When Finance Meets Trade:
Three Essays in International Economics

by

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ABSTRACT

When Finance Meets Trade: Three Essays in International Economics

by

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This dissertation examines international capital mobility, focusing on equity and debt markets. I not only study the determinants and patterns observed in capital markets, but also investigate how capital flows affect and are affected by trade. The first chapter *"Productivity matters: a new angle on equity home bias"* examines the effect of countries' industrial structure on global portfolio diversification. Results indicate that *sectoral* home bias is stronger in unproductive sectors where investors face fewer risks than in productive sectors. Furthermore, *national* home bias is stronger in the countries with diversified industrial structures because intra-national risk hedging across industries replaces the need for inter-national risk hedging across countries. In the second chapter *"Optimal trade policies after sovereign defaults,"* my coauthor and I offer new theoretical and empirical insights into the effect of sovereign defaults on trade. Empirical evidence from the changes in trade shares after debt renegotiations as well as Aid-for-trade statistics indicates that sovereign debt renegotiation is not associated with trade sanctions. Using a two-country DSGE model with incomplete financial markets, we are able to explain why trade sanctions are not observed. Our model departs from the existing literature on sovereign defaults by building on the strategic interaction between debtors and creditors. We solve the model

numerically to determine the optimal trade costs given different combinations of debt and income levels. The third chapter *"Does debt structure matter? Financial constraints and trade revisited"* examines the implications of firms' heterogeneous debt structure for international trade. Small firms rely heavily on bank loans while big firms have access to corporate bonds. I model this as a nonlinear financial constraint which places disproportional burden on small firms which further limits their production and ability to export. An empirical analysis based on the model complements previous work in examining the degree to which financial constraints impede trade.

CHAPTER I

Sectoral Productivity Matters: A New Angle on Equity Home Bias

This chapter theoretically and empirically examines how industrial structure impacts equity home bias at both industry and country levels. I build a two-country two-sector model to examine how the differences in sectoral productivity affect a country's risk exposure and hence influence its investors' portfolio choice. First, the model contends that investors show stronger home bias in unproductive sectors than in productive sectors where they face more risks. Using a unique dataset on equity holdings, I calculate the industry level home bias of 26 sectors in 43 countries and empirically confirm the model's prediction. A second model prediction is that investors avoid highly-specialized countries as a consequence of their risk-hedging motives. I confirm the prediction in the data by finding that national home bias is negatively correlated with a country's degree of industrial specialization. Third, the model uncovers the relationship between investors' sectoral choice and country bias which sheds light on the interaction between intra-national risk hedging across sectors and inter-national risk hedging across countries. Fourth, the chapter provides an explanation for the increase in developing countries' foreign investment; the expansion of emerging markets' tradable sectors increases domestic risks, which induce investors in these countries to aggressively hold foreign assets. I calibrate the model to the Chinese trade data and successfully replicate the trend of China's historical holdings of US equities.

1.1 Introduction

International finance models typically show that investors can reap substantial benefits from international portfolio diversification. Yet the data indicate that domestic equity accounts for a predominant share of investors' portfolios, despite the current integration of the world capital market. The phenomenon of 'equity home bias', documented by *French and Poterba* (1991) and *Tesar and Werner* (1995), continues to be a puzzle in international economics.

Various attempts have been made to explain home bias by analyzing investors' risk-hedging motives, but most papers abstract from industrial structure and as a consequence ignore within- and across-industry productivity differences across countries. In this chapter, I contend that sectoral productivity differences matter significantly for investors' risk-hedging pattern and portfolio choice. I identify and explain two novel facts about home bias by adding the sectoral dimension to the current literature. First, I show that *sectoral* home bias is stronger in unproductive sectors where investors face fewer risks than in productive sectors. Second, I find that *national* home bias is stronger in the countries with diversified industrial structures because intra-national risk hedging across industries replaces the need for inter-national risk hedging across countries.

A large body of literature has focused on home bias at the national level, but little is known at the industry level about investors' preference between domestic and foreign assets. Using a unique dataset on institutional investors' equity holdings complemented by information on sectoral stock market values, I compute the sectoral home bias of 26 industries from 43 countries. Furthermore, I empirically find that sectoral home bias is negatively correlated with sectoral productivity.

My explanation for the variation in sectoral home bias is as follows. International investors hold financial assets to hedge against two specific kinds of risks: labor income risk and real exchange rate risk. Productivity differences affect both a sector's labor force and its trade pattern. As a consequence, industries have distinct exposure to these two kinds of risks. A sector with greater productivity is exposed to more risks because the country's labor income and real exchange rate are more correlated with the returns to that sector than the returns to an unproductive sector. Therefore, investors hold fewer home assets in productive sectors and hence show weaker sectoral home bias.

In order to better understand what drives the difference in sectoral home bias, I build a model in a two-country two-sector dynamic stochastic general equilibrium (DSGE) setting. The model embeds *Eaton and Kortum* (2002)'s framework to capture the effect of productivity on sectoral size and trade. In order to derive analytical solutions to the portfolio choice problem in a baseline case with symmetric countries and complete markets, I follow the approach in *Coeurdacier* (2009) by analyzing the correlations of returns from different assets around the steady state of the economy. I also extend the model by incorporating nontradable sectors. In deriving static and dynamic equity holdings in extended models, I follow the method of *Devereux and Sutherland* (2007, 2011), who employ a higher degree of approximation of an investors' objective function to capture lower-order portfolio behavior.

The solution to the model also enriches our understanding of *national* home bias. In this multi-sectoral setting, investors are able to risk-hedge not only by holding assets in different countries (inter-country risk-hedging) but also by holding domestic assets in different sectors (intra-country risk-hedging). If the covariance across domestic assets ensures efficient risk- hedging, there is less need for investors to hold foreign equities. Thus, there is an interesting interaction between the choice over sectors and the choice over countries.

The interaction predicts that industrial specialization has a negative effect on national home bias. More diversified countries exhibit higher degrees of intra-national risk hedging such that sectoral shocks in an individual industry do not affect the whole economy in a substantial way. In contrast, highly-specialized countries incur greater risks due to their few productive sectors. There is limited intra-national risk hedging since other domestic sectors are susceptible to the loss of returns once the key industries are in peril. Consequently, national home bias in those countries is low as their investors hold fewer domestic assets and rely more heavily on international risk hedging by holding foreign assets.

To account for intra- versus inter-national risk hedging patterns, I empirically test the relationship between national home bias in equity holdings and countries' industrial specialization index proxied by the Herfindahl-Hirschman Index (HHI). I find a negative correlation which supports the prediction of the model: More specialized countries have lower national home bias.

In the final section of the chapter, I elaborate on one model application that it offers an explanation for developing countries' aggressive investment in developed countries' assets, despite the fact that developing countries provide higher returns to capital. The results of my model suggest that developing countries' heavy reliance on trade together with their concentration of production in tradable sectors induces their investors to invest abroad to hedge against domestic risks. This can explain why we observe the surge in South-to-North capital flows in recent decades. I calibrate my model to the Chinese data and successfully replicate the country's trend of US equity holdings by targeting the trade data.

This chapter extends the literature that studies investors' risk-hedging motives as a reason for equity home bias by adding the sectoral productivity dimension. *Coeurdacier and Rey* (2013) provide a comprehensive survey of this strand of literature. Other examples include *Baxter and Jermann* (1997) and *Heathcote and Perri* (2013) which focus on the hedging of labor income risk with different assumptions regarding the covariance between physical capital and human capital. *Cole and Obstfeld* (1991), *Coeurdacier* (2009) and *Kollmann* (2006) introduce real exchange rate risk by including one tradable good from each country. Compared to previous work, my model allows for multiple sectors of production within countries and intra-sectoral trade across countries. Investors not only choose assets based on the country of issue but also the sector, and thus have more ways to hedge against the two risks. My model is also a more general case of *Tesar* (1993), *Matsumoto* (2007) and *Collard et al.* (2007) who have one tradable and one nontradable sector in each country. I introduce sector-specific trade costs in *Eaton and Kortum* (2002)'s framework to capture the nontradability of some industries.

The chapter is also related to the literature on the interaction of risk sharing and industrial specialization. The strand of literature can be traced back to *Helpman and Razin* (1978) who argue that the benefits of specialization can be achieved by trade in assets to insure against production risk. Recently, *Kalemli-Ozcan et al.* (2003) and *Koren* (2003) find empirical support for the positive impact of financial integration on trade specialization. This chapter focuses on the feedback of industrial structure on asset positions by examining how trade specialization affects portfolio diversification.

The remainder of the chapter proceeds as follows: Section 2 presents the empirical findings about sectoral and national home bias. Section 3 describes and solves the model. Section 4 elaborates on the application of the model. Section 5 concludes.

1.2 Empirical Analysis

In this section, I empirically examine two hypotheses about equity home bias. First, at the sectoral level, investors exhibit stronger home bias in less productive sectors than in more productive sectors. Second, at the national level, counties with a higher degree of industrial specialization show weaker aggregate home bias. The analysis will support the model prediction that sectoral productivity differences affect portfolio choices between domestic and foreign assets.

1.2.1 Data Description

Equity Holdings

Factset/Lionshare provides comprehensive data on the equity holdings of institutional investors from over 100 countries or regions since 1998. Typical institutional investors include banks, insurance companies, retirement or pension funds, hedge funds and sovereign wealth funds. Table A.1 lists the top twenty U.S. institutional investors by assets as of 2014Q3.

Institutional investors have played an increasing role in equity markets worldwide. Figure A.1 shows how the US household share of equity ownership has fallen over time. Robert Shiller calls this phenomenon 'migration of capital from Main Street to Wall Street'. The dominance of institutional investors over household investors is also commonly observed in other countries.[1]

Factset/Lionshare data originate from public filings by investors (such as 13-F filings with the Securities and Exchange Commission in the U.S.), regulatory agencies around the world and company annual reports. Using the dataset, we can group securities by their location and sector, as well as group holders by their nationality.[2]

Figure 1.2.1 shows the funds allocation for the US on Jan 5, 2015. The U.S. invests 83.1% of its equities domestically.[3] The U.S. is highly diversified in terms of sectors, with finance, health and electronics being the most popular ones.

Stock Market Values

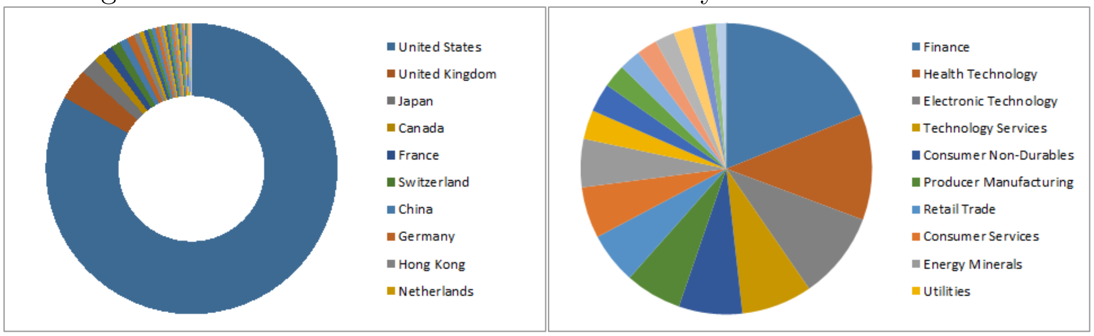
Thomson Reuters Datastream offers global country- and sector-level financial data including market values. Factset/Lionshare and Datastream unfortunately do not cate-

[1] According to INSEAD OEE Data Services, households only accounted for 12% ownership of the EU corporate equities in 2012.

[2] Data limitations only allow me to aggregate the top 50 institutional investors in each of the 100+ countries. Since the top institutional are the most comprehensive and unbiased investors (like those listed in Table A.1), their portfolio choices are representative of the national equity preference to a great extent.

[3] It is partly due to the gigantic size of its stock market relative to other markets. The US accounts for around 40% of the world market portfolio.

Figure 1.1: US Institutional Investors' Country and Sector Allocation



Note: This figure shows the US institutional investors' equity portfolio on Jan 5, 2015. The source is the ownership data from Factset/Lionshare. The left chart is the allocation across countries, and the right chart is the allocation across sectors.

gorize industries in the same way. Table A.1 lists the concordance of the two classification system.

Productivity Measures

I use the UNIDO Industrial Statistics Database to calculate sectoral productivity. It reports data at the 4-digit level of ISIC Rev.4 on value-added, employment, wages and fixed capital formation by sector. I consider two measures of productivity: labor productivity and total factor productivity. The former is more comprehensive since investment data are scarce for developing countries. I divide value-added of a sector by its employment to get sectoral labor productivity.

I calculate sectoral total factor productivity (TFP) using the method documented by *Inklaar and Timmer* (2013)) when they construct the Penn World Table. Capital stocks are estimated using the perpetual inventory method (PIM) based on $K_{t+1} = (1-\delta)K_t + I_t$, where K_t is capital stock and I_t is investment or fixed capital formation. δ represents capital depreciation which is assumed to be 10% annually. To apply PIM, I need to compute the initial capital stock K_0 of a sector. *Inklaar and Timmer* (2013) argue that assuming an initial capital/output ratio k in $K_0 = Y_0 \times k$ leads to superior results. I compute the value of k by dividing the country's capital stock by its GDP (both of the initial period) in the Penn World Table. Initial capital stock K_0 will be the product of initial net output V_0 and k. After computing K_0, I use $K_{t+1} = (1-\delta)K_t + I_t$ to trace the dynamic capital stock K_t. I also calculate the sectoral factor intensity $1-\alpha$ by averaging the share of wages in value-added of a sector over time. Given all this information, sectoral total factor productivity is computed as $TFP_t = \frac{Y_t}{K_t^\alpha L_t^{1-\alpha}}$. Estimates are averaged across time between 1998 and 2014 to be used in the cross-sectoral regression.

1.2.2 Sectoral Home Bias

Following *Ahearne et al.* (2004) and *Coeurdacier and Rey* (2013), I use the difference between the actual country-level holdings of equities and the share of market capitalization in the global equity market to measure national home bias. Home bias in country i sector s is equal to

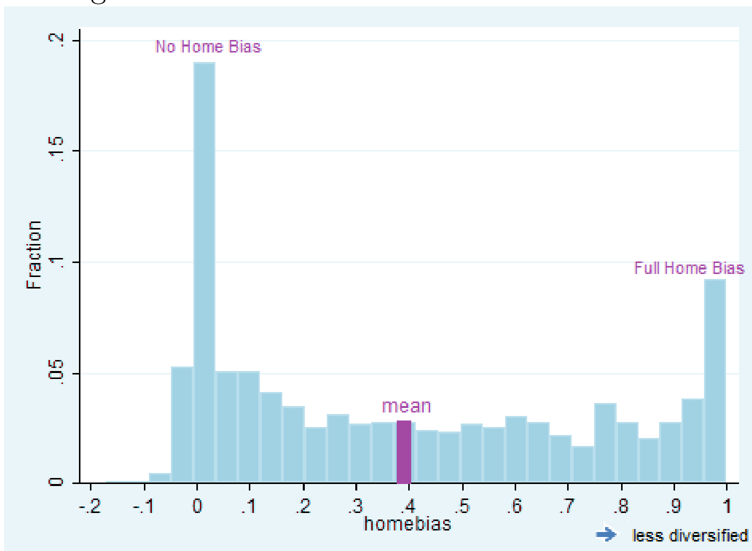
$$HB_{i,s} = 1 - \frac{\text{Share of Sector s Foreign Equities in Country i Equity Holdings}}{\text{Share of Sector s Foreign Equities the World Market Portfolio}}$$

$HB_{i,s} = 1$ indicates that country i is fully home biased in sector s since it does not hold any foreign equities. $HB_{i,s} = 0$ indicates that country i is fully diversified across countries. In theory, $HB_{i,s}$ can take any value below 1 (including negative values). The numerator in the expression for $HB_{i,s}$ uses the data from Factset/Lionshare directly, while the denominator uses market values from Datastream to get a country's equity share in industry s.

