonds and equities influences the exchange rate pass-through strongly. A higher degree of international financial integration causes a decline of the exchange rate pass-through.

Results

Cross-sectional evidence for 109 countries in the last two decades shows that higher levels of equity trade are associated with a) a decline in net debt holdings in domestic currency relative to those in foreign currencies, and b) with a decline of the exchange rate pass-through. To explain this finding, a two-country model of optimal portfolio choice and endogenous pricing currencies is developed. Starting from a world with trade in nominal bonds, the possibility of trade in equity is added, reflecting a higher degree of financial market integration. This allows agents to hedge more effectively against shocks. Foreign debt stabilizes income after the occurrence of demand disturbances, while international equity stabilizes unwanted volatility in response to nominal shocks. Consequently, agents can make more use of foreign debt to hedge against demand shocks. The re-balancing of cross-country asset holdings affects the nominal exchange rate, which is the key variable for firms deciding to pre-set their export price in their own currency (full pass-through) or in the local currency (incomplete pass-through). Financial market deepening will impact the level of pass-through. International trade of equities creates a larger impact of supply disturbances on the nominal exchange rate, as these shocks impact relative profits. With trade in equities, profit differentials across countries change relative aggregate demand and thus move the exchange rate. Since supply disturbances also change marginal costs, their correlation with the nominal exchange rate increases. To avoid high production in times of high marginal costs, firms decide to price in local currency, when international financial markets are more integrated. Thus, international financial market integration causes a fall in the exchange rate pass-through.

Nichttechnische Zusammenfassung

Fragestellung

Wechselkursänderungen spielen – insbesondere durch ihren Einfluss auf den internationalen Handel und die Bewertung grenzüberschreitender Vermögenspositionen – eine wichtige Rolle für die Konjunkturentwicklung. In den vergangenen Jahrzehnten haben sich die wichtigsten Bestimmungsgrößen der beiden genannten Kanäle stark verändert, wobei vor allem ein schwächeres Durchwirken von Wechselkursänderungen festzustellen ist. Wie lässt sich die schwächere Weitergabe von Wechselkursentwicklungen erklären?

Beitrag

Dieses Forschungspapier liefert einen neuen Erklärungsansatz für die schwächere Weitergabe von Wechselkursänderungen. Hierzu wird theoretisch und empirisch untersucht, wie sich die Integration der internationalen Finanzmärkte darauf auswirkt. Es wird argumentiert, dass die internationale Finanzmarktintegration (gemessen an Umfang und Art der verfügbaren Aktiva) sowie die daraus resultierende Währungszusammensetzung internationaler Portfolios (inländische in Relation zu ausländischen Anleihen und Aktien) die Weitergabe von Wechselkursänderungen erheblich beeinflussen. Ein höherer Grad an internationaler Finanzmarktintegration bewirkt eine schwächere Weiterwälzung von Wechselkursänderungen.

Ergebnisse

Querschnittsdaten zu 109 Ländern aus den letzten zwei Jahrzehnten belegen, dass ein stärker ausgeprägter Aktienhandel mit a) einem Rückgang des Nettobestands an Schuldverschreibungen in Inlandswährung im Vergleich zu Schuldtiteln in Fremdwährung und b) einer schwächeren Weitergabe von Wechselkursänderungen einhergeht. Um dieses Ergebnis zu erklären, wird ein Zweiländermodell mit optimaler Portfoliowahl und endogenen Fakturierungswährungen entwickelt. Zum Handel mit Nominalanleihen kommt die Möglichkeit des Handels mit Aktien hinzu, um einen höheren Grad an Finanzmarktintegration widerzuspiegeln. Dies ermöglicht den Wirtschaftsakteuren eine effektivere Absicherung gegen Schocks. Während ausländische Schuldverschreibungen nach Auftreten von Nachfragestörungen das Einkommen stabilisieren, trägt der internationale Aktienhandel in der Reaktion auf nominale Schocks zu anhaltend geringerer Volatilität bei. Infolgedessen können die Wirtschaftsakteure verstärkt auf ausländische Schuldtitel zurückgreifen, um sich gegen Nachfrageschocks abzusichern. Die Umschichtung länderübergreifender Aktivabestände beeinflusst den nominalen Wechselkurs, der die Schlüsselgröße für die Entscheidung der Unternehmen darstellt, ob sie ihren Exportpreis in der heimischen Währung (vollständige Weitergabe) oder in der Fremdwährung (unvollständige Weitergabe) festlegen. Die Vertiefung der Finanzmärkte wird die Durchwirkungsintensität von Wechselkursänderungen beeinflussen. Der internationale Aktienhandel führt dazu, dass sich Angebotsstörungen stärker auf den nominalen Wechselkurs auswirken, da solche Schocks die relativen Gewinne beeinflussen. Mit dem Handel von Aktien führen die Ertragsunterschiede zwischen den Ländern zu einer veränderten relativen aggregierten Nachfrage und beeinflussen somit auch den Wechselkurs. Da sich Angebotsstörungen auch in den Grenzkosten niederschlagen, erhöht sich die Korrelation zum nominalen Wechselkurs. Um in Zeiten hoher Grenzkosten eine hohe Produktion zu vermeiden, entscheiden sich Unternehmen bei stärker integrierten internationalen Finanzmärkten für eine Preisgestaltung in lokaler Währung. Somit bewirkt die internationale Finanzmarktintegration eine schwächere Weitergabe von Wechselkursänderungen.

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Abstract

This paper provides an explanation for the observed decline of the exchange rate pass-through into import prices by modeling the effects of financial market integration on the optimal choice of the pricing currency in the context of rigid nominal goods prices. Contrary to previous literature, we take the interdependence of this choice with the optimal portfolio choice of internationally traded financial assets explicitly into account. In particular, price setters move towards more local-currency pricing and portfolios include more foreign debt assets following increased financial integration. Both predictions are in line with novel empirical evidence.

Keywords: Exchange rate pass-through, financial integration, portfolio home bias, international price setting
JEL-Codes: F41, F36, F31

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1 Introduction

Exchange-rate movements play an important role for economic developments, mainly via their impact on international trade and on the valuation of cross-border asset positions. Key variables for both channels, trade and financial, have changed significantly over recent decades, with the decline in the exchange rate pass-through being the most prominent observation.[1] Previous literature has investigated these two channels individually. We argue that this masks an important part of the picture and take their interdependence explicitly into account. We find theoretically that the currency decomposition of international portfolios has a strong bearing on the value of the exchange rate pass-through, which allows us to explain the observed decline of the latter over time. Specifically, we demonstrate that international financial integration, measured by the number and nature of available assets, affects the optimal international portfolio compositions of domestic relative to foreign bonds and equities, which in turn influences the exchange rate pass-through indirectly but strongly. We present supportive novel empirical observations showing that an increase in equity trade is positively associated with a decline in the holdings of domestic relative to foreign net debt positions (that is, a fall in the debt home bias) and a falling degree of exchange rate pass-through, as predicted by the model.[2]

Over the last two decades, an unparalleled expansion in asset trade has indeed taken place. The left panel of Figure 1 shows the sum of portfolio equity assets and liabilities plus the sum of foreign direct investment assets and liabilities over GDP (blue solid line), as reported in the updated and extended version of the data set constructed by Lane and Milesi-Ferretti (2007), over the time period 1990 to 2004 for a broad set of countries.[3] As visible, trade of equity has grown impressively relative to GDP post 1987, the start of the "financial globalization period" (see Kose et al., 2006), as well as relative to total debt assets and liabilities pictured by the black dashed line in the same panel.[4] At the same time, holdings of net debt positions in domestic relative to foreign currencies have declined internationally. In the right panel of Figure 1, we plot the net debt in domestic currency less net debt in foreign currencies over GDP (blue solid line) and over total debt assets and liabilities (black dashed line), for the same country group as above. Hence, the empirical evidence shows a trend towards holding debt in foreign currency, such that domestic agents benefit from a depreciation of their own currency.[5]

To explain the shifts in international portfolio composition and the falling exchange rate pass-through simultaneously, we develop a two-country stochastic general equilibrium model of optimal portfolio choice and endogenous pricing currencies in which we analyze the relationship between the exchange

[1]For example, Ihrig et al. (2006) report a statistically significant decline in the average exchange rate pass-through between 1975-1989 and 1990-2004 in the G-7 countries. Olivei (2002), Marazzi et al. (2005), and Gust et al. (2010), have established similar results concentrating on the U.S., while Otani et al. (2003) draws corresponding conclusion for Japan. The study of cross-country trade between EMU and non-EMU countries by Campa et al. (2005) also suggests a decline in the exchange rate pass-through in a majority of countries. Furthermore, the International Monetary Fund (2006b) shows a considerable fall of pass-through into import prices for Canada, France, Germany, Italy, Japan, the UK, and the US from the period 1975-89 to 1990-2002. Frankel et al. (2005) and the International Monetary Fund (2006a) document a particular strong decline for emerging economies. HM Customs and Excise (2001) reports a reduction of the share of UK imports priced in pound sterling between 1999 and 2002 by 18 per cent. See also Taylor (2000) and Campa and Goldberg (2002).

[2]When referring to equity trade in the empirical and theoretical parts of the paper, we always include FDI. The relevant property for our analysis is the state-dependent payoff that depend on demand and technology, which is shared by both types of investments.

[3]We use this time period throughout the paper due to the availability of data on currencies of foreign debt holdings. Appendix B provides a detailed description of the data, including a country list.

[4]Arguably, falling transaction costs and reduced informational frictions have triggered this development, which we take as given in the present analysis. Exploring the exact reasons for the financial globalization is beyond the scope of this paper.

[5]Similarly, Bertaut and Griever (2004) document an increase in the portfolio weights of *foreign* long-term debt between 1997 until 2001 for Australia, Denmark, the Euro Area, the United Kingdom, and Sweden.

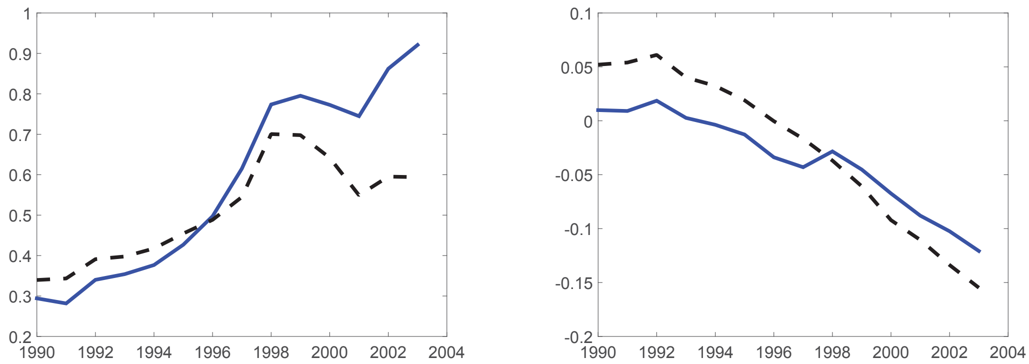

Figure 1: Sum of portfolio equity and FDI assets and liabilities over GDP (left, blue solid line) and divided by sum of debt assets and liabilities (left, black dashed line); average debt home bias over GDP (right, blue solid line) and divided by sum of debt assets and liabilities (right, black dashed line) in percentage points. Country sample: see Table B-3. Sources: Lane and Milesi-Ferretti (2007) and Lane and Shambaugh (2010).

rate pass-through and international financial integration in detail. In particular, starting from a world with trade in nominal bonds only, we add the possibility of trade in equity, representing increased international financial market integration.[6] The expanded set of tradable financial assets allows agents in both countries to hedge more effectively against shocks hitting the economies. Foreign debt proves useful to stabilize income after the occurrence of demand disturbances, but also displays unwanted volatility of its return in case of nominal disturbances, such as monetary policy shocks. Using international equity holdings, this side effect can be counteracted and agents can make more use of foreign debt to hedge against demand shocks.[7] The re-balancing of optimal international cross-country asset holdings does not come without an effect on other variables in our general equilibrium model, especially on the nominal exchange rate. Since it is the key variable for firms deciding to pre-set their export price in their own currency (full exchange rate pass-through) or in the local currency (incomplete exchange rate pass-through), financial market deepening will have a strong bearing on the level of pass-through. Specifically, international trade of equities creates a larger impact of productivity disturbances on the nominal exchange rate, as these shocks impact relative profits. With trade in equities, profit differentials across countries change relative aggregate demand and thus move the exchange rate. Since productivity disturbances also change marginal costs, their correlation with the nominal exchange rate increases. To avoid high production in times of high marginal costs, firms decide to price predominantly in local currency.[8] Consequently, when international financial markets are more integrated, the exchange rate pass-through declines. As a final effect, again illustrating the interdepen-

[6]Thus, the degree of international financial integration is measured by the amount of financial instruments available to insure against different types of risk. Kose et al. (2006) argue that this quantity-based measure is best suited to capture international financial integration.

[7]Coeurdacier and Gourinchas (2011) have shown that the presence of bond trade, additional to trade in equity, matters for hedging possibilities and equilibrium portfolio allocations. They do not, however, investigate the interaction with optimal price-setting.

[8]The positive effect of a higher correlation between marginal costs and the nominal exchange rate on the optimal usage of local-currency pricing has been shown by Devereux et al. (2004). In a previous version, Devereux and Engel (2004) find that switching from a bond-only international financial market to a complete set of state-contingent assets increases the importance of relative instead of absolute monetary stability for price setting. As their model features only monetary disturbances as a source of fluctuations and does not endogenize optimal portfolio decisions, we see our paper as complementary. Similarly, our analysis adds to the insights of Engel and Matsumoto (2009), who show that an explicit exchange-rate insurance can induce the same allocation as trade in a complete-markets setup. In our model with more shocks, bond and equity holdings serve as imperfect substitutes for such an insurance.

dencies between the different channels, a reduced pass-through reduces the boost in business income that is triggered by an exchange-rate depreciation and serves as an automatic hedge against shocks that put downward pressures on consumption and the exchange rate simultaneously. To substitute for this channel, households hold even more foreign debt, as its value increases with a depreciating exchange rate. This implies that the debt home bias falls further.

Despite the importance of the exchange rate pass-through for welfare and optimal monetary policy, there have been relatively few explanations put forward for explaining its recent decline.[9] Taylor (2000) points out that in (increasingly prevailing) low-inflation environments the persistence of inflation is lower, which also reduces the persistence of cost changes and the incentives to change prices after exchange-rate movements. Campa and Goldberg (2005) confirm the negative correlation between lower inflation rates and lower pass-through, but attribute this to the shift of imports towards goods that exhibit a lower degree of pass-through. Gust et al. (2010) argue that increased trade integration, combined with higher productivity growth outside the US and a non-constant elasticity of substitution between goods, explains the reduced pass-through in the US. Our explanation for the falling exchange rate pass-through via an increased international financial integration does not contradict the above hypotheses as it can be one of several important factors explaining the decline in the exchange rate pass-through.

By modeling the link between the trade and the financial channel, we combine two separate strands of literature. On the one hand, the above mentioned theoretical papers deal with the determinants and effects of local-currency pricing vs. producer-currency pricing, while the optimal international portfolio choice is subject of a distinct body of literature. Most importantly, we use the method developed by Devereux and Sutherland (2011) to solve for the optimal composition of each country's debt and equity portfolio in terms of currency denomination. The insights obtained from considering both channels might be particularly important for groups of countries that move towards a currency union. The preceding financial market integration can reduce exchange rate pass-through, lowering the costs of giving up the nominal exchange rate as a channel of adjustment after idiosyncratic shocks, see Engel (2000) and Devereux and Engel (2003). To the best of our knowledge, this aspect of the endogeneity of optimum-currency-area criteria has not been explored so far.

The remainder of this paper is organized as follows. In Section 2 we provide empirical evidence on the link between international financial integration and the increase in debt home bias on one side and the degree of exchange rate pass-through on the other. Section 3 describes our theoretical framework and lays out the optimal portfolio choice under alternative assumptions regarding financial markets. Section 4 describes analytical results regarding the interaction between international financial markets and the pricing-currency choice for a simplifying calibration and presents numerical simulations for the general case. Section 5 concludes. In Appendix A we solve the model for unrestricted parameter values, while Appendix B lists the sources for all data used throughout the paper.