The comprehensive sectoral home bias indices are shown in Table A4, complemented by an abbreviation list of countries and sectors (Table A.1).[4] Figure 1.2.2 shows the histogram of sectoral home bias. The index ranges from -.2 to 1, with many observations

[4] I exclude the countries whose institutional investors hold only domestic assets. Their investment pattern is driven by factors other than risk-hedging motives. These countries include Columbia, Cyprus, Bulgaria, Egypt, India, Indonesia, Sri Lanka, Thailand, Peru, Oman and Turkey. Most of these countries' governments impose strict capital controls on foreign portfolio investment.

Figure 1.2: Distribution of Sectoral Home Bias



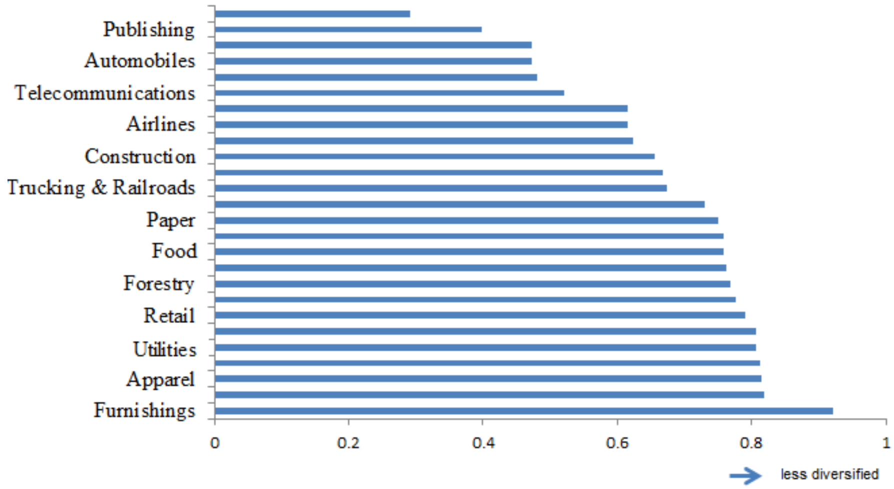
Note: This chart displays the histogram of the sectoral home bias index. The formula of the index is $HB_{i,s}$=1-Share of Sector s Foreign Equities in Country i Equity Holdings/Share of sector s Foreign Equities the World Market Portfolio. The data are from Factset/Lionshare and Datastream. The index covers 26 sectors from 43 countries. There are 834 observations in total, with mean 0.39 and std. dev. 0.36. Detailed information is provided in Table A4.

clustered around 0 and 1. Figure 1.2.2 plots US sectoral home bias. Furnishings, apparel and utilities show the strongest home bias, while publishing, automobiles and telecommunications show the weakest.

Using the data on sectoral home bias, I explore the the impact of productivity on sectoral home bias. As productive sectors hire more labor , the returns to productive sectors should be more correlated with domestic labor income than is the case for the returns to unproductive sectors. Hence, productive sectors are exposed to greater labor income risk. Consequently, investors respond by showing weaker home bias in productive sectors. In this spirit, I test whether the correlations between sectoral productivity and sectoral home bias are negative by running the following regression

$$HB_{i,s} = \alpha_0 + \alpha_1 X_{i,s} + Z + \epsilon_{i,s}$$

Figure 1.3: Ranking of U.S. Sectoral Home Bias



Note: This chart lists the US sectoral home bias from highest to lowest. The horizontal axis labels the home bias index.

The dependent variable $HB_{i,s}$ is sectoral home bias of country i sector s. The independent variable is sectoral productivity $X_{i,s}$. Besides, Z denotes various configurations of fixed effects including country fixed effects (denoted Z_i) and sector fixed effects (denoted Z_s). Country fixed effects enable us to evaluate the role of relative productivity instead of absolute productivity, since in this case country level productivity is controlled for and we can focus on the within-country variation in sectoral productivity. On the other hand, sector fixed effects capture many industry-specific characteristics including factor intensity and nontradability.

The regression results are summarized in Table C. Overall, sectoral home bias is significantly negatively correlated with sectoral productivity. The results are robust to various specifications of fixed effects. In the OLS case, when labor productivity increases by 1 standard deviation, sectoral home bias decreases by .303 standard deviation; When TFP increases by 1 standard deviation, sectoral home bias decreases by .208 standard deviation. The negative correlation between sectoral home bias and sectoral productivity is robust when the standard errors are clustered at country and sector levels (see Appendix A.2.1 for more information). Hence, the empirical analysis on sectoral home bias con-

Table 1.1: Sectoral Home Bias and Sectoral Productivity

Dep. Var: Sectoral HB	(1)	(2)	(3)
labor productivity	-0.113 ***	-.113 ***	-0.112 ***
	(0.0167)	(0.0167)	(0.0167)
	[-0.303]	[-0.304]	[-0.302]
constant	1.626 ***	1.621 ***	1.612 ***
	(0.185)	(0.186)	(0.189)
Country FE	No	Yes	No
Sector FE	No	No	Yes
Observations	454	454	454
Adj R^2	0.0899	0.088	0.0882
Dep. Var: Sectoral HB	(1)	(2)	(3)
TFP	-0.038 ***	-0.037 ***	-0.045 ***
	(0.010)	(0.010)	(0.010)
	[-0.208]	[-0.207]	[-0.247]
constant	0.472 ***	0.405 ***	0.438 ***
	(0.048)	(0.057)	(0.050)
Country FE	No	Yes	No
Sector FE	No	No	Yes
Observations	350	350	350
Adj R^2	0.0431	0.0550	0.0562

Note: Robust standard errors in parentheses and standardized coefficients in brackets.***significant at 1%. The dependent variable is sectoral home bias. The independent variables are productivity in natural logs. The table reports coefficients in the ordinary least squares (OLS), country fixed effect, sector fixed effect and country-sector fixed effect models.

firms the hypothesis that home bias is weaker in productive sectors than in unproductive sectors.

In addition to the baseline specification, I do robustness checks by including intermediate imports and outbound foreign direct investment (FDI) as independent variables (see Appendix A.2.2 for more information). This exercise is to address the concern that trade patterns can also potentially influence equity home bias: given the integration of world production, investors may choose to invest abroad because production takes place in other countries. Table A.2.2 shows that the negative correlation between sectoral productivity and sectoral home bias still holds when we control for intermediate imports and outbound FDI. Meanwhile, these two new variables do not show significant association with home bias.

Based on the variation in sectoral home bias, I further hypothesize that productivity differences across sectors within a country affect a country's overall risk exposure and hence influences its national home bias. I explore this relationship further in the following section.

1.2.3 National Home Bias

Using the same dataset and method, I calculate home bias at the national level by adding up equities by country

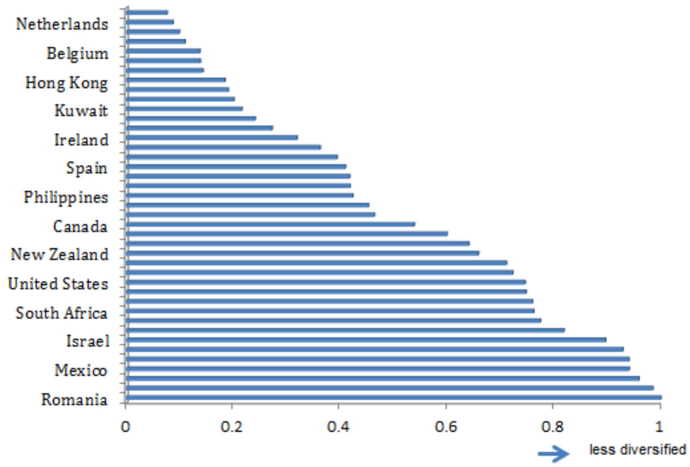
$$HB_i = 1 - \frac{\text{Share of Foreign Equities in Country i Equity Holdings}}{\text{Share of Foreign Equities the World Market Portfolio}}$$

Figure 1.2.3 and Table A.1 show this constructed national home bias index.[5] Ireland, Luxembourg, Singapore, Belgium and the Netherlands are among the countries that show the weakest home bias. They share some common features like being small open economies. Romania, Malaysia, Korea and China show the greatest home bias. This can be due either to their stringent capital control regime or to their hedging motives. I will explore the latter in the theoretical part of the chapter.

The home bias index allows me to empirically test my hypothesis that national level home bias is negatively correlated with countries' degree of industrial specialization. The reasoning behind the hypothesis is that, to shield themselves from the excessive risks associated with the productive sectors, investors either hold domestic assets in unproductive sectors or foreign assets. The former is intra-national risk-hedging across sectors and the latter is inter-national risk-hedging across countries. However, when productive sectors account for a predominant share in a country, intra-national risk-hedging is limited: if the key industries fail, the whole economy plummets and the domestic unproductive assets are not immune to the loss of returns. Hence, investors should avoid holding home assets in such a concentrated economy, which leads to low national home bias. Based on this reasoning, I hypothesize that national home bias is stronger in countries with diversified

[5] My national home bias index is the most comprehensive so far by covering the most countries, meanwhile it is consistent with those in existing literature (shown in Figure A.1).

Figure 1.4: Ranking of National Home Bias



Note: This chart displays the national home bias index. The formula of the index is HB_i=1-Share of Foreign Equities in Country i Equity Holdings/Share of Foreign Equities the World Market Portfolio. The data are from Factset/Lionshare and Datastream.

industrial structure than in countries with specialized structure.

I use the Hirschman-Herfindahl index (HHI) to measure industrial specialization. HHI in country i is defined as the sum of squared shares of each sector (s) in the country's total output.

$$HHI_i = \sum_{s=1}^{S} b_{i,s}^2$$

The higher the index value, the more concentrated is the country's production. I use the three-digit ISIC Rev.4 sectoral data from UNIDO averaged from 1998 to calculate countries' HHI. The regression results are summarized in Table 2.2.

In column 1 of Table 2.2, when a country's HHI increases by 1 standard deviation, its national home bias decreases by .37 standard deviation. In column 2 where I add the size of the economy (proxied with GDP) as another control variable, the result is similar. The coefficients of HHI are negative at 1% level of significance.

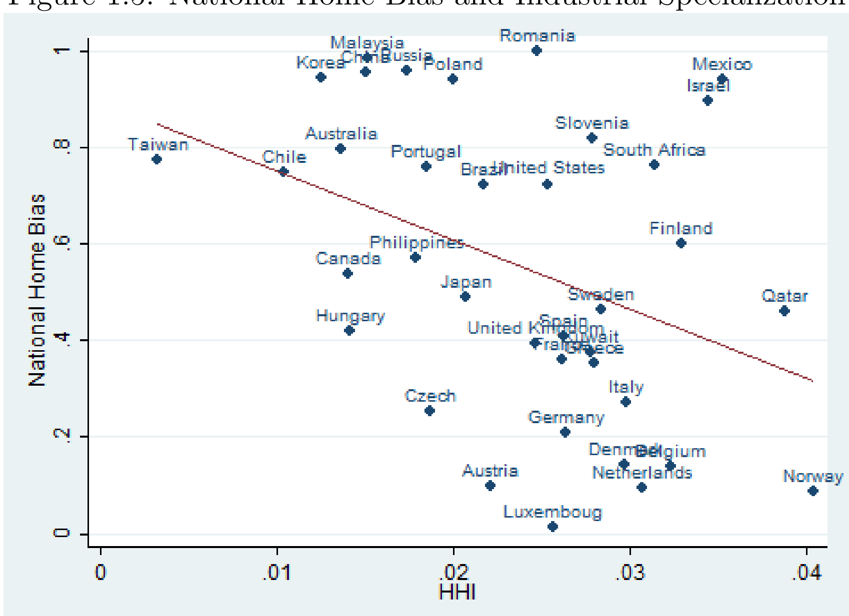
In column 3 of Table 2.2, I add a dummy for OECD countries to control for the fact that the institutional features of financial markets are different between developing and developed countries. The coefficient of the OECD dummy turns out to be significantly

Table 1.2: National Home Bias and Countries' Industrial Specialization

Dep. Var: National HB	(1)	(2)	(3)	(4)
HHI	-5.900 ***	-5.682 ***	-6.278***	-5.002 **
	(1.645)	(1.843)	(2.210)	(2.364)
	[-0.37]	[-0.35]	[-0.39]	[-0.31]
log(GDP)		0.003	0.012	0.006
		(0.035)	(0.034)	(0.036)
OECD dummy			-0.211 **	
			(0.090)	
tax haven dummy				-0.087
				(0.166)
constant	0.704***	0.622	0.552	0.524
	(0.069)	(0.976)	(0.920)	(0.991)
# observations	40	40	40	40
R^2	0.1364	0.1247	0.2172	0.1349

Note: Robust standard errors in parentheses and standardized coefficients in brackets. **significant at 5%,***significant at 1%. The dependent variable is national home bias. The independent variables include Herfindahl-Hirschman Index (HHI) and GDP in natural logs. In addition, OECD dummy equals one if a country is a member of the Organisation for Economic Cooperation and Development (OECD). Tax haven dummy takes the value of one for countries with zero percent capital gains tax rates.

Figure 1.5: National Home Bias and Industrial Specialization



Note: This figure plots the relationship between national home bias and countries' specialization index. Herfindahl-Hirschman Index (HHI) is on the horizontal axis and national home bias is on the vertical axis.

negative at 5%, indicating that OECD countries show weaker national home bias. After controlling for this dummy, the coefficient of HHI increases in the absolute value, which indicates that specialization is more important in explaining the variation in national home bias.

In column 4 of Table 2.2, I add a dummy for tax havens to correct for potential bias arising from Factset's data limitation that institutional investors in some countries may not only represent the citizens of their own countries, which is especially the case for tax havens which attract many foreign households. I set the dummy equal to one for countries with no capital gains tax. The coefficient of HHI is still negative at 5% level of significance in this case.

Figure 1.2.3 plots country i's national home bias H_i against the industrial specialization index (HHI_i). Countries like Qatar and Norway, which are heavily dependent on their oil industry as the main source of income, have high HHI_i. As a consequence of their dependence on the oil sector, other sectors in the two countries cannot buffer the economy when there are significant fluctuations in the oil industry. Thus, the investors in the two countries would rather hold foreign assets and exhibit weak national home bias. In contrast, the U.S. and China have highly diversified industrial structures, so they can enjoy a relatively high level of intra-country inter-industry risk hedging. As a result, home bias in these two economies is relatively high.

To sum up the section, I compute sectoral home bias and find its negative correlation with productivity. I also find that national home bias decreases in countries' degree of industrial specialization. In the next section, I build a model to account for these empirical findings.

1.3 Model

I set up a model in which I derive countries' optimal portfolio in a two-country two-sector framework. The solution sheds light on the risk-hedging patterns across sectors and across countries. The model also explains the empirical findings about sectoral and national home bias in the previous section and elicits implications in the next section about world financial flows.