[9] Obstfeld and Rogoff (2000) highlight the importance of the pass-through by showing that with full exchange rate pass-through it is not desirable for monetary policy to target the nominal exchange rate in terms of welfare. A floating exchange rate allows for the adjustment of relative prices and helps to stabilize output and other macroeconomic variables in response of an external shock. However, if exchange rate pass-through is incomplete the exchange rate becomes powerless to alter relative prices and, hence, the shock-absorbing mechanism of a floating exchange rate evaporates (Devereux and Engel, 2003). An important consequence is that under these assumptions countries should adopt a monetary policy oriented at minimizing exchange-rate fluctuations to improve welfare. Other studies showing the importance of pass-through include Betts and Devereux (1996, 2000), Engel (2000), and Obstfeld and Rogoff (2002).

2 Empirical evidence

In the following we use regression analyses to empirically identify the importance of financial integration, measured by international equity trade and FDI, for determining the debt home bias and the exchange rate pass-through. The debt home bias (dhb) is defined as net debt holdings in domestic currency minus net debt holdings in foreign currency. Our empirical analysis shows that higher levels of equity trade lead to a decline in both the dhb and the exchange rate pass-through. These observations are the motivation for our theoretical model in the next section, which includes optimal decisions on the dhb and the exchange rate pass-through depending on the level of financial integration.

To analyze the connection between increased trade in equity and a falling debt home bias we conduct a panel regression analysis of 109 countries covering the time period 1990-2004. In Columns (1)-(4), Table 1 shows a significant negative relationship between the sum of portfolio equity and FDI assets and liabilities on one side and debt home bias over GDP (as defined above) on the other. We use robust regressions, discard outliers, and cluster standard errors at the country level.[10] We control for a set of other variables that might influence the debt home bias and include time and country fixed effects in the pooled OLS regressions. The controls are log GDP, log population, the updated Chinn and Ito (2006) index for the capital account openness, net exports over GDP, net foreign assets (NFA) over GDP, and total debt (log of debt assets plus liabilities). We include the index of Chinn and Ito as restrictions on debt and equity trade could have an impact on the relative size of these two variables. Furthermore, Columns (5)-(9) show that the negative effect of total equity trade is also present if debt home bias over total debt (sum of debt assets and liabilities) is used as the dependent variable. Regarding the size of the effect, an increase of one percentage point in the sum of equity and FDI assets and liabilities over GDP decreases debt home bias over GDP by around .35 percentage points, and debt home bias over total debt by around .24 percentage points in our preferred specifications in Columns (3) and (7). Importantly, this effect is also present if we control for total debt in both sets of regressions. Both results are statistically significant at the 1% and 5% level, respectively. Specifications (4) and (8) in Table 1 implement the mean group estimator of Pesaran and Smith (1995), allowing for heterogenous slope coefficients across countries. This estimation results in even larger and more significant coefficients for both specifications. We can therefore conclude that the more equity is traded internationally, the lower is the debt home bias. This implies that agents choose a debt portfolio from which they benefit more in case of a depreciation of their own currency.

Unfortunately, we lack a similar comprehensive data set on exchange rate pass-through. Our analysis is therefore restricted to a smaller sample, which can give us only indications of the relationship between pass-through and equity trade. Specifically, we use data on how much of the invoicing of imports and exports is done in local currency. Kamps (2006) provides an unbalanced panel of 17 countries, ranging from 1994 until 2004.[11] As a first approach, we plot the share of imports priced in local currency against our measure for financial integration in Figure 2. A clearly positive correlation of 0.63 emerges. This correlation, however, is not directly related to the explanation for falling pass-through presented in this paper because it links the financial integration of the importing (in contrast to the exporting) country to the pricing-currency choice.

As we are interested in the impact of financial integration of a given country on the behavior of its domestic firms, we turn to the share of exports priced in the currency of the exporting country in Table 2. A lower number indicates that fewer prices react to movements of the nominal exchange

[10] See Appendix B for the country list, data sources, a description of the data selection, as well as summary statistics and correlations. Note that in this specification both the dependent variable and the regressor of interest are divided by GDP. This does not introduce a correlation as we find a negative relationship between the two.

[11] Countries and descriptive statistics are listed in Appendix B.

Table 1: Impact of equity trade on debt home bias over GDP or total debt

	(1) dhb/gdp	(2) dhb/gdp	(3) dhb/gdp	(4) dhb/gdp	(5) dhb/debt	(6) dhb/debt	(7) dhb/debt	(8) dhb/debt
(Eq. & FDI)/GDP	-0.414***	-0.369***	-0.346***	-0.565***	-0.337***	-0.269**	-0.243**	-0.854***
	(0.114)	(0.102)	(0.106)	(0.091)	(0.112)	(0.106)	(0.105)	(0.166)
NFA/GDP	-0.763***	-0.553***	-0.543***	-0.738***	-0.428***	-0.483***	-0.424***	-0.957***
	(0.067)	(0.061)	(0.062)	(0.075)	(0.067)	(0.106)	(0.093)	(0.117)
log(Gross Debt)		0.214***	0.150**	0.030		-0.080	-0.057	-0.456***
		(0.053)	(0.066)	(0.045)		(0.088)	(0.085)	(0.095)
Openness		-0.130***	-0.150***	-0.072*		-0.231**	-0.185**	-0.089
		(0.048)	(0.044)	(0.041)		(0.096)	(0.071)	(0.079)
Net Exp.		-0.135	-0.133	-0.054		-0.069	-0.044	-0.023
		(0.082)	(0.084)	(0.072)		(0.090)	(0.089)	(0.126)
Chinn-Ito			-0.023*	0.001			-0.011	0.003
			(0.012)	(0.004)			(0.013)	(0.005)
log(GDP/Pop.)			-0.083	-0.078**			-0.029	-0.117**
			(0.052)	(0.031)			(0.063)	(0.047)
log(Pop.)			-0.480**	-0.070			-0.143	-0.052
			(0.187)	(0.134)			(0.260)	(0.253)
Constant	0.079***	0.076	1.952***	0.902**	0.263***	0.420***	0.969	2.144***
	(0.027)	(0.048)	(0.739)	(0.411)	(0.031)	(0.081)	(1.065)	(0.780)
T & C FE	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Observations	1414	1375	1351	1099	1414	1375	1351	1099
Adjusted R^2	0.624	0.669	0.684		0.311	0.334	0.376	
F	27.900	39.097	44.218		8.362	8.574	8.882	

Robust standard errors (clustered at the country level) in parentheses. $p < 0.10$ is denoted by *, $p < 0.05$ by **, $p < 0.01$ by ***. dhb/gdp=debt home bias (net debt in domestic currency minus net debt in foreign currencies) over GDP, dhb/debt=debt home bias over sum of debt assets and liabilities, (Eq. & FDI)/GDP=sum of equity assets and liabilities plus sum of FDI assets and liabilities over GDP, NFA/GDP=net foreign assets over GDP, log(Gross Debt)=log of sum of debt assets and liabilities, Chinn-Ito=index of financial openness from Chinn and Ito (2006), Openness=Sum of imports and exports over GDP, Net Exp.=net exports over GDP, log(GDP/Pop.)=log of GDP over population, log(Pop.)=log of population, T & C FE=time and country fixed effects. Columns (4) and (8) display results from mean group estimators. Data sources are listed in Appendix B.

rate, implying a lower degree of pass-through. As exchange-rate and inflation volatility are likely to influence the level of pass-through, they are also included as control variables (a preceding three-year window was used for their construction). Because of the lacking degrees of freedom, only column (1) with a reduced set of regressors features standard errors that are clustered at the country level. To economize on the degrees of freedoms a linear time trend is included in columns (2)-(4) instead of time fixed effects, which are used in columns (5)-(8). Columns (2), (3), (5), and (6) include only subsets of all regressors for the same reason. Given these limitations, we find a relatively strong negative relationship between financial integration and producer-currency pricing. A one-percentage

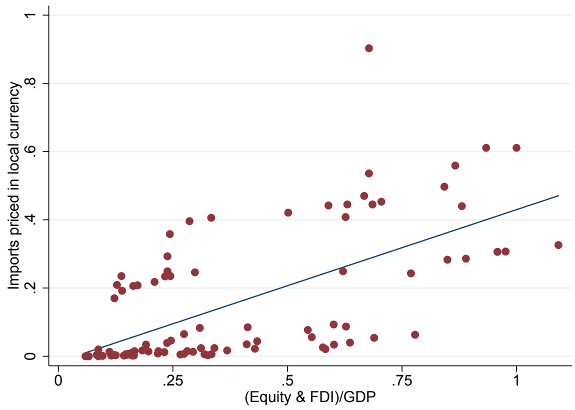

Figure 2: Relationship between share of imports priced in local currency and equity plus FDI (assets plus liabilities) over debt (assets plus liabilities). A linear regression line is added. Sources: Kamps (2006) and Lane and Milesi-Ferretti (2007).

point increase of gross trade in equities and FDI is associated with a reduction of the share of exports priced in the home currency of around .35 percentage points, depending on the specification. There are too few observations per country for a group mean group estimator. Export prices that are not set in domestic currency can also be set in vehicle currencies, such as the US dollar or the euro. This case shares some properties from both local and producer-currency pricing. Developments in the importing countries that affect its exchange rate relative to the vehicle currency alter its import prices. On the other hand, foreign developments that only affect the exporters' exchange rates towards the vehicle currency do not change goods' prices in the currency of the importing country. We hence conduct a robustness check in column (8) by using the sum of the shares of export goods priced in home currency, US dollar or euro as the dependent variable. We find a clear negative relationship between financial integration and producer or producer-plus-vehicle-currency pricing across specifications.

We can summarize our empirical assessment by two main empirical findings: higher levels of international equity trade and FDI are associated with lower debt home bias and a smaller degree of exchange rate pass-through. The next section presents a model that is able to replicate these empirical patterns by allowing for both an endogenous portfolio choice by households and optimal price-setting behavior by firms.

3 The Model

This section presents a formal analysis of the effects of international asset trade on the exchange rate pass-through. The analysis builds on Devereux and Engel (2003) and similar models. There is a stochastic two-country world in which agents of the home, H, and foreign, F, country produce traded goods. Both countries are of the same size, have symmetric structures, and their inhabitants are indexed by numbers in the interval $[0, 1]$. Home agents consume a continuum of differentiated home and foreign goods. Each household provides labor to the domestic monopolistic firms. Firms set their home and export prices prior to the realization of aggregate technology disturbances, monetary policy shocks, and demand disturbances. The latter are induced by the fiscal authority in each country. Firms meet demand at the pre-set price. Foreign country conditions, whose variables are indicated by an asterisk, are defined analogously.

Table 2: Relationship between equity trade and share of exports priced in home currency

	(1) PCP	(2) PCP	(3) PCP	(4) PCP	(5) PCP	(6) PCP	(7) PCP	(8) PCP+VCP
(Eq. & FDI)/GDP	-0.239**	-0.250***	-0.219**	-0.219**	-0.362***	-0.328***	-0.347***	-0.218**
	(0.083)	(0.082)	(0.094)	(0.095)	(0.095)	(0.107)	(0.109)	(0.077)
log(Gross Debt)	0.286***	0.232***	0.255***	0.246***	0.323***	0.351***	0.315***	0.043
	(0.075)	(0.045)	(0.053)	(0.054)	(0.053)	(0.068)	(0.072)	(0.051)
Inflation Vol.	-0.027	0.146	0.200	0.235	-0.534	-0.558	-0.436	-0.488
	(0.075)	(0.531)	(0.512)	(0.555)	(0.572)	(0.591)	(0.609)	(0.432)
Exch. Rate Vol.	-0.005	-0.003	-0.008	-0.005	0.020	0.019	0.023	0.005
	(0.003)	(0.029)	(0.030)	(0.030)	(0.031)	(0.032)	(0.032)	(0.023)
NFA/GDP		-0.112	-0.021	-0.006	0.042	0.140	0.085	0.045
		(0.079)	(0.119)	(0.131)	(0.104)	(0.142)	(0.168)	(0.119)
Chinn-Ito		0.016		0.017	0.024**		0.033	-0.014
		(0.011)		(0.017)	(0.012)		(0.022)	(0.016)
Openness		-0.071		-0.015	-0.134		-0.053	-0.147
		(0.081)		(0.106)	(0.099)		(0.176)	(0.125)
Net Exp.			0.173	0.133		0.159	0.239	-0.074
			(0.323)	(0.332)		(0.371)	(0.375)	(0.266)
log(GDP/Pop.)			0.073	0.055		0.151**	0.041	0.019
			(0.046)	(0.054)		(0.072)	(0.133)	(0.094)
log(Pop.)			-0.292	0.160		-0.404	0.491	-0.324
			(0.446)	(0.687)		(0.462)	(0.784)	(0.556)
Constant	0.160***	-1.288	2.635	4.438	0.273***	0.210	-1.880	1.969
Time		0.001	-0.001	-0.003				
T FE	No	No	No	No	Yes	Yes	Yes	Yes
Observations	53	53	53	53	53	53	53	53
Adjusted R^2	0.591	0.576	0.563	0.554	0.634	0.594	0.599	0.410
F	2006.731	11.221	9.671	7.862	6.312	5.347	5.033	3.143

Robust standard errors (clustered at the country level in first column) in parentheses. $p < 0.10$ is denoted by *, $p < 0.05$ by **, $p < 0.01$ by ***. All specifications include country fixed effects. PCP=share of exports set in home currency, PCP+VCP=share of exports set in home currency, US dollar or euro, Inflation Vol.=variance of quarterly inflation in the three preceding years, Exch. Rate Vol.=variance of quarterly nominal effective exchange rate in the three preceding years. For a description of other control variables, see Table 1. Data sources are listed in Appendix B.

There are two periods. In period $t = 0$ no output is produced and no consumption takes place but households trade assets in international financial markets *before* any shocks occur in the economies in period $t=1$. Two different international financial asset market structures are assessed. Households can either choose the amount of money they like to invest in home and foreign nominal bonds, or in home and foreign nominal bonds as well as equities (i.e., claims on the future profits of home and foreign firms). Moving from an asset market where only nominal bonds are traded to financial markets where both nominal bonds and equities are held is interpreted as international financial market integration. After asset trade has taken place, firms decide whether to pre-set the price of their export good for the next period in their own currency (i.e., producer-currency pricing, PCP) or in the currency of the importing country (i.e., local-currency pricing, LCP). In period $t=1$ households decide about money balances, consumption, and labor supply, while firms produce and sell goods that consumers demand, once uncertainty is resolved. For ease of notation, we only denote period 0 variables with a time index.

3.1 Households, firms and international financial markets

Preferences and demand for goods Expected utility of the representative household is increasing in the aggregate consumption index C and real money balances M/P, and decreasing in the disutility of work effort L, all in period 1:

$$U = E_0 \left[\frac{C^{1-\rho} - 1}{1-\rho} + \chi \ln \frac{M}{P} - K \frac{L^v}{v} \right]. \tag{1}$$

The expectation operator across states of natures in period $t = 1$ given date $t = 0$ information is denoted by E_0. The parameter $\rho > 0$ is the degree of relative risk aversion, $v \geq 1$ is the inverse of the elasticity of labor supply while χ and K are strictly positive parameters. Total labor supply L of the representative household is distributed across monopolistic firms of unit mass, indexed by z, so that $L = \int_0^1 L(z)dz$. The consumption index C is a composite of domestic goods and goods produced abroad,

$$C = \left[a^{\frac{1}{\eta}} C_H^{\frac{\eta-1}{\eta}} + (1-a)^{\frac{1}{\eta}} C_F^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}, \quad \text{with} \quad P = \left[a P_H^{1-\eta} + (1-a) P_F^{1-\eta} \right]^{\frac{1}{1-\eta}}, \tag{2}$$

being the home consumer price index. The elasticity of substitution between home and foreign goods $\eta > 0$ governs the sensitivity of the allocation between home and foreign goods with respect to relative price changes. The parameter $a = 1 - n/2$ measures the share of home goods in the home consumption basket in case of equal prices (see Sutherland, 2005), where trade openness is measured by the parameter $0 \leq n \leq 1$. This formulation accounts for the empirical consumption bias towards tradable goods produced locally. In case of complete trade openness ($n=1$), there is no home bias in consumption, i.e., domestic and foreign households consume equal shares of home and foreign goods. In case of $n=0$, both countries are completely closed. Home and foreign goods are each consumed in constant-elasticity-of-substitution bundles of differentiated products, with $\sigma > 1$ reflecting the elasticity of substitution between differentiated goods. All home goods sold domestically by local firms are priced in domestic currency, resulting in the bundle $C_H = (\int_0^1 C_H(z)^{\frac{\sigma-1}{\sigma}} dz)^{\frac{\sigma}{\sigma-1}}$ with the corresponding price index $P_H = (\int_0^1 P_H(z)^{1-\sigma} dz)^{\frac{1}{1-\sigma}}$. Imports can be priced either in the consumer's (LCP) or exporting firm's (PCP) currency. It is assumed that the fraction $\tilde{z}^*$ of firms in the foreign country employs LCP, and the remaining fraction $1-\tilde{z}^*$ are engaged in PCP, such that

$$P_F=\left(\int_0^{\tilde{z}^*} P_F(z)^{1-\sigma}dz+\int_{\tilde{z}^*}^1 (SP_F^*(z))^{1-\sigma}dz\right)^{\frac{1}{1-\sigma}} \quad \text{for} \quad C_F=\left(\int_0^1 C_F(z)^{\frac{\sigma-1}{\sigma}}dz\right)^{\frac{\sigma}{\sigma-1}}. \quad (3)$$

The nominal exchange rate S reflects the home currency price of one unit of foreign currency. Analogous conditions hold for the export goods of the home country H, with $\tilde{z}$ reflecting the fraction of home firms deciding for LCP, while the remaining fraction $1-\tilde{z}$ of firms follows PCP. Maximizing (2) subject to $PC = P_H C_H + P_F C_F$ leads to the following demand functions for home and foreign goods

$$C_H = a\left(\frac{P_H}{P}\right)^{-\eta} C \quad \text{and} \quad C_F = (1-a)\left(\frac{P_F}{P}\right)^{-\eta} C, \quad (4)$$

with the demand functions for individual home and foreign goods given by

$$\begin{aligned} C_H(z) &= (P_H(z)/P_H)^{-\sigma} C_H && \text{for } z = 0, ..., 1, && (5)\\ C_F(z) &= \left(\frac{P_F^{LCP}(z)}{P_F}\right)^{-\sigma} C_F && \text{for } z = 0, ..., \tilde{z}^*, &&\\ C_F(z) &= \left(\frac{SP_F^{PCP}(z)}{P_F}\right)^{-\sigma} C_F && \text{for } z = \tilde{z}^*, ..., 1, && \end{aligned}$$

showing that $\tilde{z}^*$ foreign firms provide the home country with the foreign good at a price charged in home currency and $1-\tilde{z}^*$ at a price in foreign currency. Analogous demand functions apply for the home good consumed in the foreign country. Our goal will be to derive $\tilde{z}$ and $\tilde{z}^*$ in equilibrium, given the underlying international financial market structure.

International financial markets and budget constraints We assume two different international financial market structures: in period $t=0$, international asset trade may take place in nominal bonds (NB) or in nominal bonds and equity (NBE). Thus, the degree of international financial integration is measured by the amount of financial instruments available to insure against different types of risk.

Trade in bonds only (NB economy)
When international financial markets are less integrated it is assumed that only trade in home and foreign nominal bonds can be conducted in period $t=0$. Bonds are in zero net supply in each period such that

$$B_H + B_H^* = 0 \qquad \text{and} \qquad B_F + B_F^* = 0, \quad (6)$$

where B_H (B_F) are domestic (foreign) nominal bonds held by domestic households and B_H^* (B_F^*) are domestic (foreign) bonds held by foreign consumers. Home bonds are denominated in home currency and foreign bonds in foreign currency. For given prices of home, p_B, and foreign bonds, p_B^*, and an initial net foreign asset position of zero, the home household faces the following budget constraint at time $t=0$

$$p_B B_H^* - S_0 p_B^* B_F = 0. \quad (7)$$

The foreign budget constraint at $t=0$ can be written in terms of the currency of country H as: $S_0 p_B^* B_F - p_B B_H^*$. Furthermore, due to symmetry the price for bonds is initially identical and $S_0 = 1$. Consequently, $p_B = p_B^*$ holds and $B_H = -B_F$ and $B_H^* = -B_F^*$. If country H (F) goes short in its own bonds, $B_H < 0$ ($B_F^* < 0$), this implies that this country holds a positive position of foreign bonds, B_F (B_H^*). Using (6), this can be written as

$$B_H = B_F^* \qquad \text{and} \qquad B_H^* = B_F.$$

We can thus summarize holdings of the respective own bonds as $B = B_H = B_F^*$. Our goal will be to solve for B. $B < 0$ then implies that country H borrows in domestic currency and lends in foreign currency. H would in this case benefit from a depreciation of its currency. After the realization of shocks in period $t = 1$, the representative household derives its income by supplying labor at the nominal wage rate and by receiving nominal profits from domestic firms as well as returns from bond holdings determined in the previous period. Turning to the expenditure side, the household consumes, holds money M, and pays lump-sum taxes T, given the initial money stock M_0. The budget constraints of the representative households in countries H and F in period $t = 1$ are then given by

$$\begin{aligned} \Pi + B_H - SB_F^* + WL &= PC + M - M_0 + T, \\ S\Pi^* - B_H + SB_F^* + SW^*L^* &= SP^*C^* + S\left(M^* - M_0^* + T^*\right), \end{aligned} \tag{8}$$

respectively. Total nominal profits from home and foreign sales of the domestic and foreign firms are Π and Π^*. W and W^* denote the nominal wage rate at home and abroad. The Euler equations that characterize the domestic household's optimal portfolio choice decision are given by

$$\lambda_0 p_B = E_0\left(\lambda\right), \qquad \lambda_0 p_B^* = E_0\left(\lambda S\right),$$

where $\lambda = \frac{C^{-\rho}}{P}$ is the Lagrange multiplier associated with the period $t = 1$ budget constraint. Since $p_B = p_B^*$, the marginal returns of both types of assets have to be equal in expected terms if expressed in the same currency. Hence, the following equations define the asset market equilibrium conditions at home and abroad,

$$E_0\left(\frac{C^{-\rho}}{P}\right) = E_0\left(\frac{C^{-\rho}}{P}S\right) \quad \text{and} \quad E_0\left(\frac{C^{*-\rho}}{SP^*}\right) = E_0\left(\frac{C^{*-\rho}}{SP^*}S\right). \tag{9}$$

Note that due to the zero net foreign asset positions, either no or both bonds will be held, such that the Euler equations have to hold for both bonds.

Trade in bonds and equity (NBE economy)

If financial markets are integrated, two types of financial assets are traded, bonds and equities. Initially, households fully own their local firms and the net foreign asset position is zero. The relevant budget constraint in the NBE economy at $t = 0$ is then

$$p_B B_H - S_0 p_B^* B_F^* + \phi p_E + \varphi S_0 p_E^* = p_E, \tag{10}$$

where p_E (p_E^*) is the price for a home (foreign) equity share and ϕ (φ) is the amount of home (foreign) shares purchased by domestic consumers. Since the supply of of home and foreign shares is normalized to unity, the equilibrium in the asset market is characterized by $\varphi = 1 - \varphi^*$. Moreover, it follows from initial symmetry that $\varphi^* = \phi$, which implies that $\varphi = 1 - \phi$. Our goal will be to derive the optimal equity and bond positions. In period $t = 1$ the budget constraints of the representative consumers in countries H and F are given by

$$\begin{aligned} \phi\Pi + (1-\phi)\, S\Pi^* + B_H - SB_F^* + WL &= PC + M - M_0 + T, \\ \phi S\Pi^* + (1-\phi)\,\Pi - B_H + SB_F^* + SW^*L^* &= SP^*C^* + S\left(M^* - M_0^* + T^*\right), \end{aligned} \tag{11}$$

where households derive their financial income from holding nominal bonds and receiving nominal profits from domestic and foreign firms according to the amounts of shares held, determined in the previous period. For $\phi > 0.5$ we have a home bias in equity holdings. For trade in equities, the Euler equations with respect to equity equalize the marginal costs of buying an additional share in period $t=0$ to the marginal gains in period $t=1$. They are given by

$$\lambda_0 p_E = E_0\left(\lambda\Pi\right) \quad \text{and} \quad \lambda_0 p_E = E_0\left(\lambda S\Pi^*\right).$$

Plugging the Lagrange multiplier of the period $t = 1$ budget constraint into the above equation, the Euler equations can be written as

$$E_0\left(\frac{C^{-\rho}}{P}\Pi\right) = E_0\left(\frac{C^{-\rho}}{P}S\Pi^*\right) \quad \text{and} \quad E_0\left(\frac{C^{*-\rho}}{SP^*}\Pi\right) = E_0\left(\frac{C^{*-\rho}}{SP^*}S\Pi^*\right), \tag{12}$$

which define the equity market optimality conditions at home and abroad. The optimality conditions regarding the bonds market are as in the NB economy, given in equation (9).

Money demand and labor supply In period $t=1$ the representative consumer maximizes her utility (1) with respect to consumption, money balances, and work effort, subject to the budget constraint (8) or (11). The first-order conditions associated with consumption, money holdings and the labor supply decision imply

$$\frac{M}{P} = \chi C^{\rho} \quad \text{and} \quad \frac{W}{P} = \frac{KL^{\upsilon-1}}{C^{-\rho}}, \tag{13}$$

respectively. The second equation states that the marginal rate of substitution between consumption and leisure is equal to their relative price. As in Devereux and Engel (2004), we assume in the following that $\upsilon = 1$, which implies an infinite wage elasticity of labor supply. The foreign country has similar first-order conditions. The first-order conditions associated with money holdings allow us to state the money market conditions as functions of nominal spending at home and abroad as

$$PC = \frac{1}{\chi}\frac{M}{C^{\rho-1}} \quad \text{and} \quad P^*C^* = \frac{1}{\chi}\frac{M^*}{C^{*\rho-1}}. \tag{14}$$

Expressing the two conditions in domestic currency units and solving for the nominal exchange rate yields

$$S = \frac{M}{M^*}\left(\frac{PC}{SP^*C^*}\right)^{-\rho}\left(\frac{SP^*}{P}\right)^{1-\rho}. \tag{15}$$

The nominal exchange rate will be affected by the underlying international financial market integration since differences in nominal spending, $\frac{PC}{SP^*C^*}$, depend on the number of asset types to be traded, as shown by equations (8) and (11).

Monetary and fiscal authorities The money supply in each country has an expected value of $E_0(\ln M) = E_0(\ln M^*) = 0$ and a finite variance $Var(\ln M)$ and $Var(\ln M^*)$, where the home and foreign monetary disturbances are uncorrelated. The home government finances its consumption spending by means of taxes and seigniorage. Its budget constraint equals $PG = T + M - M_0$, where T denotes lump-sum taxes. It is assumed that total government expenditure G is a random demand shift with a mean value of $E_0(\ln G) = 0$ and a finite variance $Var(\ln G)$. A similar expression holds for the foreign country. The government in each country consumes the same shares of local and foreign products as the private sector, such that home government demand for differentiated goods takes the same form as the private demand functions in (4), $G_H = a\,(P_H/P)^{-\eta}\,G$ and $G_F = (1-a)\,(P_F/P)^{-\eta}\,G$. Consequently, the individual government demand function are the same as in (5) and hold correspondingly for the foreign country. We assume that home and foreign government spending shocks are uncorrelated.

Profits and firms' price setting decisions Firms produce differentiated goods under monopolistic competition and hire labor L at the nominal wage rate W. In $t=0$, firms set their future prices and decide in which currency the export goods are priced to maximize expected profits from sales in $t=1$. The production function of firm z and market clearing for its goods are given by

$$Y\,(z) = AL\,(z) = C_H\,(z) + G_H\,(z) + C_H^*\,(z) + G_H^*\,(z)\,,$$

where A is the productivity parameter that can be seen as a random shift in productivity with a mean value of $E_0\,(\ln A) = 0$ and a finite variance $Var(\ln A)$. A similar expression holds for the foreign country. We assume that both shocks are not correlated. The associated expected profits for domestic sales are

$$E_0\,(\pi(z)) = E_0 d\,(P_H(z) - mc)\left(\frac{P_H(z)}{P_H}\right)^{-\sigma}\left(\frac{P_H}{P}\right)^{-\eta} D.$$

Profits are discounted with the stochastic discount factor $d = C^{-\rho}/P$ since firms are owned initially by domestic households and future profits from production will be evaluated according to the household's marginal utility of consumption. D denotes a home demand variable which consists of private ($(1-a)C$) and state ($(1-a)G$) consumption and is taken as given by firms. Marginal costs are equal to

$$mc = \frac{W}{A}. \tag{16}$$

The profit-maximizing price for domestic sales of an individual home firm equals

$$P_H(z) = \frac{\sigma}{\sigma-1}\frac{E_0(dmcC_H)}{E_0(dC_H)},$$

given the respective individual demand functions. When firms decide whether to set the export price in their own currency (PCP) or in the local currency (LCP), they compare their expected profits from selling under PCP to those under LCP. The profit function of a home firm from sales to the foreign country under LCP can be written as

$$\pi^{LCP}(z) = d\left(SP_H^{*LCP}(z) - mc\right)\left(\frac{P_H^{*LCP}(z)}{P_H^*}\right)^{-\sigma}\left(\frac{P_H^*}{P^*}\right)^{-\eta} D^*. \tag{17}$$

Thus, profits under LCP are linear in the nominal exchange rate. This means that under LCP domestic currency revenues increase one-to-one with a nominal exchange-rate depreciation. Costs are unaffected by changes in the nominal exchange rate since exchange-rate movements do not induce any changes in demand or the domestic CPI. The profit-maximizing price for local-currency pricing firms is $P_H^{*LCP}(z) = \frac{\sigma}{\sigma-1}E_0(mcZ^*)/E_0(SZ^*)$, for $z = 0, ..., \tilde{z}$, with $Z^* = dP_H^{*\sigma-\eta}P^{*\eta}D^*$. Using this solution, the expected discounted profits from export sales in the local currency are

$$E_0\left(\pi^{LCP}(z)\right) = \tilde{\sigma}\,(E_0(SZ^*))^{\sigma}\,(E_0(mcZ^*))^{1-\sigma}, \tag{18}$$

where $\tilde{\sigma} = (1/(\sigma-1))(\sigma/(\sigma-1))^{-\sigma}$. The first term of the right-hand side of equation (18) reflects the expected revenues from sales, while the second term shows the cost component of expected profits.