1.3.1 Setup

1.3.1.1 Producers

Two countries ($i = \{H, F\}$) both produce two types of consumption goods ($s = \{a, b\}$). In every country-sector-pair-specific industry (denoted as $f_{i,s}$), there is a continuum of varieties $z \in [0, 1]$. The composite good in an industry is a CES aggregate of different varieties with elasticity of substitution ϵ:

$$Y_{i,s} = [\int_0^1 y_{i,s}(z)^{\frac{\epsilon-1}{\epsilon}} dz]^{\frac{\epsilon}{\epsilon-1}}$$

A firm in country i sector s producing variety z draws its technology $A_{i,s}(z)$ from the Frechet Distribution, as in *Eaton and Kortum* (2002):

$$F_{i,s}(A) = exp(-T_{i,s}A^{-\theta})$$

$T_{i,s}$ captures the central tendency of sector s in country i: the higher the $T_{i,s}$, the higher average productivity of the industry. Meanwhile, θ reflects the dispersion of the industry; it takes on a great value when the sectoral variance is low. Over time, $T_{i,s}$ follows an AR(1) process with autoregressive coefficients $\rho_{i,s}$ and i.i.d. shocks $\epsilon_{i,s,t} \sim N(0, \sigma_\epsilon^2)$:

$$T_{i,s,t} = \rho_{i,s}T_{i,s,t-1} + (1 - \rho_{i,s})\bar{T}_{i,s} + \epsilon_{i,s,t}$$

Firms hire labor to produce goods. Labor is mobile within a country but immobile across countries. Thus, the production cost is local wage rate w_i. Under perfect competition, the price of one unit of variety z in country i sector s is

$$p_{i,s}(z) = \frac{w_i}{A_{i,s}(z)}$$

In this two-country world, consumers shop globally for the best deal. The actual price of z they pay is the lower of the domestic price and the foreign price. In the benchmark case without trade costs,

$$p_{i,s}(z) = \min\{p_{H,s}(z), p_{F,s}(z)\}$$

Aggregating the prices across varieties, I get sectoral prices under the Frechet distribution:

$$P_s = [\Gamma(\frac{\theta + 1 - \epsilon}{\theta})]^{\frac{1}{1-\epsilon}} \Phi_s^{-\frac{1}{\theta}} \equiv \gamma \Phi_s^{-\frac{1}{\theta}} \qquad where \qquad \Phi_s = \sum_{i \in \{H,F\}} T_{i,s} w_i^{-\theta}$$

Consequently, $\pi_{ij,s}$ — the trade share of country j's products in sector s country i — is equal to the probability that the price of country j's goods is lower. From its expression below, trade share increases in productivity $T_{j,s}$ but decreases in w_j the labor cost of the country.

$$\pi_{ij,s} = \frac{T_{j,s} w_j^{-\theta}}{\Phi_s}$$

Relative productivity across sectors is different across countries. Without loss of generality, I assume country H is more productive in sector a and country F is more productive in b:

$$\frac{\bar{T}_{H,a}}{\bar{T}_{H,b}} > \frac{\bar{T}_{F,a}}{\bar{T}_{F,b}}$$

There is an equity market where firms sell their stocks to both domestic and foreign households. The firms use $1-\alpha$ of their revenues to cover labor costs, and pay α as dividends to their stock owners. In other words, dividends are a constant share (α) of claims to firms' output.[6]

$$d_{i,s}(z) = p_{i,s}(z)y_{i,s}(z) - w_{i,s}(z)l_{i,s}(z) = \alpha p_{i,s}(z)y_{i,s}(z)$$

In the model, households do not choose firm-level equities but country-sector-specific equities. In total, there are four types of equities, each representing an industry $f_{i,s}, (i \in H, F, s \in a, b)$. The dividends in sector s country i are a constant share of the sectoral output:

$$d_{i,s} = \int_0^1 d_{i,s}(z)dz = \alpha Y_{i,s}$$

1.3.1.2 Households

A representative agent in country i has constant-relative-risk-aversion (CRRA) preference in consumption. His objective is to maximize the expected lifetime utility defined as

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{C_{i,t}^{1-\sigma}}{1-\sigma}$$

His consumption bundle consists of his expenditure on the two goods: a and b.[7] In the symmetric case, I assume the weight of the more productive goods in consumption is the same across countries[8]. Consumption and aggregate price at home and abroad are given by

[6] It is isomorphic to the case where production is Cobb-Douglas and dividends are claims to capital income.

[7] The CES functional form is similar to many international macroeconomics models on the topic but the context is different. In one strand, *Coeurdacier* (2009) and *Kollmann* (2006) have a consumption composite of aggregate domestic and aggregate foreign goods. In another strand with multi-sectoral analysis, *Tesar and Stockman* (1995) and *Matsumoto* (2007) have a composite of tradables and nontradables. In my story, the two goods can be a pair of any two sectors, whether tradable or not. If there is need to introduce non-tradable features of some particular sectors, I can introduce sector-specific trade costs $\tau \to \infty$.

[8] The symmetry of preference over sectors simplifies the derivation of a closed-form solution. If we assume $\psi > \frac{1}{2}$, it means a household consumes more goods in a sector his country is good at producing.

$$C_i = (\psi_i^{\frac{1}{\phi}} C_{i,a}^{\frac{\phi-1}{\phi}} + (1-\psi_i)^{\frac{1}{\phi}} C_{i,b}^{\frac{\phi-1}{\phi}})^{\frac{\phi}{\phi-1}}, \qquad P_i = (\psi_i P_{i,a}^{1-\phi} + (1-\psi_i) P_{i,b}^{1-\phi})^{\frac{1}{1-\phi}}$$

where $\psi_H = 1 - \psi_F = \psi$. Given the CES preference, the expenditure share of country s in sector i is dependent on sectoral prices: $\Lambda_{i,s,t} = \psi_{i,s}(\frac{P_{i,s,t}}{P_{i,t}})^{1-\phi}$ with $\psi_{H,a} = \psi_{F,b} = \psi$ and $\psi_{H,b} = \psi_{F,a} = 1 - \psi$.

In the stock market, a household purchases the equities in country i sector s at time t for price $q_{i,s,t}$. Let $\nu_{i,s,t}$ denote the number of shares in country i sector s a domestic household holds at time t, and $\nu^*_{i,s,t}$ denote the asset holdings of the foreign household. Their budget constraints are

$$P_{H,t}C_{H,t} + \sum_{s=\{a,b\}} [q_{H,s,t}(\nu_{H,s,t} - \nu_{H,s,t-1}) + q_{F,s,t}(\nu_{F,s,t} - \nu_{F,s,t-1})]$$
$$= w_{H,t}L_{H,t} + \sum_{s=\{a,b\}} (d_{H,s,t}\nu_{H,s,t} + d_{F,s,t}\nu_{F,s,t}) \qquad (1.1)$$

$$P_{F,t}C_{F,t} + \sum_{s=\{a,b\}} [q_{H,s,t}(\nu^*_{H,s,t} - \nu^*_{H,s,t-1}) + q_{F,s,t}(\nu^*_{F,s,t} - \nu^*_{F,s,t-1})]$$
$$= w_{F,t}L_{F,t} + \sum_{s=\{a,b\}} (d_{H,s,t}\nu^*_{H,i,t} + d_{F,s,t}\nu^*_{F,s,t}) \qquad (1.2)$$

The budget constraints state that the sum of consumption expenditures and changes in equity positions is equal to the sum of labor income and dividend income.

In the labor market, a representative household supplies one unit of labor inelastically. The amount of labor is fixed in each country, thus we have the market-clearing condition:

$$L_{i,a,t} + L_{i,b,t} = L_i$$

With the greater size of the productive sector, we arrive at the usual assumption of consumption home bias commonly seen on the topic. See, for instance, *Kollmann* (2006) and *Heathcote and Perri* (2013).

In the benchmark case, $L_H = L_F = 1$. Due to the mobility of labor across sectors, wage within a country is identical: $w_{i,a,t} = w_{i,b,t} = w_{i,t}$. Without loss of generality, I normalize $w_{F,t}$ to one and denote $w_{H,t}$ as w_t.

1.3.1.3 Optimal Allocation

In this two-country context, the complete market features perfect risk-sharing across countries such that an individual country's consumption is not subject only to its own income constraint. According to *Backus and Smith* (1993), the optimal consumption allocation in the complete market satisfies the condition that the relative marginal utility across countries equals the consumption-based real exchange rate:

$$\frac{U'(C_{H,t})}{U'(C_{F,t})} = \frac{P_{H,t}}{P_{F,t}} = e_t$$

The solution to the portfolio choice problem will support this optimal allocation.

1.3.1.4 Equilibrium

The equilibrium of the model consists of a sequence of prices such as goods prices $P_{i,s,t}, P_{i,t}, P_{s,t}$, wages $w_{H,t}, w_{F,t}, w_t$, asset prices $q_{i,s,t}$, dividends $d_{i,s,t}$ and the real exchange rate e_t, as well as a vector of quantities including output $Y_{i,s,t}$, consumption $C_{i,s,t}, C_{i,t}$, labor $L_{i,s,t}$, and asset holdings $\nu_{i,s,t}$ such that:

(a) Firms choose prices and quantities to maximize their profits;

(b) Households choose consumption and equity holdings to maximize expected lifetime utility;

(c) Goods market clears: $\sum_{i=\{H,F\}} Y_{i,s,t} = \sum_{i=\{H,F\}} C_{i,s,t}$;

(d) Factor market clears: $\sum_{s=\{a,b\}} L_{i,s,t} = L_i$;

(e) Equity market clears: $\nu_{i,s,t} + \nu^*_{i,s,t} = 1$ for $i \in \{H, F\}, s \in \{a, b\}$.

(f) Portfolio holdings support the optimal consumption allocations in the complete market.

1.3.2 Portfolio Choice

I apply and extend *Coeurdacier and Rey* (2013)'s analysis to a case with multiple sectors in a country, in order to solve for the portfolio choices in the model. To do so, I log-linearize the model around the steady state (see Appendix A.3.1) and solve for the portfolio that supports the optimal consumption allocation regardless of the types of productivity shocks to be realized in the economy. I will start with the partial equilibrium where I relate portfolio choices to variables' covariances and then proceed to the general equilibrium where the portfolio is expressed in terms of parameters in the model.

There are four types of country-sector-pair-specific equities in the domestic households' portfolio and three unknown weights: the weight of sector a in the portfolio μ and the weights of domestic assets within each sector S_a, S_b. Thus, the weights of the four assets $f_{H,a}, f_{H,b}, f_{F,a}$ and $f_{F,b}$ are $\mu S_a, \mu(1 - S_a), (1 - \mu)S_b$ and $(1 - \mu)(1 - S_b)$ respectively. With the symmetry across countries, foreign asset holdings should be the mirror image of domestic asset holdings: $S_a = S^*_b, S_b = S^*_a, \mu^* = 1 - \mu$ (asterisk is shorthand for foreign choices). Plugging the result in the static budget constraints of the two countries yields

$$P_H C_H = w_H L_H + \mu S_a d_{H,a} + \mu(1 - S_a) d_{F,a} + (1 - \mu) S_b d_{H,b} + (1 - \mu)(1 - S_b) d_{F,b} \quad (1.3)$$

$$P_F C_F = w_F L_F + \mu S_a d_{F,b} + \mu(1 - S_a) d_{H,b} + (1 - \mu) S_b d_{F,a} + (1 - \mu)(1 - S_b) d_{H,a} \quad (1.4)$$

I examine the country's national home bias by adding up the two budget constraints (Equation 1.3 and 1.4). Let $\chi(x_1, x_2)$ be the covariance between variable x_1 and variable x_2 and $\chi^2(x)$ be the variance of variable x. I also denote the sum of the covariances of variable $\hat{x}$ with $\hat{d}_a, \hat{d}_a$ as $\sum \chi(\hat{x})$ and the variance of sectoral relative returns as $\chi^2 = \chi^2(\hat{d}_a) = \chi^2(\hat{d}_b)$.

Proposition I.1. *The share of domestic assets in the portfolio is*

$$\mu S_a+(1-\mu)S_b = \frac{1}{2}+[\frac{\sigma-1}{2\sigma\alpha}\sum\chi(\hat{e})-\frac{1-\alpha}{2\alpha}\sum\chi(\hat{wL})-\frac{2\mu-1}{2}\sum\chi(\hat{d}_H)][\chi^2+\chi(\hat{d}_a,\hat{d}_b)]^{-1} \tag{1.5}$$

When the households are risk averse, they increase their aggregate domestic holdings to hedge against real exchange rate risk. Meanwhile, they increase their aggregate foreign holdings to hedge against labor income risk.

Proof. See Appendix B. □

In Equation 1.5, aggregate domestic share (denoted as D hereafter) consists of four terms: $\frac{1}{2}$, $\sum\chi(\hat{e})$, $\sum\chi(\hat{wL})$ and $\sum\chi(\hat{d}_H)$. $\frac{1}{2}$ represents households' diversification motives across countries. The other three terms capture households' asset positions driven by risk-hedging incentives. With $\chi^2+\chi(\hat{d}_a,\hat{d}_b)>0$, D increases in $\sum\chi(\hat{e})$ when $\sigma>1$, meaning that risk-averse households buy domestic assets to hedge against real exchange rate risk. The intuition is that when households are risk averse, they have stronger needs to smooth consumption across time. When local goods are expensive, they do not postpone consumption but purchase assets with high returns to stabilize their purchasing power. As a result, they hold domestic assets as there is a positive correlation between domestic returns and local prices. Besides, D also decreases in $\sum\chi(\hat{wL})$, indicating that households hold foreign assets to hedge against domestic labor income risk. This result arises from the positive correlation between domestic labor income and domestic asset returns. So far, the conclusions resonate with those in prior works summarized in a generic form by *Coeurdacier and Rey* (2013).

What is new in my chapter is the term capturing the covariance between domestic returns across sectors $\sum\chi(\hat{d}_H)$. Its sign determines the relationship between the choice over sectors and the choice over countries.

Proposition I.2. *Sectoral share μ and national share D are substitutes as long as $\sum\chi(\hat{d}_H)>0$. If $\sum\chi(\hat{d}_H)<0$, μ and D are complements.*

The reasoning is as follows. $\hat{d}_H$ is the increase of $d_{H,a}$ relative to that of $d_{H,b}$. When $\sum \chi(\hat{d}_H)$ is positive, it means the sum of domestic sectoral returns relative to foreign ones is increasing in the relative performance of domestic productive sector relative to that of the domestic unproductive sector. Algebraically,

$$\sum \chi(\hat{d}_H) = \chi(\hat{d}_H, \hat{d}_a) + \chi(\hat{d}_H, \hat{d}_b) = \chi(\hat{d}_{H,a} - \hat{d}_{H,b}, \hat{d}_{H,a} - \hat{d}_{F,a}) + \chi(\hat{d}_{H,a} - \hat{d}_{H,b}, \hat{d}_{H,b} - \hat{d}_{F,b}) > 0$$

When intra-national gap $(\hat{d}_{H,a} - \hat{d}_{H,b})$ is widening, so is inter-national gap $(\hat{d}_{H,s} - \hat{d}_{F,s}, s = a, b)$. The internal condition and the external condition work in the same direction on the relative performance of sector $f_{H,a}$. $f_{H,a}$ the productive sector at home is associated with great risks, so aggregate domestic holdings D decrease in aggregate productive sectors' holding μ; Households skew their choice towards foreign assets to globally diversify the risks arising from favoring the productive sector. In the other case where $\sum \chi(\hat{d}_H) < 0$, intranational risk and international risk partially cancel out. For instance, the improved performance of the productive sector at home deteriorates the relative performance of the home country as a whole. The negative correlation makes domestic assets a good hedge against the risks associated with the productive sector. Therefore, aggregate domestic holdings D increase in aggregate sectoral holdings of the productive sector μ.

By adding this interplay between sector choice and country choice, I point to a new explanation of why national home bias in some countries is high. In an economy with $\sum \chi(\hat{d}_H) > 0$, home bias can be high because the country holds many unproductive sectors' assets so that risk-hedging across sectors replaces the need for risk-hedging across countries.

Next I analyze the general equilibrium of the model. Households choose the optimal values of μ, S_a and S_b regardless of the type of shocks to be realized in the economy. Thus, I solve the portfolio problem by matching the corresponding coefficients after log-linearizing the model.

Proposition I.3. *In this complete market, sectoral home bias in the general equilibrium features*

$$\Omega_1 \equiv \mu S_a - (1-\mu)(1-S_b) = -\frac{T}{T+1}\frac{1-\alpha}{\alpha} + \frac{T}{T+1}\frac{1}{\alpha}\frac{(1-\frac{1}{\sigma})}{\lambda-\theta} \tag{1.6}$$

$$\Omega_2 \equiv (1-\mu)S_b - \mu(1-S_a) = \underbrace{-\frac{1}{T+1}\frac{1-\alpha}{\alpha}}_{\text{Labor Income Risk}} \underbrace{-\frac{1}{T+1}\frac{1}{\alpha}\frac{(1-\frac{1}{\sigma})}{\lambda-\theta}}_{\text{Exchange Rate Risk}} \tag{1.7}$$

where $\lambda \equiv 1+\theta-\phi+(2\psi-1)^2(\phi-\frac{1}{\sigma})$

Proof. See Appendix B. □

In the expressions above, Ω_1 reflects households' preference for the domestic productive sector relative to the foreign productive sector, while Ω_2 reflects households' relative preference for the domestic unproductive sector over the foreign unproductive sector. The term $-\frac{1-\alpha}{\alpha}$ captures households' hedging against labor income risk in holding equities. When we add the coefficients before the term across Ω_1 and Ω_2, we have $\frac{T}{T+1}+\frac{1}{T+1}=1$. On the other hand, $\frac{1}{\alpha}\frac{(1-\frac{1}{\sigma})}{\lambda-\theta}$ captures the real exchange rate risk. When we take the difference between the coefficients before the term across Ω_1 and Ω_2, we have $\frac{T}{T+1}-(-\frac{1}{T+1})=1$.