The dependence of expected profits on exchange-rate volatility can be seen more clearly when taking a second-order approximation of profits under LCP:

$$E_0\left(\widehat{\pi}^{LCP}(z)\right) \propto \sigma\frac{Var(\widehat{S})}{2} - (\sigma-1)\left[\frac{Var(\widehat{mc})}{2} + \frac{Var(\widehat{Z^*})}{2} + Cov(\widehat{mc}, \widehat{Z^*})\right], \quad (19)$$

where $\widehat{X} = \ln X - \ln \overline{X}$ denotes the percentage deviation of the variable X from its steady state $\overline{X}$. Furthermore, $\widehat{XY} = (\ln X - \ln \overline{X}) + (\ln Y - \ln \overline{Y})$ reflects the sum of the percentage deviations of the variables X and Y from their respective steady states. The variance of X is denoted by $Var(\widehat{X}) = E_0(\widehat{X}^2)$ and $Cov(\widehat{X}, \widehat{Y}) = E_0(\widehat{X} \cdot \widehat{Y})$ reflects its covariance with variable Y. Equation (19) shows that expected profits under LCP are increasing in nominal exchange-rate volatility via its effect on expected revenues. Furthermore, changes in the nominal exchange rate do not affect expected costs. The profit function of a home firm from sales to the foreign country under PCP can be written as

$$\pi^{PCP}(z) = d\left(P_H^{PCP}(z) - mc\right)\left(\frac{P_H^{PCP}(z)}{SP_H^*}\right)^{-\sigma}\left(\frac{P_H^*}{P^*}\right)^{-\eta} D^*. \quad (20)$$

Under PCP, profits are convex in the nominal exchange rate. Then, due to the expenditure-switching effect, a nominal exchange-rate depreciation increases foreign demand for domestic goods by more than one-for-one since $\sigma > 1$. This means that ceteris paribus, with a rise of the nominal exchange rate, revenues from sales under PCP increase relative to LCP. However, in contrast to LCP, a change in the nominal exchange rate directly impacts expected costs and hence expected profits negatively. The corresponding profit-maximizing price for firms that employ producer-currency pricing is then given by $P_H^{PCP}(z) = \frac{\sigma}{\sigma-1}E_0 mcS^\sigma Z^*/E_0(S^\sigma Z^*)$, for $z = \tilde{z}, ..., 1$. Using this solution, the expected discounted profits from export sales are given as

$$E_0\left(\pi^{PCP}(z)\right) = \tilde{\sigma}\left(E_0(S^\sigma Z^*)\right)^\sigma \left(E_0(mcS^\sigma Z^*)\right)^{1-\sigma}. \quad (21)$$

The influence of exchange-rate behavior on expected profits can be illustrated by taking a second-order approximation of expected profits under PCP:

$$E_0\left(\widehat{\pi}^{PCP}(z)\right) \propto \sigma^2\frac{Var(\widehat{S})}{2} - (\sigma-1)\left[\frac{Var(\widehat{mc})}{2} + \frac{Var(\widehat{Z^*})}{2} + Cov(\widehat{mc}, \widehat{Z^*}) + \sigma Cov(\widehat{mc}, \widehat{S})\right]. \quad (22)$$

Under PCP, nominal exchange-rate variability increases revenues. However, changes in the nominal exchange rate also induce demand changes under PCP. As the firm has to meet demand at the given price, it has to increase its labor inputs after an exchange-rate depreciation. If this happens in times of high marginal costs, i.e., $Cov(\widehat{mc}, \widehat{S}) > 0$, expected total costs are higher relative to LCP. This fact will be of importance when assessing the role of international financial market integration on the export-price setting behavior of firms. As financial integration affects the properties of the nominal exchange rate, it will influence the price setting decision of firms. Following Devereux et al. (2004) and subtracting (19) from (22), we obtain the decision rule of the home firm whether to set its export price in its own or in the local currency. The firm will use PCP (LCP) as long as expected profits under PCP (LCP) are higher than under LCP (PCP), which is the case if

$$\frac{Var(\widehat{S})}{2} - Cov(\widehat{mc}, \widehat{S}) > 0, \;\; (< 0). \quad (23)$$

The optimal pricing currency condition (23) holds under the assumption that the discount factor, prices of other firms, foreign total demand, and foreign prices are exogenous to an individual firm and its pricing-currency decision. Analogously, a foreign firm has equivalent profit structures and will decide to price its exports to the domestic economy in the foreign (home) currency if

$$\frac{Var(\widehat{S})}{2} + Cov(\widehat{mc^*}, \widehat{S}) > 0, \;\; (< 0). \tag{24}$$

The last two equations determine the optimal values of $\tilde{z}$ and $\tilde{z}^*$ and thereby the equilibrium home (foreign) exchange rate pass-through, $1 - \tilde{z}$ $(1 - \tilde{z}^*)$, conditional on the financial market structure.

3.2 Equilibrium and steady state

The rational expectations equilibrium is a set of values for consumption, output, labor, wages, prices, and the optimal portfolio shares, given the distribution of shocks to technology, government spending, and money supplies at home and abroad, (A, A^*, G, G^*, M, M^*). The model is solved by linearizing (first order, except where noted otherwise below) around the symmetric non-stochastic steady state where the economic disturbances equal zero. Steady-state variables are denoted by a bar. The above described optimality and market clearing conditions are then used to determine the endogenous variables in equilibrium, in particular the equilibrium home exchange rate pass-through, $1-\tilde{z}$ (for foreign: $1 - \tilde{z}^*$), as well as the equity, ϕ, and bond portfolios

$$b \equiv B/\overline{PC},$$

which corresponds to the debt home bias. In the steady state, a country's sales revenues are given by $\overline{REV} = \overline{YP_H} = \overline{PC}$. It follows that profits and labor income are shares of a country's income, given by $\overline{\Pi} = (1/\sigma)\overline{REV}$ and $\overline{WL} = ((\sigma - 1)/\sigma)\overline{REV}$, respectively. Because of the symmetry across countries, purchasing power parity holds in steady state, such that $\overline{SP^*} = \overline{P}$. Furthermore, individual prices are given by $\overline{P_H} = ((\sigma-1)/\sigma)\overline{W}/\overline{A}$. As the two countries are identical in steady state, the law of one price holds within and across goods, $\overline{P_H} = \overline{SP^*_H} = P_F = \overline{SP^*_F}$. Having described the optimal pricing and portfolio conditions, the equilibrium, and the steady state, we will now show how the integration of international asset markets affect the exchange rate pass-through via the composition of asset trades on financial markets.

4 Financial Markets and the falling exchange rate pass-through

To illustrate the mechanisms at work we first make use of a simplifying calibration in Section 4.1 and derive an analytical solution. Section 4.2 reports results of numerical simulations for general calibrations of the model, whose unrestricted solution together with additional intuition is presented in Appendix A. In the following we draw on this solution for deriving the simplified version.

4.1 Analytical solution for a simple calibration

As a first step, we assume that there is no home bias in household and government consumption, such that $a = 0.5$. Furthermore, we assume log-utility, i.e., $\rho = 1$, and that the elasticity of substitution between home and foreign traded goods, η, equals unity.[12] This allows us to derive a closed-form

[12]The assumption of $\eta = 1$ implies Cobb-Douglas preferences. In this case, the terms of trade provide a risk-sharing role, as shown by Cole and Obstfeld (1991), and the asset market structure might not be relevant. However, this is only true when there are only productivity shocks and international asset positions are zero. In the case of demand shocks, such as government spending shocks, risk sharing requires relative income to move asymmetrically, which might also cause non-zero asset positions.

solution. With the solution at hand we first discuss the portfolio allocation problem and then show how it relates to the price-setting behavior of firms. We solve for the nominal exchange rate by making use of the money market equilibrium. Expressing (15) in log-linear terms yields

$$\widehat{S} = (\widehat{M} - \widehat{M^*}) - (\widehat{PC} - \widehat{SP^*C^*}). \tag{25}$$

In equilibrium the nominal exchange rate will not only be affected by the relative money supplies but also by the differences in nominal spending, $\widehat{PC} - \widehat{SP^*C^*}$. How this difference reacts to shocks depends on the amount and types of assets traded.

4.1.1 Trade in bonds only

Consider first equations (8), which show that relative nominal spending in case of trade in bonds only equates to

$$\widehat{PC} - \widehat{SP^*C^*} = -2b\widehat{S} + (\widehat{REV} - \widehat{SREV^*}) - (\widehat{G} - \widehat{G^*}), \tag{26}$$

with $\widehat{G} = G/\overline{C}$. The financial return to the bond holdings b is given by the negative nominal exchange-rate movement, $-\widehat{S}$, while revenues of firms from sales to the home and foreign consumers are non-financial income, denoted by REV. In the following we use the linearization $\widehat{REV} = \frac{1}{\sigma}\widehat{\Pi} + \frac{\sigma-1}{\sigma}\widehat{WL}$ and the fact that $B_H = B_F^*$, as $S_0 = 1$. b is the equilibrium amount of bonds we are looking for. Given equation (26), we can express the nominal exchange rate (25) in the economy with trade in bonds only as

$$\widehat{S} = \frac{1}{1-2b}(\widehat{M} - \widehat{M^*}) + \frac{1}{1-2b}(\widehat{G} - \widehat{G^*}), \tag{27}$$

observing that $\widehat{REV} - \widehat{SREV^*} = 0$ in our simple model structure with $\eta = 1$, since expenditure-switching effects offset higher relative revenues in the domestic currency one-for-one after exchange-rate movements. Given the properties of the economies with nominal bonds only, the exchange rate only transmits two of the three possible economic disturbances across countries. Technology shocks only affect the division of income between workers and firms, but do not change aggregate demand because of pre-set prices. The impact effect of the shocks is affected by the size of the equilibrium portfolio holdings b. A negative b lets domestic households financially gain from a depreciation. This counteracts the depreciation pressure triggered by a monetary loosing or higher government spending, dampening the exchange-rate volatility. The fact that not all disturbances are transmitted via the nominal exchange rate has additional implications for the price-setting decision of firms. To see this more clearly, consider the linearized version of home marginal costs, equation (16), together with (13) and its foreign counterpart

$$\widehat{mc} = \widehat{M} - \widehat{A} \qquad \text{and} \qquad \widehat{mc}^* = \widehat{M}^* - \widehat{A}^*. \tag{28}$$

It follows that the covariance between marginal costs and the nominal exchange rate can be written as

$$Cov(\widehat{mc}, \widehat{S}) = \frac{Var(\widehat{M})}{1-2b} \quad \text{and} \quad Cov(\widehat{mc}^*, \widehat{S}) = -\frac{Var(\widehat{M}^*)}{1-2b}. \tag{29}$$

Note that when only nominal bonds are traded, only monetary disturbances affect the covariance relationship between marginal costs and the nominal exchange rate. Since all shocks are uncorrelated, the variance of the nominal exchange rate equals

$$Var(\widehat{S}) = \frac{Var(\widehat{M} + \widehat{M^*})}{(1-2b)^2} + \frac{Var(\widehat{G} + \widehat{G^*})}{(1-2b)^2}, \tag{30}$$

with $Var(\widehat{G}+\widehat{G}^{*})$ and $Var(\widehat{M}+\widehat{M}^{*})$ reflecting the sum of domestic and foreign variances of the government spending and monetary policy shocks. The magnitude of the covariance relationship also depends on the equilibrium bond holdings b.

What will be the amount of equilibrium bonds b held within this financial market structure? There are three shocks in each country, but only one instrument in the form of bond holdings to hedge against these shocks. Since technology shocks do not change aggregate demand, the exchange rate is hence unaffected and international borrowing and lending does not need and cannot be used to insure against this type of shocks. A positive disturbance to government spending, i.e., $\widehat{G}>0$, causes a depreciation of the nominal exchange rate with a simultaneous increase in taxation. Households can thus hedge against the risk of a decline in consumption by choosing the appropriate equilibrium bond portfolio. In particular, net foreign bond holdings, i.e., $b<0$, are a good hedge against this type of income risk as it increases financial income via a depreciating exchange rate in times of high taxation.

Monetary shocks, on the other hand, do not change available resources directly but have an impact on the exchange rate. This additional volatility reduces the incentive to hold assets whose returns depend on the exchange rate, i.e., foreign bonds. Facing this tradeoff, households will opt for an intermediate solution by holding a relatively small amount of foreign bonds to hedge against consumption risk associated with government spending shocks. To obtain the equilibrium portfolio choice of b we follow the approximation method for computing the equilibrium portfolio positions developed by Devereux and Sutherland (2011) and take a second-order approximation of the asset market equilibrium condition for the home country (9) and its foreign counterpart. The full details of the derivations are found in the appendix. From equation (A-10), the solution to the equilibrium bond portfolio is then given by

$$b^{NB}=-\frac{Var(\widehat{G}+\widehat{G}^{*})}{2Var(\widehat{M}+\widehat{M}^{*})}. \tag{31}$$

The equilibrium bond position implies that the home country lends in the foreign currency and borrows in its own since $b<0$. Thus, in states when the domestic currency is weak the equilibrium bond position ensures that the home country will receive net payments from abroad. The equilibrium bond holdings have direct implications for the home firm's pricing decision. For illustrative purposes we consider a symmetrical equilibrium where all home and foreign shock variances are identical and equal unity. The firm's decision rule to either price its exports in its own or in local currency can be written as follows, see equations (23) and (24) with (29) and (30).

$$\mathcal{R}^{NB}\equiv\frac{Var(\widehat{S})}{2}-Cov(\widehat{mc},\widehat{S})=\frac{1+2b}{(1-2b)^{2}}\gtrless 0. \tag{32}$$

Equation (32) shows that the decision of firms to set their export prices either in their own currency (PCP) or in the currency of consumers (LCP) depends on the equilibrium value of b. This interaction is dominated by the above explained impact of b on the variance of the exchange rate. If the equilibrium bond position is $b>-1/2$, it follows from (32) that $\mathcal{R}^{NB}>0$ and firms will decide to price their export goods in the domestic currency. If $b<-1/2$, firms will decide to price exports in the foreign currency. Given the symmetric equilibrium under the simple calibration with home and foreign shock variances being unity, the equilibrium bond position equals $b=-1/2$. This implies that $\mathcal{R}^{NB}=0$. Consequently, in the NB economy firms will be indifferent between setting their export prices in PCP or LCP. The same argument applies to the foreign country. This represents a general outcome, also for different calibrations (which would change the above formulas): if the variance of the money supply is the same in both countries, firms are indifferent between the pricing possibilities if only nominal bonds are traded. A similar result has been derived by Devereux et al. (2004), who point out that firms tend to set their export prices in the currency that is governed by the more stable monetary growth. If foreign money supply is very volatile, the exchange rate moves a lot, while the covariance between marginal costs and the exchange rate depends only on the variability of the domestic money supply in such an economy. According to equations (23) and (24), firms of both countries are hence induced to set their prices in home's currency. However, if firms are indifferent, $\tilde{z}$ and $\tilde{z}^*$ can take any value on the continuum between 0 and 1. The probability that all firms will set their prices in the same currency ($\tilde{z}, \tilde{z}^* = 0$ or 1) is hence zero. Consequently, there is neither full nor zero exchange rate pass-through, i.e., $0 < \tilde{z}, \tilde{z}^* < 1$.[13] However, this indeterminacy only arises if the volatility of monetary shocks are exactly equal across countries. In the likely case of different volatilities, one country prices according to PCP and the other follows LCP, resulting in a global pass-through of 0.5.

4.1.2 Trade in bonds and equities

When financial markets become more integrated, households in the model have the possibility to trade not only nominal bonds internationally but also equities. Since those assets have a different risk profile, the two countries exchange assets to smooth fluctuations in consumption across different states of natures. Country differences of the linearized $t = 1$ budget constraints (11) for the home country and its foreign counterpart result in this case as

$$\widehat{PC} - \widehat{SP^*C^*} = \frac{2\phi - 1}{\sigma}(\widehat{\Pi} - \widehat{S\Pi^*}) - 2b\widehat{S} - (\widehat{G} - \widehat{G^*}) + \frac{\sigma - 1}{\sigma}(\widehat{WL} - \widehat{SW^*L^*}). \tag{33}$$

In equilibrium the relative total returns on equity, $\widehat{\Pi} - \widehat{S\Pi^*}$, are given by the difference between total revenues from sales of goods by firms to the home and foreign market and labor income at home and abroad,

$$\widehat{\Pi} - \widehat{S\Pi^*} = \sigma(\widehat{REV} - \widehat{SREV^*}) - (\sigma - 1)(\widehat{WL} - \widehat{SW^*L^*}).$$

Remember from above that $\widehat{REV} - \widehat{SREV^*} = 0$ in our simple model structure. Relative labor income is obtained by combining the optimal labor supply condition of households together with the market clearing condition and the production function of the representative firm. Then we have

$$\widehat{\Pi} - \widehat{S\Pi^*} = -(\sigma - 1)(\widehat{WL} - \widehat{SW^*L^*}) = (\sigma - 1)\left[(\widehat{A} - \widehat{A}^*) - (\widehat{M} - \widehat{M}^*) + \frac{\tilde{z} + \tilde{z}^*}{2}\widehat{S}\right], \tag{34}$$

Note that under this calibration the government consumes equal parts of domestic and imported goods, such that its effect on relative profits works only via the exchange rate. An exchange-rate depreciation, in turn, increases foreign costs expressed in domestic currency (as above) and raises domestic wage demands due to rising import prices if there is at least some pass-through. In case of complete pass-through ($z = z^* = 0$), these effects cancel. In the following we solve for the optimal portfolio positions. Given the above equations, we can express the nominal exchange rate (25) as

$$\widehat{S} = \frac{[2(\phi - 1)\frac{\sigma - 1}{\sigma} + 1](\widehat{M} - \widehat{M}^*) - 2(\phi - 1)\frac{\sigma - 1}{\sigma}(\widehat{A} - \widehat{A}^*) + (\widehat{G} - \widehat{G}^*)}{1 - 2b + 2(\phi - 1)\zeta}. \tag{35}$$

with $\zeta = \frac{\sigma - 1}{\sigma}\frac{\tilde{z} + \tilde{z}^*}{2}$. The equilibrium outcome of the nominal exchange rate depends on the equilibrium portfolio allocation of bonds, b, and equities, ϕ. Furthermore, in contrast to the economy in which only nominal bonds can be traded, the holding of equities lets the exchange rate transmit all three

[13] Note that lower values for $\tilde{z}$ and $\tilde{z}^*$ imply a lower consumption volatility. This could push firms that are otherwise indifferent between pricing strategies towards choosing PCP ($\tilde{z}, \tilde{z}^* < 1$).

economic disturbances across countries.[14] If agents hold more or less than 100% of claims to their profits, i.e., $\phi \neq 1$, technology shocks affect aggregate income via altered profits instead of just shifting the division between domestic wage and profit income, as it is the case if only nominal bonds are traded internationally. Hence, the covariance between marginal costs and the nominal exchange rate is affected not only by monetary disturbances, but also by productivity shocks. From (28) and (35) it follows that this covariance can be written as

$$\begin{aligned} Cov(\widehat{mc}, \widehat{S}) &= \frac{2(\phi-1)\frac{\sigma-1}{\sigma}+1}{1-2b+2(\phi-1)\zeta} Var(\widehat{M}) + \frac{2(\phi-1)\frac{\sigma-1}{\sigma}}{1-2b+2(\phi-1)\zeta} Var(\widehat{A}), \\ Cov(\widehat{mc}^*, \widehat{S}) &= -\frac{2(\phi-1)\frac{\sigma-1}{\sigma}+1}{1-2b+2(\phi-1)\zeta} Var(\widehat{M}^*) - \frac{2(\phi-1)\frac{\sigma-1}{\sigma}}{1-2b+2(\phi-1)\zeta} Var(\widehat{A}^*). \end{aligned} \tag{36}$$

The variance of the nominal exchange rate results from (35) as

$$Var(\widehat{S}) = \frac{[2(\phi-1)\frac{\sigma-1}{\sigma}+1]^2 Var(\widehat{M}+\widehat{M}^*) + [2(\phi-1)\frac{\sigma-1}{\sigma}]^2 Var(\widehat{A}+\widehat{A}^*) + Var(\widehat{G}+\widehat{G}^*)}{[1-2b+2(\phi-1)\zeta]^2}. \tag{37}$$

For a given monopolistic markup, $\sigma/(\sigma-1)$, the sign and magnitude of the covariance of the nominal exchange rate with marginal costs and its variance will depend on both the equilibrium amount of bonds and equities held as well as on the exchange rate pass-through (via ζ).