From this analysis, the two sectors within a country achieve intra-national risk-hedging by (1) alleviating the positive correlation between labor income and financial returns to the other sector and (2) stabilizing the real exchange rate such that the country's purchasing power is not subject to the price fluctuation of the other sector. Therefore, the interaction between the sectors within a country enriches countries' risk-hedging patterns.

When we add up Equation 1.6 and 1.7, we find the share of aggregate domestic equities is

$$D = \frac{1}{2} - \frac{1}{2}\frac{1-\alpha}{\alpha} + \frac{1}{2}\frac{1}{\alpha}\frac{T-1}{T+1}\frac{1-\frac{1}{\sigma}}{\lambda-\theta} \tag{1.8}$$

Equation 1.8 in the general equilibrium is the counterpart to Equation 1.5 in the partial equilibrium. The first term $\frac{1}{2}$ is the diversification term, the second terms captures the hedging of labor income risk and the third term reflects the hedging of real exchange rate risk[9]. The result is comparable to that in *Coeurdacier and Rey* (2013), only when we abstract from the multi-sectoral setting by assuming T goes into infinity.

Therefore, the national home bias of country H follows

$$H_H = 1 - \frac{1-D}{1/2} = -\frac{1-\alpha}{\alpha} + \frac{1}{\alpha}\frac{T-1}{T+1}\frac{1-\frac{1}{\sigma}}{\lambda-\theta}$$

From the expression, we draw the following conclusion:

Proposition I.4. *National home bias decreases in T the productivity disparity.*

When there is much productivity disparity between the productive sector and unproductive sector, the world production and trade are more specialized. Under this circumstance, intra-national risk-hedging against real exchange rate risk weakens when T gets bigger, which in turn induces households to hold more foreign assets for inter-national risk-hedging. In the extreme case when $T = 1$, we are back to the *Baxter and Jermann* (1997)'s case in the absence of real exchange rate risk. In this case, we ignore sectors' different ability to influence the exchange rate; Households hold foreign assets only to deal with labor income risk.

The result predicts that countries with diversified industrial structures have stronger national home bias than countries with few major industries (which is supported by empirical evidence in Section 1.2.3). Countries like the US have higher national home bias because they can benefit much from intra-national risk-hedging which dampens their incentives to hold foreign assets. But this option is not possible for some oil exporters because their production is overly concentrated in natural resources. The limited domestic options prompt them to invest abroad.

Productivity is not only related to the choice over countries but also to the choice over

[9] When the elasticity of substitution between tradable sectors is above unity (Literature including *Levchenko and Zhang* (2011) set it equal to 2.), $\lambda < \theta$ always holds.

sectors. When we take the difference between Equation 1.6 and 1.7, we find

$$\mu = \frac{1}{2} - \frac{1}{2}\frac{T-1}{T+1}\frac{1-\alpha}{\alpha} + \frac{1}{2}\frac{1}{\alpha}\frac{1-\frac{1}{\sigma}}{\lambda-\theta} \tag{1.9}$$

Proposition I.5. *The share of the more productive sector decreases in T the productivity disparity.*

The greater T, the greater labor income risk is associated with the productive sector. Households respond by favoring the assets in the unproductive sector. In the extreme case where $T = 1$, we are back to *Coeurdacier* (2009)'s case in the absence of labor income risk. In this case, we ignore sectors' different ability to influence labor income; Households choose assets in the unproductive sector only to hedge against real exchange rate risk.

This result indicates that countries with concentrated industrial structures should avoid assets of their major industries. Otherwise price fluctuations in productive sectors will cause drastic shifts in the households' labor income. For instance, Qatar and Norway should diversify their investment among different industries besides oil. In contrast, countries with diversified industrial structures have more income stabilizers at home, so their preference for productive sectors in the portfolio will not cause fatal problems. An example is that Germany and the US do not need to avoid investing in the auto industry to hedge risks.

So far, I have extended *Coeurdacier and Rey* (2013)'s analysis to a case with multiple sectors. In the next section, I will use *Devereux and Sutherland* (2007)'s method to solve for sectoral home bias and examine how it varies with productivity disparity T.

1.3.3 Sectoral Home Bias

Devereux and Sutherland (2007, 2011) combine a second-order approximation of the portfolio Euler equation with a first-order approximation of other equations in the model to calculate the static portfolio. Around the steady state of this economy, the approach offers a unique solution where a country's holdings of a sector's assets at home and abroad add up to zero.

Since the analytical results are not illustrative enough, I analyze comparative statics graphically to examine the effect of productivity on sectoral home bias. I get the values for most of the parameters from previous literature in trade and macroeconomics. For instance, *Eaton and Kortum* (2002) measure technology dispersion θ to be 8.28. *Levchenko and Zhang* (2011) set the elasticity of substitution between broad sectors ϕ equal to 2. Assumptions about discount factor and technology process are standard. I also assume the coefficient of relative risk aversion is 2 and the weight of productive sectors in consumption is 0.6.[10] In sum, parameter values are listed in Table 1.3.3.

Figure 1.6 plots domestic households' holdings of domestic assets, where the black

Table 1.3: Parametrization in the Benchmark Case

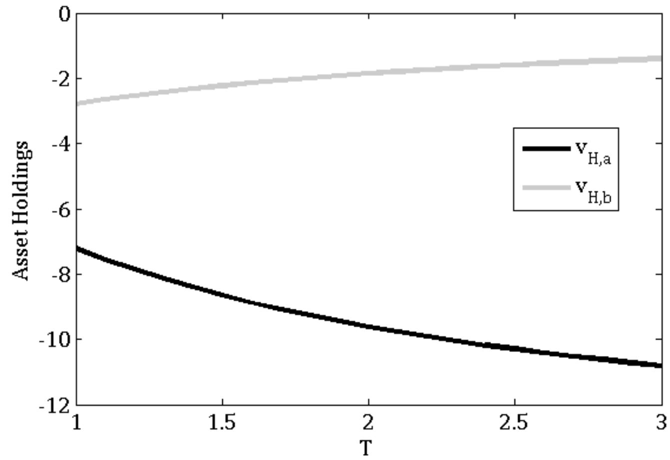
Parameter	Description	Value
β	discount factor	0.95
σ	coefficient of relative risk aversion	2
θ	technological dispersion in the EK model	8.28
ρ	coefficient of autocorrelation in technology	0.9
σ_a	standard deviation of productivity shocks	.025
ψ	weight of the productive sectors' goods in consumption	0.6
ρ	elasticity of substitution between sectors	2

line is the position of the domestic productive sector and the grey line is the position of the domestic unproductive sector. The holdings of foreign assets are the mirror image of the holdings of domestic assets in the same sector. The unit on the y-axis is the share of the asset in the steady state home income $\bar{Y}_H$. $T = \frac{\bar{T}_{H,a}}{\bar{T}_{H,b}}$ measures the strength of relative productivity.

When I increase the value of T from 1 to 3, $\nu_{H,a}$ decreases and $\nu_{H,b}$ increases, while $\nu_{H,a}$ is consistently below $\nu_{H,b}$. With the increase in T, countries are more specialized in

[10] Appendix D shows that the results of sectoral home bias basically stay the same qualitatively under different parametrization of these two variables.

Figure 1.6: Sectoral Home Bias and Relative Productivity T



production and trade. Thus, the productive sector $f_{H,a}$ is even more exposed to risks. In response, domestic households sell more assets in sector $f_{H,a}$ and increase their holdings of $f_{H,b}$.

In order to further explain the mechanism, Table 1.3.3 lists the correlations between asset returns $(r_{i,s}, i \in \{H, F\}, s \in \{a, b\})$ and labor income (wL) as well as exchange rate (e) when $T = 3$. From the two rows of the table, $r_{H,a}$ has the greatest correlations, followed by $r_{F,b}$ and then $r_{H,b}$, while $r_{F,a}$ has the least correlations with w and e. The risk-hedging motives prompt households to hold the assets that have the least correlations while avoiding those with the greatest correlations with labor income. Consequently, households prefer $f_{H,b}$ and $f_{F,a}$ to $f_{F,b}$ and $f_{H,a}$. This accounts for the greater home bias in sector b than in sector a.

To sum up, sectoral home bias is stronger in unproductive sectors than in productive sectors. Households sell short more of domestic productive sectors' assets for hedging purposes. The difference in sectoral home bias between a and b increases in the relative productivity T.

Table 1.4: Asset Returns' Correlations with Labor Income and Real Exchange Rate

	$r_{H,a}$	$r_{H,b}$	$r_{F,a}$	$r_{F,b}$
$\rho(wL, r_{i,s})$	0.1896	0.1393	-0.0359	0.1405
$\rho(e, r_{i,s})$	0.2142	0.1613	-0.0202	0.2292

Note: This table lists the correlation between the sectoral financial returns of country i sector s and the real exchange rate e as well as the domestic labor income wL.

1.3.4 Dynamic Analysis

In this section, I study the dynamics of the economy in response to sectoral productivity shocks. I start with macroeconomic variables and then proceed to asset positions.

Figure 1.7 compares the influence of a one-standard deviation sectoral productivity shock at home on relative output, consumption, wage earnings and exchange rate across countries.

The aggregate domestic output relative to foreign output rises in response to the sectoral productivity shocks at home. Adjusted for different standard deviations across sectors, the effect of a 1% increase in the productivity of the productive sector ($T_{H,a}$) will be greater than that of the unproductive sector ($T_{H,b}$). Since labor income constitutes a constant proportion of aggregate output, we observe a similar trend in the impulse response of the relative wage.

Shifts in $T_{H,a}$ and $T_{H,b}$ affect the relative consumption at home as well as the real exchange rate in the opposite direction. A positive productivity shock in the productive sector depresses the domestic consumption and depreciates the home purchasing power. This is due to the fact that the productivity boost in the productive sector worsens the weighted terms-of-trade of the home country, impacting its ability to consume and to purchase. Whereas a productivity enhancement in the unproductive sector improves terms-of-trade and boosts consumption.

We can also use the method in *Devereux and Sutherland* (2011) to analyze dynamic portfolio choices [11]. Figure 1.8 depicts the dynamics of country H's holdings of sectoral domestic assets ($\nu_{H,s}, s \in \{a, b\}$), aggregate domestic assets (ν_H) and aggregate productive sectors' assets at home and abroad (ν_a).

In the first two subplots where there is productivity improvement in either domestic sector $f_{H,s}, s \in \{a, b\}$, households lower their holdings of that particular sector on impact. Whether the other sector at home can absorb some of the outflow depends on its relative productivity. In the graph, $\nu_{H,b}$ is almost unchanged by a $T_{H,a}$ shock, while $\nu_{H,a}$ goes up significantly and permanently when $T_{H,b}$ changes. In the former case, $\nu_{H,b}$ in the steady state already carries much responsibility in risk hedging. Thus, a productivity shock to the domestic productive sector $f_{H,a}$ is anticipated and accounted for by the optimal setting of $\nu_{H,b}$ in the first place. In the latter case, $\nu_{H,a}$ does not play as important a role in risk hedging as $\nu_{H,b}$ does. Hence, when a shock happens to $f_{H,b}$, $\nu_{H,a}$ has to increase significantly to offset the decrease in $\nu_{H,b}$, in which process it takes over the responsibility of stabilizing the real exchange rate and labor income. Another way to illustrate the point is that there is less productivity disparity across sectors at home with the boost of $T_{H,b}$, so sector $f_{H,a}$ becomes less risky and attracts more investment.

The aggregate domestic holdings ν_H (shown in subplot 3) give us a sense of portfolio adjustment across countries. Domestic shares decrease on impact with any positive productivity shock at home, due to the fact that the home country suffers a surprise initial loss of wealth due to their negative holdings of domestic assets. After 30 periods, holdings gradually converge to a new steady state. Whether it is higher than the original one depends on the productivity of the sector that experiences the shock. If what changes is $T_{H,a}$, domestic households want to cut their aggregate domestic holdings further as domestic

[11] The mechanism of the method can be traced back to *Samuelson* (1970) who states that an $N+2$ degree of approximation of an investors' objective function can capture the N^{th} order of portfolio behaviour. In solving the steady state (zero-order) portfolio problem, we combine the second-order approximation of the portfolio choice equation with the first-order approximation of the equations describing the economy. In solving the dynamic (first-order) portfolio problem, we combine the third-order approximation of portfolio choice equation and the second-order approximation of other equations in the model.

risks are strengthened with the productive sector's rising productivity. If $T_{H,b}$ changes, domestic holdings increase since the improvement of the unproductive sector eliminates some of the risks because now the two sectors are more even and more intra-country risk hedging becomes possible.

The last subplot in Figure 1.8 shows the change in ν_a (the sum of $\nu_{H,a}$ and $\nu_{F,a}$). ν_a increases when there is a positive shock to $T_{H,b}$. The strengthening of the unproductive sector at home alleviates the positive covariance between labor income and financial returns to sector a's assets. Consequently, households increase the holdings of sector a which is exposed to less risks than before. The last two subplots reaffirm the validity of Proposition I.4 and Proposition I.5.

1.3.5 Model Extension

In this section, I extend the baseline model by incorporating nontradability. To do so, I impose sector-specific trade costs ($\tau \to \infty$) on b and turn the model into an economy with a tradable sector (a) and a nontradable sector (b). Meanwhile I also relax the assumption of symmetric preferences across countries. Table 1.3.5 compares the results in the baseline case and the case with nontradables.

Table 1.5: Asset Holdings with and without Nontradables

		Baseline Model	Model with Nontradables
Macro Correlations	$\rho(Y_H, Y_F)$	0.38	0.36
	$\rho(C_H, C_F)$	0.81	0.39
Asset Holdings	$\nu_{H,a}$	-10.81	-10.15
	$\nu_{H,b}$	-1.40	13.67

From the table, we find the cross-country correlations of consumption $\rho(C_H, C_F)$ and output $\rho(Y_H, Y_F)$ are lower with the introduction of nontradables, since nontradables are consumed and produced locally.

Regarding asset holdings, while domestic holdings are negative in the baseline model, they turn positive for the nontradable sector in the extended model. International risk sharing has been greatly impaired, thus households do not circumvent domestic assets as before. Of the two domestic assets, investors prefer $f_{H,b}$ the nontradable sector. Investors have little incentive to hold foreign assets in nontradable sectors because they do not benefit much from linking consumption to returns in nontradable sectors. The result is consistent with those in other papers on the topic such as *Matsumoto* (2007) and *Collard et al.* (2007)[12].

1.4 Application: Trade Expansion and Foreign Investment

In this section, I elaborate on an application of the model to provide additional evidence on how countries' industrial structure drives their choice between domestic and foreign assets.

The model argues that the growth of productive sectors accumulates a country's domestic risks. Many emerging markets like China and Brazil are more productive in their tradable sectors and these countries' exports have been growing rapidly. Therefore, the investors' concerns for the mounting domestic risks prompt them to hold developed countries' assets. Hence, we observe the surge of South-North capital flows in recent decades despite the relatively high domestic returns in developing countries. This chapter provides one explanation for this phenomenon by linking the trade channel and the financial channel.

I use China as an example. The past decade has witnessed not only China's rising role as a world producer but also its rapid expansion in foreign portfolio investment. My model suggests that the coexistence of the two phenomena is not coincidence but causation

[12] My model is a more general representation of previous work, encompassing both tradables of different productivity and nontrable sectors.

instead. To illustrate how the mechanism works, I do a numerical exercise calibrated to the Chinese data to see how trade expansion in the recent decades drives capital outflow. I assume there are two countries (China and the U.S.) and two sectors (tradables and nontradables). As is argued in the model extension part (Section 1.3.5), this setup is in line with *Matsumoto* (2007) and *Collard et al.* (2007). So I choose my parametrization (listed in Table 1.6) similar to theirs to make our results comparable.

The data of bilateral trade between China and the U.S. are from the Census Bureau, while the data of China's equity holding in the U.S. are from the Department of Treasury. China's data on setoral output and trade are obtained from the National Bureau of Statistics of China. Since the equity data are only available since 2003, I will focus my analysis on the past decade.