What determines the equilibrium portfolio within this economy? Remember that households were not able to hedge completely against government spending shocks in the bonds-only economy because of the additional volatility that arises if more foreign bonds are held. This volatility is induced by the impact of monetary shocks on the exchange rate. In the bonds-and-equity economy, households can make use of the additional instrument of cross-border equity holdings to counteract this higher volatility of income. Specifically, since monetary shocks increase consumption and therefore wages, they raise marginal costs and thus lower profits. Going long in domestic equity will therefore reduce the volatility monetary policy shocks impose on foreign bond holdings: their return increases while the returns from domestic equity holdings fall.[15] This is visible by the negative relationship between domestic equity holdings and the debt home bias that gets amplified if the variability of monetary shocks is larger,

$$\begin{aligned} \phi &= 1 - \frac{\sigma}{\sigma-1} \frac{Var(\widehat{M}+\widehat{M}^*)}{Var(\widehat{A}+\widehat{A}^*) + \frac{2-z-z^*}{2} Var(\widehat{M}+\widehat{M}^*)} b^{NBE} \\ &= \frac{2Var(\widehat{A}+\widehat{A}^*) + \frac{\sigma}{\sigma-1} Var(\widehat{G}+\widehat{G}^*)}{2Var(\widehat{A}+\widehat{A}^*)}, \end{aligned} \tag{38}$$

which was again derived with the approximation method for computing the equilibrium portfolio positions developed by Devereux and Sutherland (2011).[16] Choosing $\phi \neq 1$, however, creates an impact of technology shocks on aggregate income, which tends to raise the volatility of households' income. This counteracts the incentive to deviate from the initial holdings of 100% of the own stocks, where

[14] The predicted reactions of the exchange rate to all three shocks are in line with empirical evidence in Enders et al. (2011) and related studies.

[15] Values of ϕ above unity correspond to an extreme home bias via an increased usage of more complex financial instruments, such as derivatives. See Matsumoto (2007) for similar outcomes.

[16] The term $\frac{2-z-z^*}{2} Var(\widehat{M}+\widehat{M}^*)$ in the denominator of the first expression partially offsets the fact that b^{NBE} becomes less negative if pass-through falls, see below, and hence cancels if the equilibrium value of b^{NBE} is inserted.

technology shocks have no bearing on aggregate income. The term $2Var(\widehat{A}+\widehat{A}^*)$ in the denominator reflects this tendency towards $\phi = 1$ whenever technology shocks become more important.
Given that the additional volatility due to monetary shocks via foreign bond holdings can be counteracted by the new equity position, agents can now hedge more effectively against government spending shocks. As in the bonds-only economy, they do so by buying foreign bonds. This time, however, they have to worry less about the effects of monetary shocks and hence buy more.[17]

$$\begin{aligned} b^{NBE} &= b^{NB} - \frac{\sigma-1}{\sigma}\left(1-\frac{z+z^*}{2}\right)(\phi-1) \\ &= -\frac{Var(\widehat{G}+\widehat{G}^*)[Var(\widehat{A}+\widehat{A}^*)+\frac{2-\tilde{z}-\tilde{z}^*}{2}Var(\widehat{M}+\widehat{M}^*)]}{2Var(\widehat{A}+\widehat{A}^*)Var(\widehat{M}+\widehat{M}^*)}. \end{aligned} \tag{39}$$

Comparing equations (31) and (39) shows that

$$b^{NBE} \leq b^{NB},$$

in line with the empirical findings in Section 2. The interaction between the financial channel and the trade channel becomes evident in these decisions: the payoffs of equity holding depend on the level of pass-through, while portfolio decisions influence the effects of disturbance on relative income. The latter impacts the volatility of the exchange rate and its covariance structure with marginal costs, which are the crucial variables for firms' LCP/PCP decision. Hence, to specify the equilibrium outcome in the NBE economies it is necessary to have a closer look at the firms' price-setting decision. As we will show below, more firms decide to price in local currency. This decision is driven by the increased covariance between marginal costs and the nominal exchange rate, which results from the higher impact of technological and monetary disturbances on both variables, induced by international equity holdings. Given that agents go long in own equity, positive technology shocks increase their aggregate income and appreciate the exchange rate (S decreases). At the same time, marginal costs fall, increasing their covariance with the nominal exchange rate, see equation (36). Positive monterary shocks have a similar effect, as they increase marginal costs but depreciate the exchange rate. This pattern would let firms sell especially few goods in the foreign economy when marginal costs are low and vice versa, if they employed PCP. Firms hence switch to LCP, reducing the overall exchange rate pass-through. Using (36) and (37), the home firms' pricing decision rule (23) in the symmetric equilibrium with equal unitary shock variances at home and abroad can be expressed as

$$\mathcal{R}^{NBE} = \frac{2[4(\phi-1)\frac{\sigma-1}{\sigma}+1][(\phi-1)(\frac{\sigma-1}{\sigma}-\zeta)+b]-2(\phi-1)\frac{\sigma-1}{\sigma}+1}{[2b-2(\phi-1)\zeta-1]^2}. \tag{40}$$

As visible, the financial channel, i.e., equlbirium portfolio positions, impacts firms' decision in which currency to price, showing again the interpedence of the two channels. We assess the decision rule $\mathcal{R}^{NBE}$ between $\tilde{z}=\tilde{z}^*=0$ and $\tilde{z}=\tilde{z}^*=1$ within the symmetric equilibrium with equal unitary shock variances, i.e., changing the value of ζ. The equilibrium equity position equals $\phi{=}1+\frac{\sigma}{\sigma-1}\frac{1}{2}$ and is independent of the exchange rate pass-through. Given that $\sigma > 1$, the decision rule $\mathcal{R}^{NBE}$ is negative for this range of values for b. Consequently, LCP is the unique equilibrium in the nominal bond and equity economy and $\tilde{z}=\tilde{z}^*=1$. Put differently, we obtain

$$\tilde{z}^{NBE} \geq \tilde{z}^{NB}.$$

[17] The term $-\frac{z+z^*}{2}$ in the fist line of equation (39) stems from the additional usage of foreign debt to offset the volatility of income that arises from the impact of exchange-rate movements on the payoff of international equity holdings, see equation (34).

Parameter	Value	Source
ρ	1.25	Devereux et al. (2004)
η	1.5	Devereux et al. (2004)
a	.88	U.S. average
σ	6	Rotemberg and Woodford (1993)
σ^2_M	$.0043\%$	US data
σ^2_A	$.0036\%$	US data
σ^2_G	$.0052\%$	US data
$\sigma^2_{M^*}$	$.0043\% * 1.1$	Avoiding indet.
$\sigma^2_{A^*}$	$.0036\%$	Symmetry
$\sigma^2_{G^*}$	$.0052\%$	Symmetry

Table 3: Baseline parameter values for the numerical simulation of the model.

A corresponding inequality holds for $\tilde{z}^{*NBE}$. When moving towards internationally more integrated financial markets, i.e., moving from the nominal bond economy to an economy where both bonds and equities are traded internationally, the exchange rate pass-through hence declines in both countries. This is in line with empirical evidence in Section 2.

It should be mentioned that the simple calibration with $\eta = 1$ omits one further interaction between both channels that lets the debt home bias fall following financial integration. Specifically, in case $\eta > 1$, lower pass-through reduces the boost in business revenue that follows an exchange-rate depreciation and serves as an automatic hedge against government spending shocks. Since financial integration reduces the pass-through, holding foreign debt replaces this channel. See further explanations in Section 4.2.1.

Note that by trading equity additionally to bonds, the agents stabilize their consumption fluctuations. To see this, consider equation (13), which holds under both financial market structures. Considering the difference between consumption under the two financial market structures and assuming a unitary variance of all home and foreign shock disturbances, the relative variability of consumption in the nominal bond economy is higher, since

$$Var(\widehat{C}^{NB} - \widehat{C}^{NBE}) = \frac{(1 - \tilde{z}^{NB})^2}{4},$$

for $b^{NB} = -1/2$. Putting it differently, consumption is less volatile under more integrated international financial markets and because the more integrated financial markets are, the better can households hedge against fluctuation in consumption. In the following, we show that the analytical conclusions of this section generalize to settings with more realistic parameter values.

4.2 Numerical simulations for general calibrations

In the previous section we concentrated on the model's main implications within a simplified framework. In this section we generalize the findings by relaxing the assumptions about the model's structural parameter values and about the volatilities of shocks. By numerically simulating the model for a variety of parameter values we can show that the result of declines in the exchange rate pass-through and the debt home bias remains valid within this more realistic setting. The simulations use the solution of the full model in Appendix A.

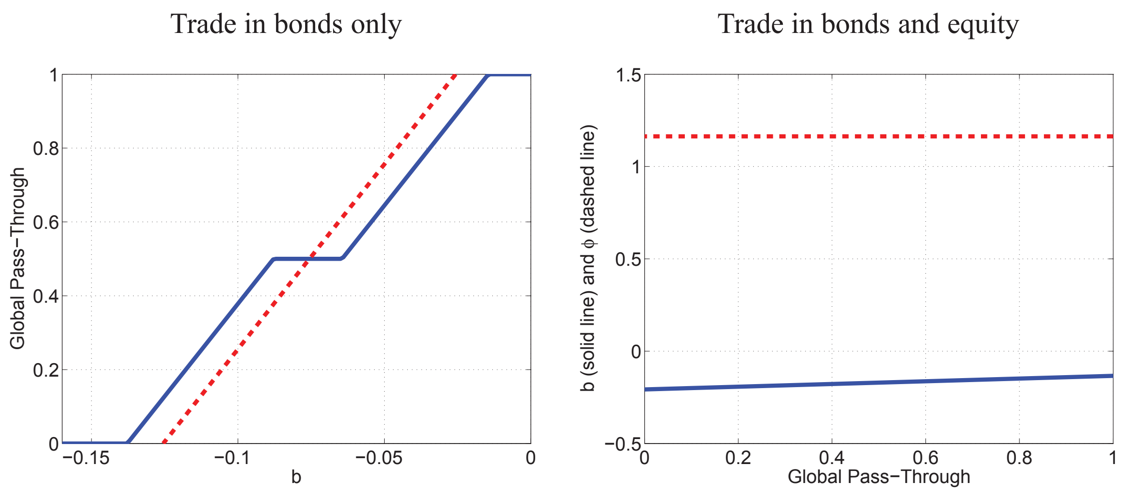

Figure 3: Left panel: dependence of global pass-through on debt home bias (blue solid line) and vice versa (red dashed line) in bonds-only case. Right panel: dependence of debt home bias (blue solid line) and equity home bias (red dashed line) on global pass-through in bonds-and-equity case.

For the baseline calibration we use parameter values, where applicable, from Devereux et al. (2004). In particular, we set the trade price elasticity between domestically produced and imported goods to $\eta = 1.5$. The coefficient of relative risk aversion is $\rho = 1.25$.[18] Trade openness is calibrated to $a = 0.88$, the empirical average for the US over recent decades. The elasticity of substitution between varieties is set to $\sigma = 6$, corresponding to a steady-state markup of 20%. To obtain values for the variances of the shocks, we estimate AR(1)-processes for the HP-filtered logs of M2, Government consumption plus investment, and Solow residuals for the US and use identical values for the foreign country.[19] The resulting variances of the error terms result in $\sigma_M^2 = 0.0043\%$, $\sigma_G^2 = \sigma_{G*}^2 = 0.0052\%$, and $\sigma_A^2 = \sigma_{A*}^2 = 0.0036\%$. The foreign volatility of the money supply is set 10% higher, $\sigma_{M*}^2 = 0.0047\%$, such that firms are not indifferent regarding the pricing-currency decision in the bonds-only case, see above. For the following results it does not matter, which country has a slightly higher volatility of the money stock. The calibration is summarized in Table 3. For all of these values, we conduct robustness checks further below.

4.2.1 Interaction between portfolio home bias and global exchange rate pass-through

Before investigating the effects of shifting from a bonds-only economy to a world with bond and equity trade, we first analyze the interdependence of global pass-through (i.e., $1 - (\tilde{z} + \tilde{z}^*)/2$) and bond and equity portfolios for the general case. Specifically, we investigate the influence of one variable on the other by fixing different values for the former and calculating optimal values for the latter.[20] The exogenously fixed variable is hence not set optimally, allowing us to generate a one-directional interdependence.

[18] Results are robust to changing these parameters, see Tables 4 and 5.

[19] See Appendix B for data sources.

[20] Note that because the countries have symmetric structures, only the value of global-pass through matters for portfolio allocations. This can be seen by the fact that all relevant equation feature $\tilde{z} + \tilde{z}^*$ instead of individual values. Similarly, there is a unique mapping from b and ϕ to the global pass-through.

Trade in bonds only (NB economy)

The left panel of Figure 3 shows this interaction for the bonds-only case. The red dashed line depicts the dependence of b (horizontal axis) on the value of the global pass-through (treated as exogenous, vertical axis), while the blue solid line shows the resulting pass-through on the vertical axis if we set the debt home bias on the horizontal axis exogenously. Technically, we replace firms' decision rules (23) and (24) with exogenous values for $\tilde{z}$ and $\tilde{z}^*$ in the first case, and equation (A-10) by exogenous values of b in the second case. When varying global pass-through, we start at $\tilde{z} = \tilde{z}^* = 0$ and let first $\tilde{z}$ increase to unity, after which $\tilde{z}^*$ rises from zero to one.[21]

As visible, a higher global pass-through has a positive impact on the debt home bias. This effect arises if $\eta > 1$. Under complete LCP, business revenues from foreign sales increase only linearly with exchange-rate depreciations. If the pass-through increases, however, business income rises overproportionally after depreciations, due to expenditure-switching effects. This effect automatically takes over some of the hedging properties that the foreign debt holdings were supposed to fulfill (against government spending shocks, that is), such that their amount can be reduced. See also equation (A-4) in the appendix, which demonstrates that the optimal b rises in the covariance between business revenue and S.