When I calibrate the model, I choose time-varying weights of domestic goods in the tradable basket ($\omega_{i,t}$) to match the data of China's exports as shares of GDP every year. Then I calculate the implied holdings of foreign assets based on the calibration. Finally, I compare the data of China's holdings of U.S. equities and the results in my simulation to evaluate the performance of the model.

Table 1.6: Parametrization

Parameter	Description	Value
β	discount factor	0.95
σ	coefficient of relative risk aversion	2
ϕ	elasticity of substitution b/w tradables and nontradables	.5
ϕ_t	elasticity of substitution b/w domestic and foreign traded goods	1.5
ψ_t	weight of tradables in consumption	0.5

Figure 1.9 shows the comparison between simulation and data pertaining to China's historical holdings of U.S. equities (expressed as a percentage of long-run average values during the period). [13] The model does a good job of capturing the trends of the asset

[13] In data, the holdings were low and stable before 2006 because China set strict restriction on foreign investment. In April 2006, the Chinese government launched QDII (Qualified Domestic Institutional Investor) scheme which allowed qualified institutions to hold foreign securities.

holdings[14].[15] Overall, China's equity holdings have grown persistently over time with their trade expansion. There is a sudden drop of asset holdings around the 2009 global financial crisis. The drop in my simulation is not obtained by the assumption of any exogenous monetary or real shocks but by the fall in China's exports alone. At the time, bilateral trade ties deteriorate during the financial crisis. Meanwhile China's tradable sector is less vulnerable to real exchange rate risk and labor income risk. Consequently, Chinese investors have less hedging motives to invest abroad, which prompts them to switch from foreign equities to domestic equities. After the financial crisis, their holdings of US assets recover due to the rebuilt trade relationship.

This exercise shows that the South-North capital movement can be driven by the e-merging markets' trade expansion. It also corroborates the main argument of the chapter that industrial structures affect countries' home bias.

1.5 Conclusion

In this chapter, I illustrate whether sectoral productivity drives a country's portfolio choice and explain why. I show empirically and theoretically that industrial structure affects equity home bias both at the industry level and at the country level. The framework I build in this model has wide applications in international economics.

In future research, I will modify the method I use to solve for the optimal portfolio. *Devereux and Sutherland* (2007, 2011) introduce a powerful tool in capturing the relative patterns of asset holdings, but the method has the following short-comings that prevent it from capturing the absolute moments. First, there is no short-sale constraint in the

[14] The correlation between data and simulation is .85. The adjusted R-squared from a regression of data on simulation is .69. Both indicate the model is successful in predicting the trend of real data on equity holdings.

[15] Although the magnitude of the simulation is much greater than that of the real data. This is partly due to the assumption of complete market and the absence of short-sale constraint, as well as the log-linearizing solution method. The great magnitude of asset holdings is typical in this strand of literature.

baseline setup so that agents may hold negative assets in the model. This assumption is not valid in many real situations, so it is necessary to extend the technique by embedding a non-negative constraint. Second, the method solves for the optimal asset holdings around the steady state of the model, which makes it hard to apply it to a case with multiple equilibria or no equilibrium. *Coeurdacier et al.* (2011) among others also discuss the problem.

The model itself can be extended in the following directions to better capture the reality of international capital flows. First, I will build and solve a full-fledged multi-country multi-sector model with a carefully calibrated numerical exercise to do both cross-sectional and time series analyses of home bias. Second, we can introduce corporate debt into the model to investigate the complementarity as well as the substitutability between debt and equity. *Coeurdacier and Gourinchas* (2011) discuss the difference between debt and equity at the national level, but the picture will be different at the industry level with corporate instead of government debt. Third, we can incorporate institutional and information frictions in the portfolio choice problem. Despite the fact that these two factors mainly work at the national level, there exists cross-industry variation as is pointed out by *Schumacher* (2012). Fourth, my model abstracts from physical capital. We can introduce capital goods and dynamic investment to match the characteristics of a production economy better. A good example in this direction is *Heathcote and Perri* (2013) who argue that the correlation between labor income and capital income affects the hedging ability of financial assets and hence changes investors' equity positions. By including these extensions, future research will provide us with a better understanding of the interplay between industrial structure and home bias.

Figure 1.7: Impulse Responses to Productivity Shocks

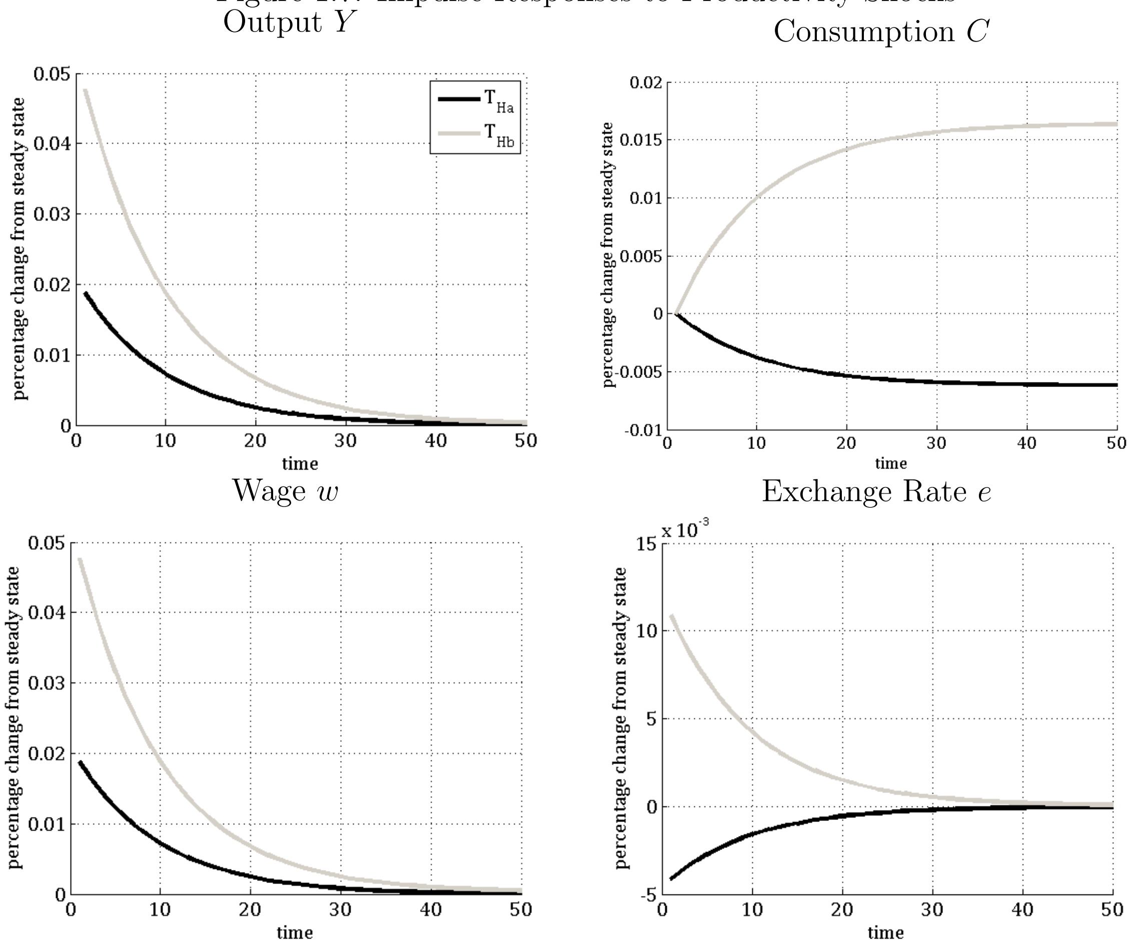


Figure 1.8: Asset Holdings in Response to Productivity Shocks

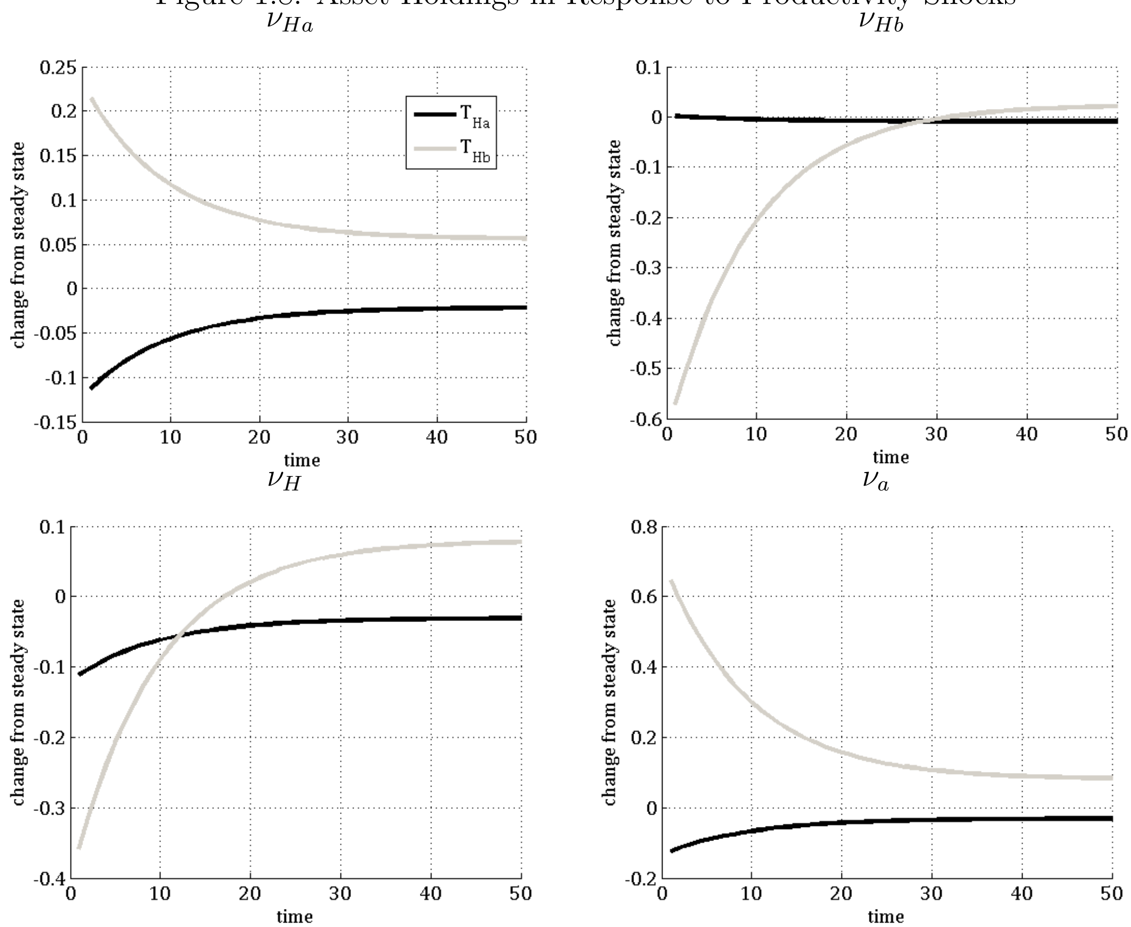
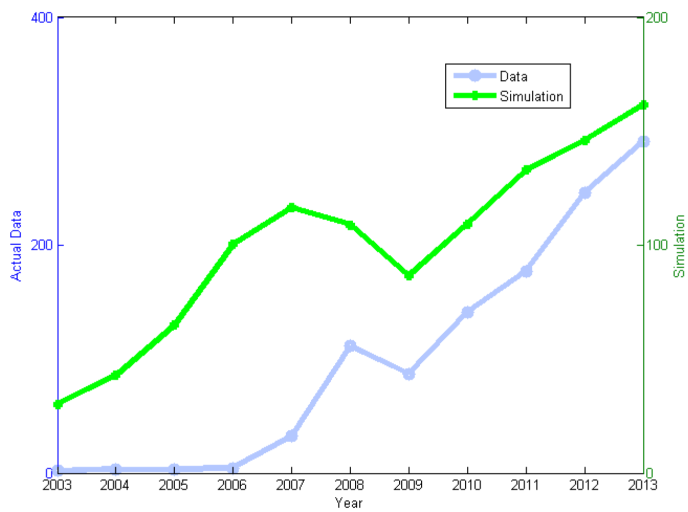


Figure 1.9: China's Historical Holdings of U.S. Equities



Note: This figure presents both simulated and actual China's holdings of US equities from 2003 to 2013. The green line is the simulated holdings I get by calibrating the model to match China's exports. The blue line is the actual data from the US Census Bureau. Both are expressed as a percentage of long-run average values during the period. The correlation between data and simulation is 0.85.

CHAPTER II

Optimal Trade Costs after Sovereign Defaults

This paper offers new theoretical and empirical insights into the effect of sovereign defaults on trade. Empirical evidence from the changes in trade shares after debt renegotiations as well as Aid-for-trade statistics indicates that sovereign debt renegotiation is not associated with trade sanctions but with trade incentives offered by creditor countries to debtor countries. Using a two-country DSGE model with incomplete financial markets, we are able to explain why trade sanctions are not observed. Our model departs from the existing literature on sovereign defaults by building on the strategic interaction between debtors and creditors. We reason that creditors lower trade costs with debtors in hopes of collecting the remaining debt during debt renegotiations. The adjustment in turn affects debtors' default decisions. The model departs from the existing literature on sovereign defaults by building on the strategic interaction between debtors and creditors. We solve the model numerically to determine the optimal trade costs given different combinations of debt and income levels.

2.1 Introduction

The danger of default exists with every financial loan, and sovereign debt is no exception. Holders of sovereign debt face additional uncertainty stemming from the lack of supernational legal entities. The recent debt crises in Europe and Latin America have demonstrated the need to study both creditors' and debtors' incentives and decisions in the initiation, negotiation and settlement process of sovereign debt contracts. This chapter aims to contribute to the discussion by focusing on a novel mechanism that has been overlooked in previous work.

Globalization since the second half the twentieth century has featured both trade liberalization and financial mobility across borders. The two channels should not be studied in isolation, as both are important sources of individual countries' economic development as well as world risk sharing. As *Tomz and Wright* (2013) point out, theoretical models are missing while empirical evidence is ambiguous over how trade and sovereign default interact. Our paper addresses this gap in the literature by providing new empirical and theoretical results that bring together the trade and borrowing channels to explain sovereign default settlement.

Trade, in previous literature on sovereign default, has played a trivial if any role. For instance, *Bulow and Rogoff* (1989) argue that default may lead to a decline in international trade, which is interpreted as a constant output loss in their model. Their approach is followed in the majority of sovereign default papers including *Aguiar and Gopinath* (2006), *Yue* (2010) , *Bai and Zhang* (2010), to name just a few. *Tomz and Wright* (2013) summarize three reasons why trade could suffer after default happens: (1) creditors' trade restrictions as a means of punishment (a.k.a. trade sanction), (2) the collapse of trade credit, and (3) creditors' asset seizures. None of these reasons can be captured by direct output loss, let alone the strategic behaviors that arise from these features. Instead, our paper will focus on how trade costs may change before and after sovereign defaults.

Rose (2005) explains empirically the cost of trade after sovereign default. Using government-to-government debt default information from the Paris Club, he finds that debt renegotiations have significantly negative effects on contemporaneous and lagged trade volume in a gravity regression. We find his results inspiring and intriguing but not fully explored. Trade volume will naturally fall with the deterioration of economic terms, which may not be fully picked up by the gravity variables. It is the *relative* share instead of the *absolute* value of trade that measures the existence and severity of punishment in the bilateral borrowing relationship. We replicate Rose's analysis on an expanded dataset that includes fifteen additional years. Similar to *Rose* (2005) we find that trade volume falls, but we also find that trade share increases significantly (by around 5%) after debt renegotiation happens. This is a surprising result that runs contrary to the traditional trade sanction arguments.

Novy (2013) argues that trade share can be used to infer time-varying bilateral trade costs directly from the model's gravity equation without imposing arbitrary trade cost functions. Based on this argument, we hypothesize trade costs change as a creditor's reaction to debt renegotiation. As there lacks comprehensive and consistent data on direct measurement of trade costs, we resort to OECD's data on aid for trade and find there is noticeable increase in trade-related assistance from creditors when debt renegotiation happens. This is complementary evidence for lower trade costs after defaults.