In the case of an exogenously set b, we observe that $\tilde{z} = \tilde{z}^* = 1$ for a low starting value of b. Because of its mitigating effect on exchange-rate volatility, described in Section 4.1.1, an increasing b (rising debt home bias) lets $\tilde{z}$ fall to zero, i.e., home switches from LCP to PCP.[22] For intermediate values of b, this remains an equilibrium. The higher the difference in volatilities of the money supply, the broader is the range in which all firms use the currency of the country with the lower money-supply volatility. Further raising b reduces exchange-rate volatility even more, which leads to a falling $\tilde{z}^*$ until the foreign country has completely switched to PCP too. As visible, both lines are increasing functions of their respective arguments. We obtain a unique solution at their intersection (in this case at a pass-through of 0.5). Also visible is a stronger dependency of the pass-through on the home bias of bond holdings, while the reverse dependence is fairly limited. Specifically, the pass-through changes from absent to complete, depending on the portfolio choice. The debt home bias, in turn, does not reverse sign, independently of the prevailing pass-through. We conclude that financial markets matter quantitatively and qualitatively more for pass-through than vice versa. Investigating the trade channel of exchange-rate movements without simultaneously considering the financial channel thus risks neglecting an important determinant of the former.

Trade in bonds and equity (NBE economy)

Figure 3 (right panel) depicts the dependence of b and ϕ (both on the vertical axis) on global pass-through (horizontal axis) for trade in bonds and equity. As in the bonds-only case, the decision rules (23) and (24) were replaced by exogenous values of $\tilde{z}$ and $\tilde{z}^*$. Figure 4 shows how global pass-through (vertical axis) depends on b and ϕ (horizontal axes). Here, the optimal portfolio choices of equation (A-20) were replaced by exogenous values for b and ϕ. As the global pass-through now depends on the home bias in bonds and in equities, Figure 4 is three-dimensional. Because there are unique mappings from pass-through to optimal asset home biases in bonds (blue solid line in the right panel of Figure 3) and equities (red dashed line), and a unique mapping from each combination of these parameter to pass-through (Figure 4), we again obtain a unique solution at their mutual intersection.

Regarding the pricing-decisions of firms, the same pattern as above is visible. Increasing the value of

[21] Since only the value of the global pass-through matters, this is without loss of generality.

[22] More generally, firms in the country with the lower money-supply volatility switch first to price in their own currency. 'Home' refers to this country in the following.

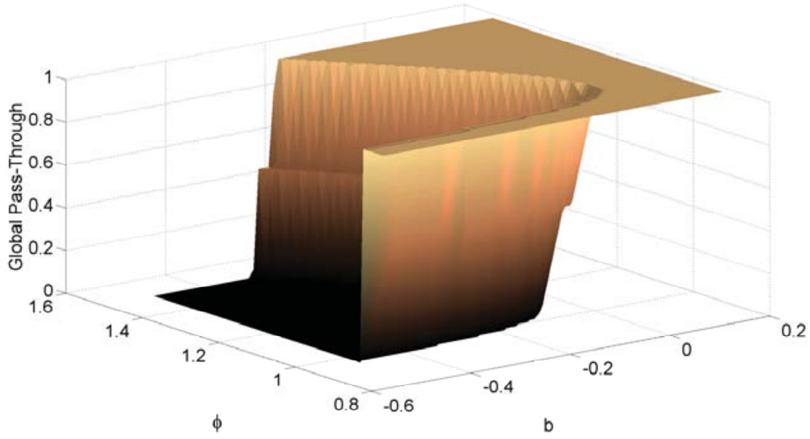

Figure 4: Bonds and equity case: dependence of global pass-through (vertical axis) on home bias in equity (left axis) and debt (right axis).

b induces first the home country to switch from LCP to PCP, followed by a small region of constant $\tilde{z}$ and $\tilde{z}^*$. Finally, the foreign country also charges according to PCP if b rises further. Looking at the reaction to a changing ϕ, the pattern is quite different. Intuitively, the optimal value of ϕ stabilizes relative incomes and hence the exchange rate. This lets producers chose LCP, while values of ϕ further away from the optimum increase exchange-rate volatility and let firms switch to PCP. More precisely, for a given intermediate value of b a low level of ϕ lets both producers follow PCP. For increasing values of ϕ, the optimal $\tilde{z}^*$ rises first, implying a falling pass-through. However, some domestic firms switch to LCP already before all foreign firms have done so. Domestic firms are also first to go back to PCP for even higher values of ϕ, followed by their foreign counterparts once all home firms use LCP. We can draw similar conclusions as in the bonds-only case. Financial markets, both in terms of home bias in bonds and in equity, matter highly for pass-through. The reverse is not true, according to Figure 3 (right panel). While the home bias in bonds varies but stays negative if global pass-through changes from zero to one (following the same intuition as in the bonds-only case), the home bias in equity is independent of the level of pass-through. As visible, pass-through has hence only a limited feedback to financial markets. We conclude that when investigating determinants of pass-through, financial markets are crucial.

4.2.2 Effects of financial integration

Table 4 displays the change in the home bias of debt holdings when switching from a bonds-only economy to international financial markets with bonds and equity, for different values of the key parameters of the model. The change in debt home bias corresponds to $b^{NBE} - b^{NB}$ as b denotes the amount of net debt held in domestic currency. The upper-left panel of Table 4 reports the change in the debt home bias for different values for ρ and η. The upper-right panel shows the same statistic for different values of the volatilities of the shocks to the money supply, while in the lower-left panel the variances of government spending shocks are altered (always between half and double the baseline value). The lower-right panel of Table 4 displays this change for different volatilities of the shocks to technology in both countries. Finally, in Table 5 we change the volatility of money shocks, set to the reported value at home and at a 10% higher rate at foreign, and technology shocks, both equal across

η \ ρ	1.00	1.55	2.10	2.65	3.20	3.75
0.75	-0.06	-0.08	-0.08	-0.08	-0.06	-0.04
1.40	-0.13	-0.15	-0.15	-0.15	-0.13	-0.11
2.05	-0.19	-0.21	-0.22	-0.22	-0.20	-0.18
2.70	-0.26	-0.28	-0.29	-0.28	-0.27	-0.25
3.35	-0.33	-0.35	-0.36	-0.35	-0.34	-0.31
4.00	-0.40	-0.42	-0.43	-0.42	-0.41	-0.38

σ_M^2 \ $\sigma_{M^*}^2$	0.24	0.38	0.52	0.66	0.80	0.95
0.22	-0.11	-0.13	-0.14	-0.15	-0.12	-0.12
0.34	-0.13	-0.14	-0.15	-0.15	-0.16	-0.12
0.47	-0.14	-0.14	-0.15	-0.15	-0.16	-0.16
0.60	-0.14	-0.15	-0.15	-0.16	-0.16	-0.16
0.73	-0.15	-0.15	-0.16	-0.16	-0.16	-0.16
0.86	-0.12	-0.16	-0.16	-0.16	-0.16	-0.17

σ_G^2 \ $\sigma_{G^*}^2$	0.26	0.42	0.57	0.73	0.88	1.04
0.26	-0.11	-0.13	-0.14	-0.15	-0.15	-0.15
0.42	-0.13	-0.14	-0.15	-0.15	-0.15	-0.16
0.57	-0.14	-0.15	-0.15	-0.15	-0.16	-0.16
0.73	-0.15	-0.15	-0.15	-0.16	-0.16	-0.16
0.88	-0.15	-0.15	-0.16	-0.16	-0.16	-0.15
1.04	-0.15	-0.16	-0.16	-0.16	-0.15	-0.15

σ_A^2 \ $\sigma_{A^*}^2$	0.18	0.29	0.40	0.50	0.61	0.72
0.18	-0.21	-0.18	-0.17	-0.15	-0.14	-0.13
0.29	-0.18	-0.17	-0.15	-0.14	-0.13	-0.12
0.40	-0.17	-0.15	-0.14	-0.13	-0.12	-0.12
0.50	-0.15	-0.14	-0.13	-0.12	-0.12	-0.11
0.61	-0.14	-0.13	-0.12	-0.12	-0.11	-0.11
0.72	-0.13	-0.12	-0.12	-0.11	-0.11	-0.10

Table 4: Changes in debt home bias ($b^{NBE} - b^{NB}$) for varying ρ and η (upper left), σ_M^2 and $\sigma_{M^*}^2$ (upper right), σ_G^2 and $\sigma_{G^*}^2$ (lower left) or σ_A^2 and $\sigma_{A^*}^2$ (lower right) due to financial integration. All variances (not the change in dhb) were multiplied by 10^4 before reporting for better readability.

countries. As visible, for reasonable ranges of parameter values, the home bias of debt holdings declines after an increase in financial market integration. Similarly, the global exchange rate pass-through for all shown combinations falls by 0.5. This results from the fact that one country always switches from PCP to LCP. Both effects are qualitatively in line with the empirical findings of Section 2.

As explained in more detail in Section 4.1, when moving towards trade in bonds and equity agents can make better use of both instrument for hedging purposes. In particular, cross-border equity holdings can be used to mitigate the negative side effects of holding foreign debt, such that more international bonds can be bought to hedge against government spending shocks. This has the side effect that cost reductions have a strong bearing on relative income derived from these international equity positions and hence on the exchange rate. A stronger covariance between marginal costs and the exchange rate results, reducing the optimal amount of exchange rate pass-through. At the same time, a lower pass-through reduces the positive effects of exchange-rate depreciations on the business income. This reinforces households decision to hold more foreign debt to compensate for this lost automatic hedge against government spending shocks.

The model predicts a plausible reduction in debt home bias by around 10-30 percentage points for calibrations close to the baseline. Also in line with empirical evidence presented in Figure 1 of the introduction, it implies a negative debt home bias. As it is a stylized 2-period model, however, we are mainly interested in the qualitative results following financial integration. Summarizing the information of the tables, increased financial integration leads to reductions in pass-through and debt home bias, independently of realistic parameter constellations. Both predictions are in line with the empirical evidence in Section 2. Given that financial integration increased considerably over the recent decades, the described mechanism can explain the observed changes of these variables over time.

σ^2_{M,M^*} \ σ^2_{A,A^*}	0.18	0.29	0.40	0.50	0.61	0.72
0.22	-0.15	-0.12	-0.11	-0.10	-0.09	-0.08
0.34	-0.19	-0.15	-0.13	-0.12	-0.11	-0.10
0.47	-0.22	-0.17	-0.14	-0.13	-0.11	-0.11
0.60	-0.23	-0.18	-0.15	-0.13	-0.12	-0.11
0.73	-0.24	-0.18	-0.15	-0.14	-0.12	-0.11
0.86	-0.24	-0.19	-0.16	-0.14	-0.12	-0.11

Table 5: Changes in debt home bias for varying $\sigma^2_M = \sigma^2_{M^*}$ and $\sigma^2_A = \sigma^2_{A^*}$ due to financial integration. All variances (not the change in dhb) were multiplied by 10^4 before reporting for better readability.

5 Conclusion

In this paper we have put forward a new explanation for the decline of the exchange rate pass-through into import prices. Crucial for our theoretical model is the impact of financial globalization, modeled as an increase in the number and nature of tradable financial assets, on the portfolio decision of households and the pricing decisions of firms. In the model, we take the impact of financial globalization and the mutual interaction between the optimal portfolio and the choice of the invoicing currency explicitly into account.

The main impact of financial globalization on pass-through works via the better possibilities to hedge against specific shocks. Households can hold more foreign debt as they can counteract the movements in its return that are not useful for hedging purposes by building up a corresponding international equity position. As a side effect, cross-border equity holdings increase the correlation between marginal costs and the exchange rate, as cost reductions change relative profits and thereby the resulting demand from financial income. Firms react by pricing more in local currency compared to a world in which only debt is traded internationally. Optimal pass-through thus falls. Finally, a lower pass-through mitigates the increase in business income after depreciations, which is compensated for by holding even more foreign debt. We also present empirical evidence supporting the negative effect of gross equity holdings on the home bias of international debt assets and the exchange rate pass-through. An important policy implication concerns the design of monetary unions: if preceded by financial integration, the effect of the nominal exchange rate on relative prices is reduced because of the lower exchange rate pass-trough. Moving towards abolishing the nominal exchange rate altogether is therefore likely to have smaller real consequences.

Appendix

A Equilibrium of the full model

In this appendix we derive the optimal portfolio solutions under the different degrees of international financial market integration for unrestricted parameter values and show how they influence the equilibrium behavior of the nominal exchange rate and the marginal costs.[23]

Money market equilibrium and the nominal exchange rate First, we use the money market equilibrium to solve for the nominal exchange rate. Expressing (15) in log-linear terms yields

$$\widehat{S} = \frac{(\widehat{M} - \widehat{M^*})}{\rho + (1-\rho)(1-a)(2-\tilde{z}-\tilde{z}^*)} - \frac{\rho(\widehat{PC} - \widehat{SP^*C^*})}{\rho + (1-\rho)(1-a)(2-\tilde{z}-\tilde{z}^*)}. \tag{A-1}$$

For future use we define $\Theta_M^S = [\rho + (1-\rho)(1-a)(2-\tilde{z}-\tilde{z}^*)]^{-1}$ and $\Theta_{PC}^S = \rho\Theta_M^S$, such that $\widehat{S} = \Theta_M^S(\widehat{M} - \widehat{M^*}) - \Theta_{PC}^S(\widehat{PC} - \widehat{SP^*C^*})$. The equilibrium nominal exchange rate will hence not only be affected by the relative money supplies but also via the differences in nominal spending, $\widehat{PC} - \widehat{SP^*C^*}$, and by the types of assets traded, as shown below.

A.1 Trade in bonds only

We follow the approximation method for computing equilibrium portfolio positions developed by Devereux and Sutherland (2011) and take a second-order approximation of the asset market equilibrium condition for the home country (9) and its foreign counterpart. The differences of these two equations lead to the following arbitrage condition

$$Cov(-\widehat{S}, \widehat{PC} - \widehat{SP^*C^*}) = \frac{1-\rho}{\rho} Cov(-\widehat{S}, \widehat{Q}), \tag{A-2}$$

which relates the covariance between excess returns on domestic nominal bonds (given by nominal exchange-rate deviations, $\hat{R}_{Fin}^B = -\widehat{S}$) and relative nominal consumption expenditures, $\widehat{PC} - \widehat{SP^*C^*}$, to the covariance between excess returns on nominal bonds and the real exchange rate $\widehat{Q} = \widehat{SP^*} - \widehat{P}$. Linearizing the period $t = 1$ budget constraints for the home and foreign country (8) and taking country differences, we get an expression for relative nominal consumption expenditures. In doing so we take the government budget constraints into consideration and assume that the log of government expenditures is equal to zero in the deterministic steady state. The relative budget constraint equals

$$\widehat{PC} - \widehat{SP^*C^*} = 2b\hat{R}_{Fin}^B + (\widehat{REV} - \widehat{SREV^*}) - (\widehat{G} - \widehat{G^*}), \tag{A-3}$$

where we have used the fact that $B_H = B_F^*$ for $S_0 = 1$. b is the equilibrium amount of bonds we are looking for. Relative sales revenues will be defined as the non-financial return, $\hat{R}_{Fin}^{Non} = \widehat{REV} - \widehat{SREV^*}$.

[23] A more detailed description of the steps taken in the derivations is available from the authors upon request.

Optimal nominal bond portfolio Plugging (A-3) into the asset market arbitrage condition (A-2) and rearranging terms we get

$$b = \frac{1}{2}\left(\frac{1-\rho}{\rho}\frac{Cov(\hat{R}^B_{Fin}, \widehat{Q})}{Var(\widehat{S})} - \frac{Cov(\hat{R}^B_{Fin}, \hat{R}^{Non}_{Fin})}{Var(\widehat{S})} + \frac{Cov(\hat{R}^B_{Fin}, \widehat{G} - \widehat{G^*})}{Var(\widehat{S})}\right). \tag{A-4}$$

This expression states that the optimal equilibrium bond holdings b (i.e., the debt home bias) depend on three components: the covariance between relative nominal bond returns (i.e., minus the nominal exchange rate) and the real exchange rate, the covariance between relative nominal bond returns and relative sales revenues, as well as the covariance between relative nominal bond returns and relative government expenditures, all weighted by the variance of relative nominal bond returns, i.e., the nominal exchange rate.

By making an optimal portfolio choice, the representative household wants to hedge its marginal utility of consumption. Households hedge consumption risks stemming from variations in their purchasing power, reflected by movements in the real exchange rate. Domestic bonds are a good hedge against this risk if domestic bond returns are high whenever the domestic price level is high, i.e., $Cov(\hat{R}^B_{Fin}, \widehat{Q}) < 0$. In the case of $\rho = 1$, a unit increase in real returns of bond assets (domestic or foreign) decreases the marginal utility of consumption by one unit, such that bond asset gains evaluated at the marginal utility of consumption vanish and the covariance between relative nominal returns and the real exchange rate becomes irrelevant for the portfolio choice decision.

Furthermore, the representative household wishes to hedge nominal income risks associated with variations in nominal revenues from domestic firms and government expenditures. Domestic bonds are a good hedge if relative domestic bond returns are high whenever domestic revenues are low. For example, an appreciation of the nominal exchange rate causes both, a fall in relative revenues from foreign sales (if $\eta > 1$) and a higher relative domestic bond return, i.e., $Cov(\hat{R}^B_{Fin}, \hat{R}^{Non}_{Fin}) < 0$. Consequently, holding a higher amount of domestic bonds allows to hedge nominal revenue risk. Government expenditures are fully paid by the seignorage and lump-sum taxes which reduce nominal disposable income. Foreign bonds are a good hedge against taxation risk if their returns are high whenever the income loss associated with government expenditure is high, i.e., $Cov(\hat{R}^B_{Fin}, \widehat{G} - \widehat{G^*}) < 0$. Since government spending shocks let the exchange rate depreciate, holding foreign bonds can at least partly offset this negative effect on income.

To solve for the optimal portfolio bond holdings we write the nominal exchange rate, nominal consumption spending, and sales revenues as functions of the underlying shocks. We first treat portfolio-based nominal income as exogenous, $\widehat{Ex}_{Fin} = 2b\hat{R}^B_{Fin}$. Relative domestic bond returns are obtained by combining equations (A-1) and (A-3):

$$\hat{R}^B_{Fin} = -\Theta^S_M(\widehat{M} - \widehat{M}^*) + \Theta^S_{PC}(\widehat{Ex}_{Fin} + \hat{R}^{Non}_{Fin}) - \Theta^S_{PC}(\widehat{G} - \widehat{G}^*), \tag{A-5}$$

where the coefficients Θ^S_M and Θ^S_{PC} are defined above and are given in Table A-1. Furthermore, non-financial income can be obtained from the sales revenue of firms, given total demand for their goods sold at home and abroad:

$$\widehat{REV} - \widehat{SREV^*} = \hat{R}^{Non}_{Fin} = \Lambda\widehat{S} - \lambda(\widehat{PC} - \widehat{SP^*C^*}) - \lambda(\widehat{G} - \widehat{G}^*), \tag{A-6}$$

with $\lambda = 1 - a - a^*$ and $\Lambda = -(1-\eta)(1+\lambda)[a(1-z^*) + a^*(1-z)]$. After substituting (A-1) and (A-3), this can be written as

$$\hat{R}^{Non}_{Fin} = \Theta^{R^{Non}_{Fin}}_{Ex_{Fin}}\widehat{Ex}_{Fin} + \Theta^{R^{Non}_{Fin}}_{M}(\widehat{M} - \widehat{M}^*) + \Theta^{R^{Non}_{Fin}}_{G}(\widehat{G} - \widehat{G}^*), \tag{A-7}$$

where the resulting parameters $\Theta^{R^{Non}_{Fin}}_{Ex_{Fin}}$, $\Theta^{R^{Non}_{Fin}}_{M}$, and $\Theta^{R^{Non}_{Fin}}_{G}$ are provided in Table A-1. Combining (A-5) and (A-7), we get

$$\hat{R}^{B}_{Fin} = \mathbf{R}_1 \widehat{Ex}_{Fin} + \mathbf{R}_2[(\widehat{M} - \widehat{M}^*), (\widehat{G} - \widehat{G}^*)]', \tag{A-8}$$

where $\mathbf{R}_1 = \Theta^S_{PC}\left(1 + \Theta^{R^{Non}_{Fin}}_{Ex_{Fin}}\right)$ is a scalar and $\mathbf{R}_2 = [-(\Theta^S_M - \Theta^S_{PC}\Theta^{R^{Non}_{Fin}}_M), -\Theta^S_{PC}(1-\Theta^{R^{Non}_{Fin}}_G)]$ is a 1×2 vector. Now we can write the relative discount factor as

$$-\rho(\widehat{PC} - \widehat{SP^*C^*}) + (1-\rho)\,\widehat{Q} = \mathbf{D}_1 \widehat{Ex}_{Fin} + \mathbf{D}_2[(\widehat{M} - \widehat{M}^*), (\widehat{G} - \widehat{G}^*)]', \tag{A-9}$$

with $\mathbf{D}_1 = -\Theta^D_{PC}(1+\Theta^{R^{Non}_{Fin}}_{Ex_{Fin}})$ being a scalar and $\mathbf{D}_2 = [\Theta^D_M - \Theta^D_{PC}\Theta^{R^{Non}_{Fin}}_M, \Theta^D_{PC}(1-\Theta^{R^{Non}_{Fin}}_G)]$ a 1×2 vector of combinations of structural parameters, where Θ^D_M and Θ^D_{PC} are shown in Table A-1. Given (A-8) and (A-9), the arbitrage condition (A-2) can be written as $\mathbf{R}\Sigma\mathbf{D}' = 0$, where $\mathbf{R} = \mathbf{R}_1\mathbf{H} + \mathbf{R}_2$, $\mathbf{H} = 2b(1-2b\mathbf{R}_1)^{-1}\mathbf{R}_2$, and $\mathbf{D} = \mathbf{D}_1\mathbf{H} + \mathbf{D}_2$ are 1×2 vectors. Σ is the 2×2 variance-covariance matrix of the exogenous disturbances to the money supply and government spending. Even though the economies are hit by monetary policy, government spending, and productivity shocks, only the first two change aggregate income and move the exchange rate. Hence, households cannot and do not need to insure themselves against relative productivity movements across countries. Solving for b yields

$$b = \left[\mathbf{R}_2\Sigma\mathbf{D}_2'\mathbf{R}_1' - \mathbf{D}_1\mathbf{R}_2\Sigma\mathbf{R}_2'\right]^{-1}\mathbf{R}_2\Sigma\mathbf{D}_2'/2. \tag{A-10}$$

Nominal exchange rate in the NB economy Given the solution to nominal bonds holdings we can express the nominal exchange rate in equation (A-1) as

$$\widehat{S} = \frac{\left(1-\rho\Theta^{PC}_M\right)(\widehat{M} - \widehat{M}^*) + \rho\Theta^{PC}_G(\widehat{G} - \widehat{G}^*)}{\rho + (1-\rho)(1-a)(2-\tilde{z}-\tilde{z}^*)}, \tag{A-11}$$

with Θ^{PC}_M and Θ^{PC}_G provided in Table A-1. As explained before, the exchange rate only transmits two of the three possible economic disturbances across countries. The impact effect of the shocks is affected by the size of the equilibrium portfolio holding of b since Θ^{PC}_M and Θ^{PC}_G depend on the size of b. The fact that not all disturbances are transmitted via the nominal exchange rate has implications for the price-setting decision of the firms since it directly affects the covariance relationship between the nominal exchange rate and marginal costs of the firm. Consider the linearized version of the marginal costs at home and foreign, equation (28). Together with equations (13) and (A-11) it follows that the covariance between marginal costs and the nominal exchange rate can be written as

$$Cov(\widehat{mc}, \widehat{S}) = \frac{\left(1-\rho\Theta^{PC}_M\right)}{\rho + (1-\rho)(1-a)(2-\tilde{z}-\tilde{z}^*)} Var(\widehat{M}), \tag{A-12}$$

$$Cov(\widehat{mc}^*, \widehat{S}) = -\frac{\left(1-\rho\Theta^{PC}_M\right)}{\rho + (1-\rho)(1-a)(2-\tilde{z}-\tilde{z}^*)} Var(\widehat{M}^*), \tag{A-13}$$

respectively. Note that in the NB economies only monetary disturbances affect the covariance relationship between marginal costs and the nominal exchange rate. The magnitude of this covariance relationship will depend on the equilibrium bond holdings b. Since all shocks are uncorrelated, the variance of the nominal exchange rate equals

$$Var(\widehat{S}) = \frac{\left(1-\rho\Theta^{PC}_M\right)^2 Var(\widehat{M} + \widehat{M}^*) + (\rho\Theta^{PC}_G)^2 Var(\widehat{G} + \widehat{G}^*)}{\left[\rho + (1-\rho)(1-a)(2-\tilde{z}-\tilde{z}^*)\right]^2}, \tag{A-14}$$

with $Var(\widehat{G}+\widehat{G}^*)$ and $Var(\widehat{M}+\widehat{M}^*)$ reflecting the sum of the variances of the government spending and monetary policy shocks at home and abroad.

A.2 Trade in bonds and equities

Additional to the asset market equilibrium condition for bonds, equation (A-2), we also take a second-order approximation of the home Euler equity equation (12) and its foreign counterpart to obtain

$$Cov(\widehat{\Pi} - \widehat{S\Pi^*}, \widehat{PC} - \widehat{SP^*C^*}) = \frac{1-\rho}{\rho} Cov(\widehat{\Pi} - \widehat{S\Pi^*}, \widehat{Q}). \quad \text{(A-15)}$$

As for bonds, we linearize the period $t = 1$ budget constraint for the home country and its foreign counterpart (11). Taking country differences yields

$$\widehat{PC} - \widehat{SP^*C^*} = \frac{2\phi - 1}{\sigma}(\widehat{\Pi} - \widehat{S\Pi^*}) + 2b\hat{R}^B_{Fin} - (\widehat{G} - \widehat{G^*}) + \frac{\sigma - 1}{\sigma}(\widehat{WL} - \widehat{SW^*L^*}).$$

Defining $\hat{R}^E_{Fin} \equiv \frac{1}{\sigma}(\widehat{\Pi} - \widehat{S\Pi^*})$ and $\hat{R}^{Non}_{Fin} \equiv \frac{\sigma-1}{\sigma}(\widehat{WL} - \widehat{SW^*L^*})$, we can rewrite the last equation as[24]

$$\widehat{PC} - \widehat{SP^*C^*} = (2\phi - 1)\hat{R}^E_{Fin} + 2b\hat{R}^B_{Fin} - (\widehat{G} - \widehat{G^*}) + \hat{R}^{Non}_{Fin}. \quad \text{(A-16)}$$

Optimal bond and equity portfolio Given that both bonds and equity are traded, the equilibrium bond position will now depend also on the covariance between the relative returns from equity and bond holdings as well as on equilibrium equity holdings. Following the solution approach of the previous section, non financial income equals

$$\hat{R}^{Non}_{Fin} = \Theta^{R^{Non}_{Fin}}_{Ex_{Fin}} \widehat{\mathbf{Ex}}_{Fin} - \Theta^{R^{Non}_{Fin}}_{A}(\widehat{A} - \widehat{A}^*) + \Theta^{R^{Non}_{Fin}}_{M}(\widehat{M} - \widehat{M}^*) - \Theta^{R^{Non}_{Fin}}_{G}(\widehat{G} - \widehat{G}^*), \quad \text{(A-17)}$$

with $\widehat{\mathbf{Ex}}_{Fin} = [2b, (2\phi - 1)]\,[\hat{R}^B_{Fin}, \hat{R}^E_{Fin}]'$ and $\Theta^{R^{Non}_{Fin}}_{Ex_{Fin}}$, $\Theta^{R^{Non}_{Fin}}_{A}$, $\Theta^{R^{Non}_{Fin}}_{M}$ and $\Theta^{R^{Non}_{Fin}}_{G}$ given in Table A-2. The structural parameters Θ^S_{PC} and Θ^S_M are also shown in Table A-2. Financial returns can be written as

$$[\hat{R}^B_{Fin}, \hat{R}^E_{Fin}]' = \mathbf{R}_1 \widehat{\mathbf{Ex}}_{Fin} + \mathbf{R}_2[(\widehat{A} - \widehat{A}^*), (\widehat{M} - \widehat{M}^*), (\widehat{G} - \widehat{G}^*)]', \quad \text{(A-18)}$$

with $\mathbf{R}_1 = [\Theta^S_{PC}(1 + \Theta^{R^{Non}_{Fin}}_{Ex_{Fin}}), -(\Theta^{R_{Fin}}_{PC} + \Theta^{R_{Fin}}_{S}\Theta^S_{PC})(1 + \Theta^{R^{Non}_{Fin}}_{Ex_{Fin}})]'$ and $\mathbf{R}_2$ being a 3x2 matrix, which is displayed in the next section and contains the additional structural parameters $\Theta^{R_{Fin}}_{PC}$ and $\Theta^{R_{Fin}}_{S}$, given in Table A-2. Finally, the relative discount factor equals

$$-\rho(\widehat{PC} - \widehat{SP^*C^*}) + (1 - \rho)\,\widehat{Q} = \mathbf{D}_1 \widehat{\mathbf{Ex}}_{Fin} + \mathbf{D}_2[(\widehat{A} - \widehat{A}^*), (\widehat{M} - \widehat{M}^*), (\widehat{G} - \widehat{G}^*)]', \quad \text{(A-19)}$$

with $\mathbf{D}_1 = -\Theta^D_{PC}(1 + \Theta^{R^{Non}_{Fin}}_{Ex_{Fin}})$ being a scalar and $\mathbf{D}_2 = [\Theta^D_{PC}\Theta^{R^{Non}_{Fin}}_{A}, \Theta^D_M - \Theta^D_{PC}\Theta^{R^{Non}_{Fin}}_{M}, \Theta^D_{PC}(1 + \Theta^{R^{Non}_{Fin}}_{G})]$ a 1×3 vector of combinations of the structural parameters, where Θ^D_M and Θ^D_{PC} are defined in Table A-2. Equations (A-17)-(A-19) allow us to write the solution to the bond and equity holding in the NBE economy as

$$\begin{bmatrix} 2b & (2\phi - 1) \end{bmatrix}' = \left[\mathbf{R}_2 \Sigma \mathbf{D}_2' \mathbf{R}_1' - \mathbf{D}_1 \mathbf{R}_2 \Sigma \mathbf{R}_2'\right]^{-1} \mathbf{R}_2 \Sigma \mathbf{D}_2', \quad \text{(A-20)}$$

where Σ now represents the 3×3 variance-covariance matrix of all three shocks.

[24] Note that the parameters of Section A.1 assume different values in this section.

Nominal exchange rate in the NBE economy The solution to the nominal exchange can be derived from the above. Given the relative budget constraint of households (A-16) and plugging in equations (A-17)-(A-20) we can write the difference in nominal spending as

$$\widehat{PC} - \widehat{SP^*C^*} = \Theta_A^{PC}(\widehat{A} - \widehat{A}^*) + \Theta_M^{PC}(\widehat{M} - \widehat{M}^*) + \Theta_G^{PC}(\widehat{G} - \widehat{G}^*). \tag{A-21}$$

Substituting this back into equation (A-1) gives

$$\widehat{S} = \frac{\left(1 - \rho\Theta_M^{PC}\right)(\widehat{M} - \widehat{M}^*) - \rho\Theta_A^{PC}(\widehat{A} - \widehat{A}^*) - \rho\Theta_G^{PC}(\widehat{G} - \widehat{G}^*)}{\rho + (1-\rho)(1-a)(2 - \tilde{z} - \tilde{z}^*)}, \tag{A-22}$$

with Θ_A^{PC}, Θ_M^{PC}, and Θ_G^{PC} displayed in Table A-2. In contrast to the NB economy, the exchange rate transmits all three economic disturbances across countries. Again, the equilibrium outcome of the nominal exchange rate depends on the equilibrium portfolio allocation of bonds, b, and equities, ϕ. From (28) and (A-22) it follows that the covariance between marginal costs and the nominal exchange rate in the NBE economies can be written as

$$\begin{aligned}
Cov(\widehat{mc}, \widehat{S}) &= \frac{\left(1 - \rho\Theta_M^{PC}\right) Var(\widehat{M}) + \rho\Theta_A^{PC} Var(\widehat{A})}{\rho + (1-\rho)(1-a)(2 - \tilde{z} - \tilde{z}^*)}, \\
Cov(\widehat{mc}^*, \widehat{S}) &= -\frac{\left(1 - \rho\Theta_M^{PC}\right) Var(\widehat{M}^*) + \rho\Theta_A^{PC} Var(\widehat{A}^*)}{\rho + (1-\rho)(1-a)(2 - \tilde{z} - \tilde{z}^*)}.
\end{aligned}$$

All shocks that affect marginal costs now also impact the nominal exchange rate. Thus, the covariance relationship between marginal costs and the nominal exchange rate is not only affected by monetary disturbances, as in the NB economy, but also by productivity disturbances. The sign of this covariance relationship, however, will depend on the equilibrium bond holdings b as well as the equilibrium equity position ϕ. Since all shocks are uncorrelated, the variance of the nominal exchange rate in the NBE economy equals

$$\begin{aligned}
Var(\widehat{S}) &= \frac{\left(1 - \rho\Theta_M^{PC}\right)^2 Var(\widehat{M} + \widehat{M}^*) + (\rho\Theta_G^{PC})^2 Var(\widehat{G} + \widehat{G}^*)}{\left[\rho + (1-\rho)(1-a)(2 - \tilde{z} - \tilde{z}^*)\right]^2} \\
&\quad + \frac{\left(\rho\Theta_A^{PC}\right)^2 Var(\widehat{A} + \widehat{A}^*)}{\left[\rho + (1-\rho)(1-a)(2 - \tilde{z} - \tilde{z}^*)\right]^2}.
\end{aligned}$$

A.3 Coefficients of the full model

Table A-1 provides the coefficients for the case of trade in nominal bonds only, while Table A-2 lists the coefficients for economies in which bonds and equity are traded.