Our findings lead us to rethink creditors' incentives: why would creditors be willing to lower their trade costs with defaulters? In practice, before a default reaches its final resolution, there is a renegotiation stage where the creditor and the debtor could agree on debt settlement based on the current income of the debtor and the size of the debt. Our hypothesis is that in the renegotiation stage, it is sometimes optimal for the creditor to lower trade costs so that the debtor is more likely to service the debt.

We build a dynamic stochastic general equilibrium model to develop our hypothesis. Our model differs from a standard sovereign default model in the following ways. First, it is a two-country model instead of a small open economy. Additionally, because we are interested in whether the model's prediction of trade shares can match our empirical findings, we will study a creditor-debtor two-country model integrated with a world market. Second, our model includes a trade component. The consumption bundle in a country consists of domestic goods, financial partners' (whether it be creditor or debtor) goods, and the goods from the world market, with an elasticity of substitution among them. Third, creditors are risk averse. Creditors in most sovereign default models are risk-neutral and perfectly competitive for tractability reasons, so that bond prices are directly linked to the world interest rate once default probability is computed. This assumption will be relaxed in our model as we assume a concave utility function. We compute a market-clearing bond price under the assumption of constant relative risk aversion (CRRA).

In our story, the amount creditors hope to collect from debtors induces the adjustment of bilateral trade costs. At the same time, the change in trade costs affects debtors' probability to service the debt. At the end of the day, default probabilities, bond prices and optimal trade costs are all endogenously derived as the solution to the general equilibrium model. Trade and debt channels are more correlated and interactive in our model than in any previous work.

Our contribution is three-fold. First, we identify an interesting but overlooked phenomenon through our empirical analysis, which calls the widely-accepted trade sanction argument into question. Second, we propose a new mechanism which links bilateral trade and bilateral borrowing. Third, we develop computation techniques that allow us to numerically solve a sovereign default model with more realistic features, such as risk-averse creditors.

In our new approach, we have maintained several important features from previous work. *Eaton and Gersovitz* (1981) propose financial autarky as a means to support debtors' incentive to repay the debt. In our model, defaulters are also denied access to new loans. In terms of empirical analysis, our paper is in line with *Martinez and Sandleris* (2011) who find that debtors' bilateral trade with creditor countries does not fall more than trade with other countries. On the computation side, we follow *Hatchondo et al.* (2010)'s recommendation and use cubic spline interpolation rather than discrete state space technique to approximate the value functions to reduce computational burdens. Our paper is also related to the recent work of *Gu* (2015) but with a different focus. She introduces vertical integration in production between a creditor and a debtor to examine the dynamics of terms of trade and trade volume, while our work aims to provide an answer to the optimal trade costs a creditor imposes on a debtor after debt renegotiations take place.

The remainder of the chapter proceeds as follows: Section 2 presents the empirical findings. Section 3 describes the model as well as the properties of the recursive equilibrium. Section 4 elaborates on the algorithm, parameterizations and numerical results. Section 5 concludes.

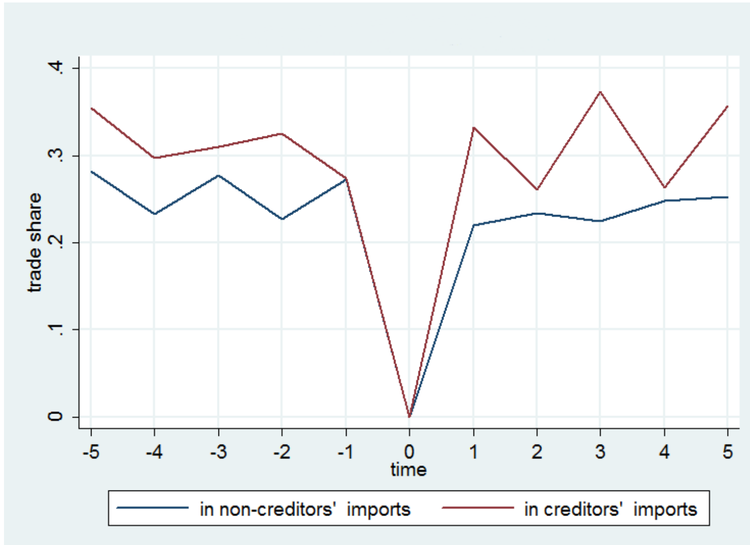
2.2 Empirical Analysis

In this section, we present our findings about the effect of sovereign defaults on trade. We are interested in the dynamics of trade shares after debt renegotiations. Trade share is a more accurate measure of trade sanctions or benefits than trade volume: if there were trade sanctions, creditors would disproportionably depress their trade with debtors. Hence, trade sanctions indicate lower creditor-debtor trade shares after debt renegotiations.

Following *Rose* (2005), we track sovereign default episodes since 1956 from the Paris Club. It is an informal group of financial officials from 19 of the world's biggest economies, which provides financial services such as war funding, debt restructuring, debt relief and debt cancellation to indebted countries and their creditors. We recognize that there are diverse forms of international lending besides the debt exchanges between governments[1], yet the Paris Club has remained a central player in the resolution of developing and emerging countries' debt problems. We can track the date, list of creditors, amount of debt and terms of treatment. Another reason that we only consider government-to-government

[1] Besides government to government bilateral debt under the Paris Club umbrella, debtor countries also issue commercial bank debt under the London Club, or issue bond debt. For detailed elaboration and comparison of different forms of sovereign debts, see *Das et al.* (2012).

Figure 2.1: Shares of Debtors' Goods in Creditors' and Non-creditors' Imports



bilateral agreements is that private lending does not have as direct impact as public lending on trade flows. After all, governments are the major players to design trade policies and sign trade treaties.

Before we move to regression analysis, it is intuitive to show graphically changes in trade shares around sovereign default periods. In Figure 2.1, we plot the share of debtors' goods in creditors' and non-creditors' imports, averaged across all the default episodes. Trade share reaches its trough in the default year (denoted as zero on the x-axis) when debtors' economies experience the hardest hit. However, it is noticeable that debtors' trade with creditors is able to recover sooner and better than that with non-creditors: while the trade share in non-creditors' imports is lower than the level before defaults, the trade share in creditors' imports bounces back and even higher than the level before defaults.

I herein use a panel regression to quantify the effect of sovereign defaults on trade. The first step we take is to replicate Rose's (2005) results with fifteen more years of data. The original gravity model in *Rose* (2005) is

$$ln(X_{ijt}) = \beta_0 + \beta_1 ln(Y_iY_j)_t + \beta_2 ln(Y_iY_j/Pop_iPop_j)_t + \beta_3 lnD_{ij} + \beta_4 Lang_{ij}$$

$$+\beta_5 Cont_{ij} + \beta_6 FTA_{ijt} + \beta_7 Landl_{ij} + \beta_8 Island_{ij} + \beta_9 ln(Area_i Area_j)$$

$$+\beta_{10} ComCol_{ij} + \beta_{11} CurCol_{ijt} + \beta_{12} Colony_{ij} + \beta_{13} ComNat_{ij} + \beta_{14} CU_{ijt}$$

$$+\beta_{15,0} IMF_{ijt} + \sum_k \beta_{15,k} IMF_{ijt-k} + \phi RENEG_{ijt} + \sum_m \phi_m RENEG_{ijt-m} + \epsilon_{ijt}$$

X_{ijt} is the trade flow between country i and j at time t. Y denotes real GDP and Pop denotes population, so that Y/Pop is income per capita. Dij represents the distance between i and j and $Area$ represents a country's land mass. Binary variables include $Lang$ (common language), $Cont$ (common border), FTA (regional trade agreement), $ComCol$ (common colonizer after 1945), $CurCol$ (colonies at time t), $ComNat$ (part of the same nation at time t) and CU (same currency). $Landl$ and $Island$ are the numbers of landlocked and island countries in the country pair, which take the value of 0,1, or 2. $RENEG_{ijt}$ is a dummy variable which is unity if i and j renegotiate debt at time t and zero otherwise. IMF_{ijt} is one(two) if one (both) of i or(and) j begin an IMF program at t and zero otherwise. Lagged $RENEG$ and lagged IMF are also listed as explanatory variables, considering the change in trade flow is a gradual and persistent process.

Our first goal is to extend Rose's data by 15 years to reflect the recent trends in sovereign defaults. In collecting the data, we do our best to choose similar, if not the same data sources as Rose, in order to make the results consistent and comparable. We get the trade data from the 'Direction of Trade Statistics (DOTS)' dataset by the International Monetary Fund (IMF). The values are in current US dollars. We deflate them by the US CPI (82-84=100) from BLS to get the real value. GDP and population data are taken from World Bank's 'World Development Indicator'. In the case of missing values, we turn to Penn World Table. Values of other common gravity variables including distance, contiguity, language and colonization are available in the CEPII dataset[2]. The information about regional trade agreements is updated with the records from the World

[2] It is a square gravity dataset for all pairs of countries, downloadable at http://econ.sciences-po.fr/thierry-mayer

Trade Organization. Lastly, we get the list for the IMF programs from Axel Dreher. See Table 5 in the Appendix for detailed categories.

Our results about trade volumes are similar to Rose's, in both the sign and magnitude of the estimated coefficients. Table 1 lists the estimates in fixed-effect and random-effect models with contemporaneous and fifteen lags of $RENEG$, the dummy variable of debt renegotiation. In all the cases (i.e. bilateral trade, trade from debtor to creditor (denoted as country1to2), and trade from creditor to debtor (country2to1)), the linearly-combined coefficients of contemporaneous and lagged debt renegotiation —$\sum_{t=1}^{15} RENEG$ — are all negative, whether we employ a fixed-effect or random-effect model. This result indicates that bilateral trade volumes between a creditor and a debtor decrease after a sovereign default.

Table 2.1: Linearly Combined Contemporaneous and Lagged Effects of Debt Renegotiation on Trade Volumes

	Coefficient	Std. Err.	t	[95 percent Conf.	Interval]
bilateral FE	-1.098	0.118	-9.300	-1.329	-0.867
bilateral RE	-1.608	0.119	-13.490	-1.842	-1.375
trade 1to2 FE	-1.416	0.150	-9.460	-1.710	-1.123
trade 1to2 RE	-2.177	0.151	-14.410	-2.473	-1.881
trade 2to1 FE	-1.426	0.144	-9.930	-1.708	-1.145
trade 2to1 RE	-1.891	0.144	-13.090	-2.174	-1.608

After replicating Rose's original results, we go a step further to analyze trade shares. We believe it is the relative but not the absolute change in trade that reflects the existence and severity of trade sanctions after defaults take place. To this end, we create two variables: $Impw1to2$ is the share of creditors' goods in debtors' imports, and $Impw2to1$ is the share of debtors' goods in creditors' imports. Then we replace trade volumes with these two measures as the dependent variable in the regression.

In addition, we add exchange rates as an independent variable as currency depreciation may bias the results. For instance, the collapse of South America during the 1970's debt crisis affected the currency values of nearly all the countries in the whole region. The covariance between exchange rates across Latino countries was different from that between Latino countries and developed countries, which mattered for the change in trade shares. To correct this bias, we collect data on exchange rates from the International Financial Statistics (IFS). The original data are in the units of currency per US dollars, which can be converted to obtain bilateral exchange rates between two arbitrary currencies.

Table 2.2: Linearly Combined Effects of Debt Renegotiation on Trade Share

	Coefficient	Std. Err.	t	$p > \|t\|$	[95 percent Conf.	Interval]
share 2in1	0.0590	0.0048	12.2000	0.0000	0.0495	0.0684
share 1in2	0.0628	0.0047	13.4600	0.0000	0.0537	0.0720

Table 2 lists the regression results in the fixed-effect model. We present the coefficient and the standard error of $\sum_{t=1}^{15} RENEG$, the linear combination of coefficients on paris,paris1-15. From the table, we find that debt renegotiations have significantly positive effect on trade shares; a sovereign default episode is associated with a 5% increase in the share of debtors' goods in creditors' imports. This number is impressive, given the number of trade partners available nowadays in the integrated world market. We believe this increase in trade shares indicates that sovereign defaults do not lead to trade sanctions, but are instead associated with trade benefits.

Trade shares have been used by trade economists to uncover trade costs. This approach is developed by *Head and Ries* (2001) and extended by *Novy* (2013), who derives a micro-founded measure of bilateral trade costs that indirectly infers trade frictions from observable trade data. The measure turns out to be consistent with a broad range of leading trade theories including Ricardian and heterogeneous-firm models. The bilateral comprehensive trade costs are calculated as

$$\tau_{ij} = (\frac{X_{ii}X_{jj}}{X_{ij}X_{ji}})^{\frac{1}{2(\sigma-1)}} - 1$$

where X_{ij} and X_{ji} denote bilateral trade, while X_{ii} and X_{jj} denote domestic expenditure. τ_{ij} represents the geometric average of trade costs between countries i and j relative to domestic trade costs within each country. Its value reflects the additional costs that trading goods between i and j involves, as compared to when the two countries trade these goods within their borders. It covers tariffs, transportation costs, and other unobservable trade barriers. It is straightforward to see an increase in trade shares is *equivalent* to a decrease in trade costs. Thus, based on the increase in trade shares, we hypothesize that bilateral trade costs between creditors and debtors decrease after defaults happen.

While our argument will be stronger if we can support our hypothesis with a consistent and continuous data set of visible and invisible trade costs, such data set is rare.[3] Alternatively, we turn to OECD's Aid-for-trade dataset to see whether the efforts to boost bilateral trade are strengthened when debt renegotiations happen. We restrict our attention to the categories of aid that are directly related to trade policy adjustment (See Table 7 for details). Figure A13 plots the change in creditors' trade-related aid to debtors around the following three default episodes: Honduras (2004), Congo (2008) and Burundi (2009). In the years of sovereign defaults, creditors double or triple their trade-related aid to help defaulters out. Instead of trade sanctions, they offer generous trade benefits. These case studies serve as indirect evidence for our hypothesis that creditors lower trade costs with defaulters.

To sum up the empirical section, sovereign renegotiation is associated with increased bilateral trade shares between debtors and creditors. This empirical result, in line with *Martinez and Sandleris* (2011), contradicts the prediction of the trade sanction theory. Based on *Novy* (2013)'s trade costs theory and Aid-for-trade data, we believe bilateral trade costs decrease after debt renegotiations.

[3]Bilateral tariff and non-tariff data from the World Bank's WITS are discontinuous and available only for the past decade. Trade costs in our paper are broader in definition, so it is hard to find direct comprehensive evidence.

2.3 Model

In the empirical section, we challenge the conventional trade sanction theory of sovereign default. Our explanation for this interesting observation is that a creditor is willing to compromise in the trade channel in order to minimize its loss from the financial side. In other words, when the creditor finds the debtor on the brink of defaulting, it is willing to lower trade costs to boost the debtor's exports such that the debtor is more likely to service the debt. The reduced trade costs will in turn determine a debtor's willingness to repay. Our model features this strategic interaction between the two parties in the Markov perfect equilibrium.

2.3.1 Model Environment

In the model, there is a creditor, a debtor and the rest of the world (ROW). Although commonly used for sovereign default problems, a model with a small open economy is not able to capture the strategic interaction between countries. Meanwhile, a standard two-country model is not helpful in studying the trade shares after sovereign defaults. To this end, we will build a creditor-debtor two-country model integrated with a world market (or ROW).

The creditor and the debtor are endowment economies with goods specific to country $i = c, d$ (c denotes the creditor and d denotes the debtor). For simplicity, we assume the income of the creditor $\bar{A}$ is constant over time and large enough for the country to always be the lender. Meanwhile, the income of the debtor follows an AR(1) process:

$$y_t = \rho_y y_{t-1} + (1 - \rho_y)\bar{y} + \epsilon_t$$

with its long-run mean $\bar{y}$ and innovation $\epsilon_t \sim N(0, \sigma^2)$.

Other than the two countries, there is a world market that both countries can interact with. Specifically, this market consists of two parts — financial and goods markets. In the world financial market, there is a risk-free asset called world bond with rate r. Meanwhile, the world goods market supplies one kind of consumption good. For simplicity, we assume a country can trade one-for-one domestic goods for goods in the world market: $c_{iw} = c_{wi}$.