The matrix $\mathbf{R}_2$ for the bond and equity case is given by

$$\mathbf{R}_2 = \begin{bmatrix}
-\Theta_{PC}^S \Theta_A^{R_{Fin}^{Non}}, & (\Theta_{PC}^{R_{Fin}} + \Theta_S^{R_{Fin}}\Theta_{PC}^S)\Theta_A^{R_{Fin}^{Non}} + \frac{\sigma-1}{\sigma} \\
-\Theta_M^S + \Theta_{PC}^S \Theta_M^{R_{Fin}^{Non}}, & \Theta_S^{R_{Fin}}\Theta_M^S - (\Theta_{PC}^{R_{Fin}} + \Theta_S^{R_{Fin}}\Theta_{PC}^S)\Theta_M^{R_{Fin}^{Non}} \\
-\Theta_{PC}^S(1 + \Theta_G^{R_{Fin}^{Non}}), & (\Theta_{PC}^{R_{Fin}} + \Theta_S^{R_{Fin}}\Theta_{PC}^S)(1 + \Theta_G^{R_{Fin}^{Non}}) - \frac{1-2a}{\sigma}
\end{bmatrix}'.$$

Table A-1: Structural coefficients of the NB economies.

$$
\begin{aligned}
\Theta_{M}^{S} &= \left[\rho + (1-\rho)(1-a)(2-\tilde{z}-\tilde{z}^{*})\right]^{-1} \\
\Theta_{PC}^{S} &= \rho \Theta_{M}^{S} \\
\xi_1 &= 2(1-a) - 2(1-\eta)(1-a)\,a\,(2-\tilde{z}-\tilde{z}^{*})\,\Theta_{PC}^{S} \\
\Theta_{Ex_{Fin}}^{R_{Fin}^{Non}} &= (1-\xi_1)/\xi_1 \\
\Theta_{M}^{R_{Fin}^{Non}} &= -\left[2(1-\eta)(1-a)\,a\,(2-\tilde{z}-\tilde{z}^{*})\,\Theta_{M}^{S}\right]/\xi_1 \\
\Theta_{G}^{R_{Fin}^{Non}} &= \left[1-2a-2(1-\eta)(1-a)\,a\,(2-\tilde{z}-\tilde{z}^{*})\,\Theta_{PC}^{S}-1+2a\right]/\xi_1 \\
\Theta_{M}^{D} &= (1-\rho)\left[1-(1-a)(2-\tilde{z}-\tilde{z}^{*})\right]\Theta_{M}^{S} \\
\Theta_{PC}^{D} &= \rho + (1-\rho)\left[1-(1-a)(2-\tilde{z}-\tilde{z}^{*})\right]\Theta_{PC}^{S} \\
\xi_2 &= 2(1-a) - \left[2b + (1-\eta)(1-a)\,a\,(2-\tilde{z}-\tilde{z}^{*})\right]\Theta_{PC}^{S} \\
\Theta_{M}^{PC} &= -\left\{\Theta_{M}^{S}\left[2b+(1-\eta)(1-a)\,a\,(2-\tilde{z}-\tilde{z}^{*})\right]\right\}/\xi_2 \\
\Theta_{G}^{PC} &= \left[2(1-a)\right]/\xi_2
\end{aligned}
$$

Table A-2: Structural coefficients of the NBE economies.

$$\Theta_A^{R_{Fin}^{Non}} = \left(\frac{\sigma}{\sigma-1} - \left[2a-1+\rho-\{\rho-(1-a)\left[\tilde{z}+\tilde{z}^*+(2-\tilde{z}-\tilde{z}^*)\left(2a(1-\eta)-1+\rho\right)\right]\}\,\Theta_{PC}^S\right]\right)^{-1}$$

$$\xi_3 = 1-\frac{\sigma-1}{\sigma}\left[2a+\rho-1-\{\rho-(1-a)\left[\tilde{z}+\tilde{z}^*+(2-\tilde{z}-\tilde{z}^*)\left(2a(1-\eta)+\rho-1\right)\right]\}\,\Theta_{PC}^S\right]$$

$$\Theta_{Ex_{Fin}}^{R_{Fin}^{Non}} = \frac{\sigma-1}{\sigma}\left[2a-1+\rho-\{\rho-(1-a)\left[\tilde{z}+\tilde{z}^*+(2-\tilde{z}-\tilde{z}^*)\left(2a(1-\eta)-1+\rho\right)\right]\}\,\Theta_{PC}^S\right]/\xi_3$$

$$\Theta_M^{R_{Fin}^{Non}} = \frac{\sigma-1}{\sigma}\{\rho-(1-a)\left[\tilde{z}+\tilde{z}^*+(2-\tilde{z}-\tilde{z}^*)\left(2a(1-\eta)-(1-\rho)\right)\right]\}\,\Theta_M^S/\xi_3$$

$$\Theta_G^{R_{Fin}^{Non}} = \frac{\sigma-1}{\sigma}\left\{\rho-\{\rho-(1-a)\left[\tilde{z}+\tilde{z}^*+(2-\tilde{z}-\tilde{z}^*)\left(2a(1-\eta)-1+\rho\right)\right]\}\,\Theta_{PC}^S\right\}/\xi_3$$

$$\Theta_{PC}^{R_{Fin}} = \left[1-2a+(\sigma-1)\rho\right]\sigma^{-1}$$

$$\Theta_S^{R_{Fin}} = \left[(\sigma-1)\{(1-a)\left[\tilde{z}+\tilde{z}^*-(2-\tilde{z}-\tilde{z}^*)\left(1-\rho-2a(1-\eta)\right)\right]-\rho\} - 2\sigma a\,(1-a)\,(1-\eta)\,(2-\tilde{z}-\tilde{z}^*)\right]\sigma^{-1}$$

$$\xi_4 = \begin{array}{l} 1+(2\phi-1)\left(\Theta_{PC}^{R_{Fin}}+\Theta_S^{R_{Fin}}\Theta_{PC}^S\right)-2b\Theta_{PC}^S- \\ \frac{\sigma-1}{\sigma}\{a+(1-a)\left[\tilde{z}+\tilde{z}^*-1+(2-\tilde{z}-\tilde{z}^*)\left(2a(1-\eta)+\rho-1\right)\right]\}\,\Theta_{PC}^S \end{array}$$

$$\Theta_A^{PC} = 2(1-\phi)\frac{\sigma-1}{\sigma}/\xi_4$$

$$\Theta_M^{PC} = \left\{\frac{\sigma-1}{\sigma}\{\rho-(1-a)\left[\tilde{z}+\tilde{z}^*+(2-\tilde{z}-\tilde{z}^*)\left(2a(1-\eta)-(1-\rho)\right)\right]\}-(1-2\phi)\Theta_S^{R_{Fin}}-2b\right\}\Theta_M^S/\xi_4$$

$$\Theta_G^{PC} = \left[(2\phi-1)\,\frac{1-2a}{\sigma}+\frac{\sigma-1}{\sigma}\,(1-2a)+1\right]/\xi_4$$

B Data appendix

Table B-1: Summary statistics of variables used in Section 2

	count	mean	Var	min	max
dhb/gdp	1414	0.28	0.15	-1.05	2.48
dhb/debt	1414	0.30	0.24	-3.61	3.31
(Eq. & FDI)/GDP	1421	0.30	0.07	0.00	1.36
NFA/GDP	1421	-0.47	0.17	-2.33	0.84
log(Gross Debt)	1421	0.79	0.17	0.15	2.38
Chinn-Ito	1396	0.12	2.16	-1.86	2.46
Openness	1382	0.70	0.15	0.14	3.50
Net Exp.	1382	-0.04	0.01	-0.73	0.55
log(GDP/Pop.)	1421	7.54	2.30	4.28	10.65
log(Pop.)	1421	2.64	2.24	-1.37	7.17
Inflation Vol.	889	0.01	0.01	0.00	2.53
Exch. Rate Vol.	637	0.40	16.07	0.00	81.63
PCP	88	0.19	0.04	0.00	0.63
PCP+VCP	1421	0.10	0.08	0.00	1.00

B.1 Data sources

We use the below variables from the following, freely accessible, data sets:

- Lane and Shambaugh (2010): debt assets in domestic currency % of GDP, debt assets in foreign currency % of GDP, debt liabilities in domestic currency % of GDP, and debt liabilities in foreign currency % of GDP for 109 countries (after eliminating outliers, see below).
- The updated and extended version of the data set constructed by Lane and Milesi-Ferretti (2007): GDP (US$), Portfolio equity assets (stock), Portfolio equity liabilities (stock), FDI assets (stock), FDI liabilities (stock), Debt assets (stock), Debt liabilities (stock), Portfolio debt assets, Portfolio debt liabilities, and net foreign assets (NFA) for the same countries as in Lane and Shambaugh (2010).
- International Financial Statistics from the IMF: exports of goods and services, imports of goods and services (both in national currencies), official or market exchange rates (to convert into US$), nominal effective exchange rate, CPI, and population.
- Chinn and Ito (2006): updated Financial Openness Index.
- OECD Main Economic Indicators: M2. OECD Economic Outlook 92: CGV: Government final consumption expenditure, volume; IGV: Government gross fixed capital formation, volume; GDPV: Gross domestic product, volume, market prices; ET: Total employment; HRS: Hours worked per employee, total economy; from 1970Q1 until 2012Q4, all for the calculation of the shock variances.

Table B-2: Correlations of variables used in Section 2.

	dhb/gdp	dhb/debt	Eq&FDI	NFA	GD	CI	Open.	NX	gdp/pop	pop	IFV	ERV	PCP
dhb/gdp	1.000												
dhb/debt	0.775	1.000											
Eq&FDI	-0.177	-0.207	1.000										
NFA	-0.842	-0.595	-0.146	1.000									
GD	0.559	0.205	0.132	-0.570	1.000								
CI	-0.291	-0.267	0.343	0.220	0.143	1.000							
Open.	-0.046	-0.180	0.270	-0.162	0.135	-0.056	1.000						
NX	-0.251	-0.235	0.220	0.233	-0.138	0.031	0.104	1.000					
gdp/pop	-0.476	-0.396	0.396	0.448	-0.060	0.563	0.028	0.391	1.000				
pop	-0.109	0.046	-0.145	0.196	-0.161	-0.120	-0.378	0.107	-0.099	1.000			
IFV	-0.016	0.004	-0.024	0.018	-0.022	0.009	-0.001	-0.028	0.036	-0.030	1.000		
ERV	0.214	0.093	-0.034	-0.197	0.157	0.055	-0.012	-0.199	-0.083	-0.025	0.612	1.000	
PCP	-0.625	-0.632	0.452	0.408	0.660	0.578	-0.515	-0.182	0.806	0.032	-0.207	-0.354	1.000
PCP+VCP	-0.172	-0.108	0.106	0.094	-0.052	0.137	0.103	0.054	0.240	0.090	0.148	-0.024	-0.458

dhb/gdp=debt home bias (net debt in domestic currency minus net debt in foreign currencies) over GDP, dhb/debt=debt home bias over sum of debt assets and liabilities, Eq. & FDI=sum of equity assets and liabilities plus sum of FDI assets and liabilities over GDP, NFA=net foreign assets over GDP, GD=log of sum of debt assets and liabilities, CI=index of financial openness from Chinn and Ito (2006), Open.=Sum of imports and exports over GDP, NX=net exports over GDP, gdp/pop=log of GDP over population, pop=log of population, IFV=variance of quarterly inflation in the three preceding years, ERV=variance of quarterly nominal effective exchange rate in the three preceding years, PCP=share of exports set in home currency, PCP+VCP=share of exports set in home currency, US dollar or euro.

- Kamps (2006): percentage of export and import goods priced in home currency, see her Table A1.

The time period for our regressions in Table 1, 1990-2004, is dictated by the length of the series in Lane and Shambaugh (2010).

B.2 Data selection

The financial variables (sum of assets plus liabilities of portfolio equity and FDI over GDP, net foreign assets over GDP, total debt over GDP) feature some outliers. These are mainly financial centers such as Hong Kong, Switzerland etc. and some developing countries with extraordinary large and negative net foreign assets. As large parts of the financial centers' assets do most likely not represent asset holdings of their own inhabitants (as assumed in our model), they are not subject of our analysis. In developing countries with large debt, the currency decomposition of net foreign asset reflects most probably choices taken by donor countries instead of optimal portfolio decisions of inhabitants. Using different ways to remove outliers, however, give similar results. We use the multivariate technique to detect outliers proposed in Hadi (1992, 1994) with a significance level of 0.05 (the results are robust to changes in this value). Removing observations that are outside of three standard deviations of the final sample for these variables results in very similar estimates. Alternatively, manually removing only the largest financial centers (defined as having values for the sum of gross equity, FDI, and debt of 7.86 or above, corresponding to the average value for Singapore, Hong Kong, and Switzerland) gives an impact of equity and FDI trade on debt home bias over GDP of -0.21 (significant at the 5% level) and of -0.13 on the share of producer-currency pricing (also significant at the 5% level), both

Table B-3: Countries used in the regressions of Section 2.

United States	El Salvador	Pakistan	Tunisia
Austria	Guatemala	Philippines	Uganda
Denmark	Haiti	*Thailand*	Burkina Faso
France	Honduras	Vietnam	Fiji
Germany	Mexico	Algeria	Papua New Guinea
Italy	Nicaragua	Botswana	Armenia
Netherlands	Paraguay	Cameroon	Azerbaijan
Norway	Peru	Chad	Belarus
Sweden	Uruguay	Congo, Republic of	Albania
Canada	Venezuela, Rep. Bol.	Benin	Georgia
Japan	Jamaica	Equatorial Guinea	Kazakhstan
Finland	Trinidad and Tobago	Ethiopia	Kyrgyz Republic
Greece	Iran, Islamic Republic of	Gabon	Moldova
Iceland	Israel	Ghana	Russia
Ireland	Jordan	Guinea	China,P.R.: Mainland
Portugal	Oman	Côte d'Ivoire	*Ukraine*
Spain	Syrian Arab Republic	Kenya	*Czech Republic*
Turkey	Egypt	Madagascar	Slovak Republic
Australia	Yemen, Republic of	Malawi	Estonia
New Zealand	Bangladesh	Mali	Latvia
South Africa	Cambodia	Morocco	*Hungary*
Argentina	Sri Lanka	Mozambique	*Lithuania*
Bolivia	India	Niger	Croatia
Brazil	*Indonesia*	Nigeria	Slovenia
Chile	Korea	Rwanda	Macedonia
Colombia	*Malaysia*	Senegal	Bosnia and Herzegovina
Dominican Republic	Nepal	Tanzania	*Poland*
		Togo	Romania

Countries are ordered according to their IFS code. Countries for which data on the pricing currency of exports is available and which were hence used in the regressions of Table 2 are written in italics.

resulting from the fixed effects regressions including all controls displayed in the tables of Section 2. Table B-1 summarizes the variables used in the regressions in Section 2, while Table B-2 shows their correlations. Table B-3 displays the countries which were used.

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