Country i's objective is to maximize its expected lifetime utility:

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{C_{i,t}^{1-\gamma}}{1-\gamma}$$

where utility takes the form of constant relative risk aversion (CRRA) with consumption

$$C_{i,t} = [\theta_{ii} c_{ii,t}^{\rho} + \theta_{ij} c_{ij,t}^{\rho} + (1 - \theta_{ii} - \theta_{ij}) c_{iw,t}^{\rho}]^{\frac{1}{\rho}}$$

The consumption composite of country i consists of domestic goods (c_{ii}), foreign goods (c_{ij}) and world goods (c_{iw}) with elasticity of substitution $\frac{1}{1-\rho}$. We further assume preference is symmetric across countries $\theta_{ii} = \theta_{ii} = \theta_h$ and $\theta_{ij} = \theta_{ji} = \theta_f$. The market clearing condition of goods i states that

$$c_{ii} + c_{ji} + c_{wi} = y_i$$

Let p_{ii} represent the price of goods i in its source country. There is a trade cost $\tau_{ij} > 1$ imposed by country i on goods coming from country j, reflecting trade restrictions like tariffs. Thus, the effective price of imports from country j to country i is $p_{ij} = \tau_{ij} p_{jj}$. As we are mainly interested in the impact of creditor's trade policies on debtor's default decisions, we assume $\tau_{dc} \equiv 1$. An implication of this assumption is that there is no trade retaliation on the debtor's side. On the other hand, the creditor has some flexibility in adjusting trade costs $\tau_{cd}, \in [\underline{\tau}, \overline{\tau}]$. Tariffs also become part of the creditor's income for the model to yield a non-corner solution to τ_{cd}. As we will show later, τ_{cd} is a crucial policy instrument that affects not only bilateral trade but also bilateral debt. Lastly, the trade costs between a country and the rest of the world are set equal to zero for simplicity: $\tau_{iw} = \tau_{wi} = 1,\ i = \{c, d\}$.

The debtor issues one-period risky bonds to the creditor. The bond market features limited enforcement since the debtor can default on its debt. There are two default states (S_0, S_1) :

State 0 (S_0): The debtor repays the bilateral debt previously and retains its financial ties with the creditor.

State 1 (S_1): The debtor defaults previously and is stuck in financial autarky.

In S_0, the debtor chooses from two default options ($D \in \{D_0, D_1\}$). It either services the debt (D_0) and stays in S_0, or defaults (D_1) and downgrades to financial autarky in the next period. In S_1, it no longer issues debt and consumes its endowment.

The timeline of the model is summarized in Figure 2. At the beginning of period t, the debtor can issue risky bond b to the creditor if it is in S_0. The creditor lends money, chooses risk-free asset b_c from the world financial market and sets trade cost τ. When the one-period bond matures at $t + 1$, the debtor observes the realization of its current endowment and chooses either to repay the debt so as to stay in S_0, or to default and move to S_1. Meanwhile the creditor sets τ' based on state variables b, b_c and y. If the debtor defaults previously, it is in financial autarky (S_1). Following *Aguiar and Gopinath* (2006), there is an exogenous probability λ for the debtor in S_1 to regain access to borrowing.

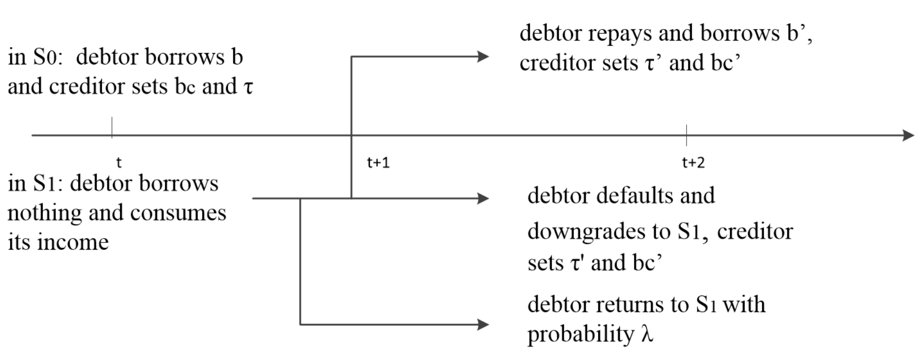


Figure 2.2: Timeline

2.3.2 Recursive Equilibrium

The state space of the model consists of default states $s \in S = \{S_0, S_1\}$ and a set of fundamental macroeconomic variables including the debtor's income, bilateral bond holdings and the creditor's wealth w. Denote the set as $x = (y, b, w) \in X$. Agents' value functions and decision rules will depend on $S \times X$. In this section, we solve for the creditor's and the debtor's problems and define the equilibrium of the model.

2.3.2.1 Debtor's Problem

In S_0, the debtor enters a period with b and observes the endowment realization y. If it chooses not to default, it issues a new bond b' at the price $q(y, b', w)$ (denominated in the debtor's goods price). If it chooses to default, its debt b is written off but it moves to financial autarky at the beginning of next period. Denote the value function of a debtor who has not previously defaulted by $V_d(S_0, y, b, w)$.

$$V_d(S_0, y, b, w) = \max\{W_0(y, b, w), W_1(y, b, w)\}$$

where $W_0(y, b, w)$ is the welfare by choosing D_0 and $W_1(y, b, w)$ is the welfare by choosing D_1. A debtor makes its default decisions upon the comparison of the two welfare levels

$$D_s = arg \max_s W_s(y, b, w), \qquad s = \{0, 1\}$$

More specifically, $W_0(y, b, w)$ can be expressed as

$$W_0(y, b, w) = \max_{C_d, \geq 0, b'} U(C_d) + \beta E[V_d(S_0, y', b', w')|y]$$

subject to

$$C_d + q(y, b', w)b' \leq y + b$$

Since everything is denominated in debtor country's domestic good, the debtor's total expenditure on consumption is

$$C_d = \frac{c_{dd}p_{dd} + c_{dc}p_{cc} + c_{dw}p_{dw}}{p_{dd}}$$

From now on, we normalize p_{dd} to be one and define $\frac{p_{cc}}{p_{dd}} \equiv p$. Thus, $C_d = c_{dd} + c_{dc}p + c_{dw}$. We also discipline the level of bonds with the financial constraint following *Aiyagari* (1994)

$$b' \geq -\frac{\bar{y}}{r}$$

where r is calibrated to the world interest rate. As long as the debtor does not borrow $b' > 0$, it saves the money in the world financial market at rate $q_f = \frac{1}{1+r}$.

Similarly, $W_1(y, b, b_c)$ the welfare of choosing D_1 follows

$$W_1(y, b, w) = \max_{C_d \geq 0} U(C_d) + \beta E[V_d(S_1, y', 0, w')|y]$$

subject to

$$C_d \leq y$$

A country in S_1 is in financial autarky, but there is an exogenous probability λ for it to return to S_0 in the next period. Hence, its value function becomes

$$V_d(S_1, y, 0, w) = \max_{C_d \geq 0} U(C_d) + \beta(\lambda E[V_d(S_0, y', 0, w')|y] + (1 - \lambda)E[V_d(S_1, y', 0, w)|y]$$

subject to

$$C_d \leq y$$

2.3.2.2 Creditor's Problem

The creditor's problem is contingent on the debtor's state. When the creditor deals with the debtor who hasn't defaulted in the last period, its value function is

$$V_c(S_0, y, b, w) = \max_{C_c, b'_c \geq 0, \tau_0} U(C_c) + \beta E[\pi_{00}(y, b', w)V_c(S_0, y', b', w')|y$$

$$+\pi_{01}(y, b', w)V_c(S_1, y', b', w')|y]$$

subject to

$$C_c - \frac{q(a, b', w)b'}{p} + q_f b'_c \leq y_c - \frac{b}{p} + b_c$$

where

$$C_c = \frac{c_{cc}p + \tau_{cd}c_{cd} + c_{cw}p}{p}$$

$\pi_{mn}(y, b', w')$ represents the debtor's probability of going to state S_n from state S_m conditional on y. There is a cutoff income value y^* of the debtor below which it will default. Thus, we have

$$\pi_{00}(y, b', w) = Pr(y' > y^*|y) = \int_{y^*}^{\bar{y}} f(y'|y)dy' = 1 - \pi_{01}(y, b', w)$$

If the debtor is in the default state, the creditor's value function $V_c(S_1, y, b, w)$ is

$$V_c(S_1, y, b, w) = \max_{C_c, b'_c \geq 0, \tau_1} U(C_c) + \beta E[\lambda V_c(S_0, y', 0, w')|y + (1 - \lambda)V_c(S_1, y', 0, w')|y]$$

subject to the budget constraint

$$C_c + q_f b'_c \leq y_c + b_c$$

The creditor's financial wealth is its aggregate holding of the two bonds. Since there is possibility of default, we need to multiply risky asset by the debtor's repayment decision

$D \in \{1, 0\}$ where $D = 1$ represents the repayment case and $D = 0$ represents the default case.

$$w = D(-b) + b_c$$

2.3.2.3 Bond Price

The creditor can choose between two assets: a risky asset and a risk free asset. The former is the bilateral bond at price q. The latter is the bond purchased from the world financial market at $q_f = \frac{1}{1+r}$. If the debtor is in the default state, the creditor's saving which is the difference between its income and consumption is used solely to purchase risk-free asset b_c. If the debtor has good credit history, the creditor's saving is divided between b and b_c. In this case, the bilateral bond price can be determined by the creditor's Euler equation

$$q\frac{\partial V_c}{\partial C_c} = \beta E \frac{\partial V_c'}{\partial C_c'}$$

The right hand side is the expected marginal utility from tomorrow's consumption, which incorporates the default probability of the debtor. As is pointed out by *Lizarazo* (2013), the bond price is higher in the case where creditors are risk-averse due to the fact that there is covariance between creditors' consumption and debtors' default decisions.

2.3.2.4 Goods Price

p denotes the creditor's goods price p_{cc} relative to the debtor's goods price p_{dd}. Based on the creditor's budget constraint,

$$\frac{c_{cc}p + \tau_{cd}c_{cd} + c_{cw}p}{p} - \frac{q(a, b', w)b'}{p} + q_f b_c' = y_c - \frac{b}{p} + b_c$$

we find p is determined jointly by debt b, wealth w and trade cost τ. In the model, the creditor chooses optimal wealth and trade costs to maximize its utility. In this process, it is considering the gains from both the lending channel and the trade channel. This explains why τ may deviate from its value when the two countries do not borrow and lend to each other. The debtor anticipates the lower trade cost and strategically makes its default decisions. This mechanism can be used to explain why both debt levels and default probabilities are higher than expected.

2.3.2.5 Markov Perfect Equilibrium

We now proceed to define the equilibrium of the model.

A *Markov Perfect Equilibrium* consists of the debtor's value function $V_d(S, X)$, the creditor's value function $V_c(S, X)$, bond holdings b', b'_c, consumption choices C_c, C_d, default decisions D, trade costs τ, bond pricing schedules $q(y, b', w)$, and relative goods prices p, such that

1. Given the bond prices q, goods prices p, trade costs τ_{cd}, the creditor's wealth w and consumption C_c, the debtor chooses optimal C_d, D and b' to maximize its expected lifetime utility.

2. Given the debtor's default decisions D, bond holdings b' and consumption C_d, the creditor chooses optimal τ_{cd}, b_c and C_c to maximize its expected lifetime utility.

3. Bond markets clear at q and goods markets clear at p.

2.4 Computation

In this two-country model, the creditor and the debtor decide interactively their policy rules. The numerical solution to the model is found over the space of three state variables, b the bilateral bond,w the creditor's wealth and y the debtor's income.

We first divide all the three state variables into grids and compute the initial value function at each grid based on different default states. Second, we derive interactively the optimal choice of bond holding of both countries and the creditor's optimal trade cost τ. In this process, we approximate the value function by cubic spline interpolation, which is significantly more efficient and accurate than the discrete state space technique which is commonly used for the computation of sovereign default problems, as is pointed out by *Hatchondo et al.* (2010). After we find optimal policy functions, we solve for the debtor's default decision and update its value function. We continue the iterating process until the difference between value functions in consecutive iterations is smaller than the precision criterion. The algorithm is described in detail below.

2.4.1 Algorithm

Step 1. Discretize b, w, y and compute the corresponding consumption of the debtor at all the grid nodes. In different default states S_0, S_1, calculate the utility from consumption V_0^0, V_1^0. The initial value guess is the higher of the two $V^0 = \max\{V_0^0, V_1^0\}$.

Step 2. In default state S_1, solve for the creditor's optimal choice of tariff τ_1 and bond holding b_c. With τ_1, calculate the price level that clears the goods market and the resulting debtor's value function V_1^1.

Step 3. In repayment state S_0, guess an initial value of tariff τ_0^0 and calculate the corresponding price level.

Step 4. Given the creditor's choice, solve the debtor's problem to get the optimal borrowing in the next period b', with which to update the best responding bond holding b_c' and τ_0^1 by maximizing the value function of the creditor.

Step 5. Continue the iterating process until τ_0 converges, at which time compute the debtor's interpolated value function V_0^1.

Step 6. Compare the debtor's value function V_0^1, V_1^1, and find the maximum $V^1 = \max\{V_0^1, V_1^1\}$.

Step 7. Repeat Step 2 - Step 6, until value function converges, $|V^{i+1} - V^i| \leq \epsilon_v$.

2.4.2 Calibration

Parameters in the model are chosen in our best effort to match either stylized facts or classical literature on the topic. The coefficient of relative risk aversion σ is set to 2. Discount factor β is set to be relatively low as in *Aguiar and Gopinath* (2006) to speed up convergence of solution and to get a reasonable prediction of default occurrence. We set the elasticity of substitution between goods ρ to be 2 and the weight of domestic/partner's goods in consumption is $\theta_h = \theta_f = .3$ in the benchmark case. These two parameters are important in reflecting the relative significance of bilateral trade. We will do a numerical exercise by looking at value functions and default decisions when varying the values of ρ. Also following *Aguiar and Gopinath* (2006), we assume income in the debtor country follows an AR(1) process with coefficient of autocorrelation $\rho_y = .9$ and standard deviation 3.4%. The advantage of choosing the parameter values in a classic paper is that we can directly compare our results, and highlight the contribution our model — which is the trade channel — to the existing literature. To this end, we also temporarily set $b_c = 0$ and focus on bilateral lending. To start with, we assume the endowment of the creditor is twice that of the debtor $\bar{A} = log2$. The relative economy size also comes into play in affecting the creditor's willingness to adjust trade costs and forgive debt.

All the parameter values are summarized in Table 3.

Parameter	Description	Value
β	quarterly discount factor	0.80
σ	coefficient of relative risk aversion	2
r	international risk-free rate	0.01
λ	probability autarky ends	0.1
	Income process	
ρ_y	coefficient of autocorrelation in endowment of debtor	0.9
σ_y	standard deviation of endowment shocks of debtor	0.034
$\bar{y}$	average endowment level of debtor	.00058
$\bar{A}$	constant endowment level of creditor	$log2$
	In the benchmark case	
θ	weight of home/partner's goods in consumption	0.3
ρ	elasticity of substitution between goods	0.75

Table 2.3: Parametrization

Variable	Description	AG's result	Our result
$std(c)$	consumption volatility	4.37	4.03
$std(tb/y)$	trade-balance volatility	.17	2.81
$corr(y, c)$	correlation between income and consumption	.99	.79
$corr(y, tb)$	correlation between income and trade-balance	-.33	-.10
$avg(b/y)$	average debt ratio	.27	.34
$d\%$	default probability	.02%	.48%

Table 2.4: Comparison across Models

2.4.3 Results

2.4.3.1 Comparison with Previous Work

We first compare the performance of our model with that of *Aguiar and Gopinath* (2006) (AG for short hereafter) in capturing the features of sovereign defaults. We use 150 simulation samples with 500 periods and report statistics in the Table 4. Among all the statistics, consumption volatility and average debt ratio are similar across models. Trade-balance volatility is much greater in my model, as the price adjusts based on the two countries' endowment as well as creditor's trade costs. The correlation between income and consumption turns out to be smaller in our model, partly due to the additional uncertainty from changes in trade costs and goods' prices. Our trade balance is counter cyclical, but the value is greater than that in AG since creditors adjust trade costs to boost debtors' exports. Lastly, both the debt level and default probability are much higher in our model. It implies that trade benefits encourage debtors to take on more debt than what they can afford to repay.

2.4.3.2 Trade Costs

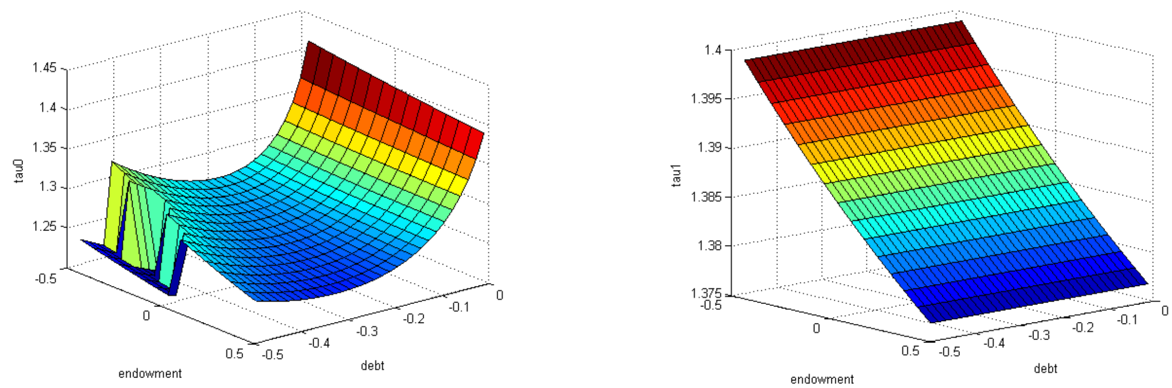
In this part, we evaluate the adjustments in trade costs. The following two graphs present the changes in τ in the two default states S_0 and S_1 given different combinations of endowment y and debt b.

It is easy to spot the monotonic relationship between τ_1 and y. When there is no outstanding debt in S_1, a debtor's price of exports negatively comoves with its endowment. As the elasticity of substitution between goods is below unity in the baseline case, the price adjusts in the same direction as the tariff revenue. Thus it is in the creditor's interest to set a high trade cost when the debtor's endowment is low. Moreover, the optimal tariff in the default state is independent of initial debt b as the tariff does not affect repayment probability.

In S_0 with outstanding debt (which corresponds to the debt renegotiation stage in data), the optimal tariff not only covaries with the debtor's endowment but also the debtor's amount of outstanding debt. For a relatively low level of debt, when we control for b, we find τ_0 decreases in the debtor's endowment y. This fact can be explained by the same reasoning as in the S_1 state: trade policies do not matter for the debtor's default decision because it is always in the debtor's interest to service the debt. Hence, the creditor chooses trade costs that will maximize its revenue. We also find in this region that controlling for the level of y, τ_0 first decreases and then increases in initial debt. This is largely due to the curvature of the interior solution to the goods market clearing condition. We find interesting jumps in optimal tariffs above a certain debt level. It is within this region that the debtor is on the brink of defaulting and has non-smooth choices of b'. The shape of the surface can be explained by the following reasons. When debt is high, the debtor has higher probability to default. To avoid the financial loss of sovereign defaults, the creditor is willing to sacrifice in the trade channel by choosing a lower value of τ. Hence, the solution to the optimal τ_0 plummets in the region. It is worth-noting that the creditor and the debtor are best responding to each other's choices. In expectation of lower τ in S_0, the debtor is also willing to take more debt than in an ordinary setting.

Next, let us compare side by side τ_0 and τ_1 by fixing the initial debt level to a high

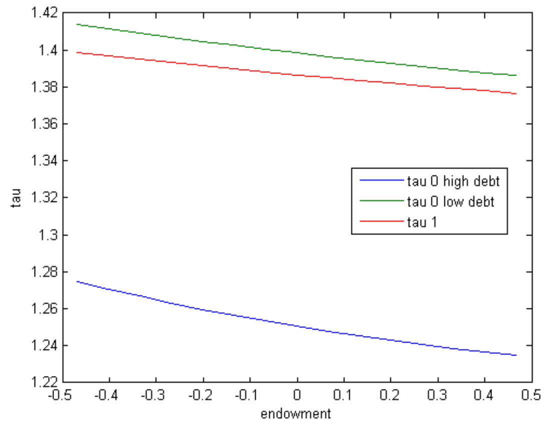
Figure 2.3: Optimal Trade Costs in S_0 and S_1



level and a low level.

In the case where initial debt is equal to zero, τ_0 and τ_1 are very close in value. τ_0 is slightly greater since the debtor is going to borrow from the creditor in the current period, the loss in wealth caused by lending is partially compensated by the increased tariff revenue. Once the level of debt goes up, τ_0 is going to be significantly lower than τ_1. This is consistent with the main empirically finding of the chapter: when the debtor is on the brink of defaulting, the creditor has the incentive to lower trade costs in order to increase the debtor's repayment probability.

Figure 2.4: τ under Different Endowment



2.5 Conclusion

This chapter identifies the increase in bilateral trade shares between a creditor and a debtor when sovereign default happens. The finding runs contrary to the traditional trade sanction theory. We build a model which incorporates the trade channel in a sovereign debt problem to account for the phenomenon. The model builds on the strategic interaction between the creditor and the debtor. By solving the model numerically, we are able to capture counter-cyclical trade balance and high default probability that are closer to data than other models.

We consider extending our model in the following ways so that it reflects reality better. First, we can build a production-economy model instead of endowment-economy model. Many debtors are in need of developed countries' support for capital goods and investment. By introducing two sectors (consumption goods and capital goods) into the model, the two countries will be more dependent on each other. Second, we consider introducing a partial default state into the model to reflect the renegotiation stage in sovereign defaults better. The equilibrium will feature financial haircut, grace period and dynamics in trade simultaneously. But the extension does come at the cost of a higher level of computation complexity. Lastly, we can relax the assumption of constant creditors' income, and study the creditors' incentives in different economic conditions. To sum up, there is much interesting interaction between the trade channel and the borrowing channel. We hope future research will explore the mechanisms in depth so that we can have a better understanding of sovereign defaults.

CHAPTER III

Does Debt Structure Matter? Financial Constraints and Trade Revisited

This chapter introduces heterogeneous debt structure across firms into the Melitz trade model to examine the impact of financial constraints on trade patterns. Small firms rely heavily on bank loans while big firms have access to corporate bonds. I model this as a nonlinear financial constraint, which places disproportional burden on small firms, which further limits their production and ability to export. Theoretically, I build a model that combines financial markets with two types of debt contracts (bank loans and corporate debt) and Melitz's trade framework. These types of debt contracts feature different flotation costs, monitoring costs, and flexibility in debt restructuring. Empirically, I find that the extensive margin effects become more pronounced when we evaluate the impact of both types of debt on trade.

3.1 Introduction

Trade economists have recently been interested in combining lessons from corporate finance theory and international trade models to illustrate the impact of financial resources on global production and exporting patterns. In particular, *Manova* (2013) builds a heterogeneous-firm trade model with financial markets. Using it, she provides an empirical paradigm to quantitatively identify the mechanisms through which financial constraints impede trade.

Previous work in this literature abstracts from heterogeneous debt structures across firms, which are potentially important in order to understand the allocation of financial resources among firms of heterogeneous productivity. Incorporating this feature is particularly important if we hope to separate the extensive margin (the selection of firms into exporting) and intensive margin (firm-level reduction in trade volume) effects in a Melitz-type heterogeneous-firm model. This chapter addresses this gap in the literature by providing both empirical and theoretical analyses.

I introduce heterogeneous debt structure into the model to recognize the fact that larger productive firms have access to corporate bond markets, while smaller firms mostly rely on bank loans as their main source of financing. This nonlinear credit constraint over the firm size distribution suggests a disproportional financial burden on small firms, which further limits their ability to produce and export when competing with big firms. Consequently, the extensive margin effect will be more pronounced in my model compared to Manova's (2013) case, where linear financial constraints are assumed. Taking corporate bonds into consideration is essential also for realism, since bond markets have become an important form of external financing for exporting giants, which include both OECD countries and emerging markets like Brazil, China, and Russia.[1]

Empirically, I extend Manova's (2013) work by including not only bank credit but also corporate bonds as sources of financial capital that firms use to fund their production and exports. Using the cross-country data of *Beck et al.* (1999) on financial structure and development, I sum bank loans and corporate bonds as shares of GDP to reflect a country's overall abundance of external financing resources. Using new measure, I follow Manova's (2013) empirical strategy to examine how financial constraints distort trade. Since a country's financial conditions disrupt trade differentially across sectors depending

[1]See table 1 for descriptive data.

on sectors' financial vulnerability, the method that exploits the variation in financial development across countries and the variation in financing needs across sectors allows me to establish causality. Employing this identification strategy, I can decompose the effects of credit constraints into three channels: (i) reductions in output; (ii) the selection of firms into exporting; and (iii) the firm level reduction in trade volume.

When I compare my case with total corporate debt as the independent variable to Manova's (2013) case where the only source of financing is bank credit, I have the following findings: First, reductions in output drive less impact. Second, the extensive margin of trade is more important in my model. For the first result, I find that reductions in output (or channel (i)) plays a less important role if we consider not only bank loans but also corporate bonds. To understand this phenomenon, I contend that big firms are the main issuers of corporate bonds and the major players in export markets. Hence, offering a country additional bond issuance opportunities will predominantly affect trade above and beyond domestic production. Thus, channel (i) is less significant than in the case with bank loans alone. For the second result, I find that the selection of firms into exporting (or channel (ii)) plays a more important role if we take corporate bonds into consideration. To interpret this fact, I reason that small-to-medium sized firms on the brink of exporting would have benefitted more from bond issuance, but limited productivity and capacity prevented them from overcoming the floatation costs in the bond market. Hence, the extensive margin effect, that is, the selection of firms into exporting, becomes more pronounced.

Motivated by these empirical findings, I build a theoretical model that incorporates two types of debt contracts (bank loans and corporate debt) into the Melitz trade framework. The debt contracts feature different flotation costs, monitoring costs and flexibility in debt restructuring. In the model, heterogeneous firms choose optimal capital structures to maximize their profits from production and export. Given the analytic results, I find that the flotation costs in the bond market make bonds a scarce financial resource, which will contract a country's exports through both extensive and intensive margins. Compared to bank loans, corporate bonds exert more extensive-margin than intensive-margin effects, because big productive firms can overcome the flotation costs to benefit from bond issuance. These modeling results match my empirical observations.

This chapter contributes to the small but growing literature on the intersection of trade and finance. *Foley and Manova* (2014) summarize the literature that brings together international trade and corporate finance. Besides the pioneering work of *Manova* (2013), *Feenstra et al.* (2014) introduce asymmetric information about firms' productivity and exporting status between creditors and entrepreneurs. In another study, *Chaney* (2013) breaks the link between firms' productivity and liquidity, which leads to different results than Manova's (2013). Nevertheless, none of these previous projects focuses on firm-level heterogeneous debt structures, with *Russ and Valderrama* (2012) being an exception. *Russ and Valderrama* (2012) assesses the impact of financial development on aggregate productivity by studying the allocation of production between small and big firms in a closed economy. My work departs from theirs by focusing on how limited financial resources shape trade patterns. My model also admits richer features of the debt market, influenced by work in corporate finance including *Crouzet* (2014), *Bolton and Freixas* (2000), and *Rajan* (1992).

The remainder of the chapter proceeds as follows: Section 2 presents the empirical findings. Section 3 describes and solves the model. Section 4 concludes.

3.2 Empirical Analysis

In this part, I empirically examine the effect of various financial resources on trade. Productive firms of greater size can tap into the corporate bond market while small firms have to mainly rely on bank loans. This distinction between big and small firms is important to quantify the mechanisms through which financial constraints impede trade. The empirical analysis corroborates this argument. The results are significantly different from those in *Manova* (2013), where bank loans are considered as the only form of external financing.

Manova (2013) provides a framework to examine the effect of credit constraints on trade. She introduces financial frictions into a heterogeneous-firm model, and tests the model implications using aggregate trade data from a large panel of countries and sectors. Nevertheless, she does not distinguish different forms of external financing and hence abstracts from heterogeneous debt structures across firms, which is potentially important in accurately identifying extensive and intensive margin effects in a heterogeneous-firm model. I apply and extend her analysis by taking both bank loans and market bonds into account.

In the spirit of *Manova* (2013), I establish causality by exploiting the variation in financial vulnerability across sectors and the variation in financial development across countries. This method is based on the idea that a country's financial conditions disrupt trade differentially across sectors depending on sectors' financial vulnerability. Since differentials correct for systematic biases at sectoral levels, this method avoids the potential pitfall of reverse causality and omitted variables.

To ensure consistency when making comparison, I choose the same data sources and definitions as *Manova* (2013) for the empirical analysis. For instance, a sector's dependence on external finance is measured as the share of capital expenditures not financed with cash flows from operations, which is calculated with the median company's data from Compustat (US). Using the same dataset, one can calculate sectors' asset tangibility measured by the share of net property, plant and equipment in total book-value assets. In terms of countries' financial development, I obtain the ratio of private bond market capitalization to GDP from *Beck et al.* (1999), who also provide information on bank credit, which is used in Manova's (2013) paper. Data on bilateral trade flows for 107 countries and 27 sectors in 1985-1995 at the 4-digit SITC Rev.2 sectoral level are obtained from

Feenstra's World Trade Database. UNIDO provides information on output and number of establishments by sector. The sources for other variables including GDP, distance, factor endowment and institutional features are described in Section 5 of *Manova* (2013).

Table C summarizes the amount of financial resources as shares of GDP in 149 countries. From the table, we find that bank credit is a more important source of external financing than corporate bonds on average across all the countries. The ratio of bank loans to GDP is .32 times on average while that of corporate bonds is merely .06. The correlation between the two measures, .54, is relatively high, meaning a country with abundant bank credit also tends to issue more bonds. Only 37 countries have active corporate bond markets; while most of them are OECD countries, we do find emerging markets on the list as well. Nevertheless, most firms in developing countries do not use corporate bonds and their only source of corporate debt financing is bank credit.

Manova (2013) uses credit by banks and other financial intermediaries to the private sector to measure a country's financial development. I will instead use the sum of bank loans and private bond market capitalization (labeled total debt in the table) in the regressions, and compare the results with those in *Manova* (2013). I expect the results to be significantly different than those in the case with bank loans only, since corporate bonds are important sources of external financing for not only most developed countries but also emerging markets including Brazil, China, and Russia. I prefer total debt to corporate bonds as the independent variable since firms may have country- or sector-specific strategic concerns when choosing their corporate debt structures. For this reason, the total amount of debt is a less ambiguous measure of financial resource availability.

There are three channels through which financial market imperfections affect trade: (i) the reduction in domestic production (ii) the selection of firms into exporting and (iii) the firm level reduction in trade volume. To disentangle (i) from others, we run the following two regressions:

$$ln(T_{ijst}) = \beta_0 + \beta_1 X_{jt} + \beta_2 X_{jt} \times FinDep_{st} + \beta_3 X_{jt} \times Tang_{st}$$

$$+ \beta_4 ln(GDP_{it}) + \beta_5 ln(GDP_{jt}) + \beta_6 ln(Dist_{ij}) + \beta_7 P_{ist} + FE + \epsilon_{ijst} \tag{3.1}$$

$$ln(T_{ijst}) = \beta_0 + \beta_1 X_{jt} + \beta_2 X_{jt} \times FinDep_{st} + \beta_3 X_{jt} \times Tang_{st} + \beta_4 ln(Estb_{jst})$$

$$+ \beta_5 ln(GDP_{it}) + \beta_6 ln(GDP_{jt}) + \beta_7 ln(Dist_{ij}) + \beta_8 P_{ist} + FE + \epsilon_{ijst} \tag{3.2}$$

where T_{ijst} is the bilateral trade volume from country j to country i in sector s at time t. X_{jt} is the exporting country's level of financial development, which is measured either as bank loans or total debt (the sum of bank loans and private bond market capitalization), both are measured as shares in GDP. $FinDep_s$ and $Tang_s$ are the dependence on external finance and tangibility of sector s. GDP_i and GDP_j are importer's and exporter's GDPs while $Dist_{ij}$ is the distance between the two countries. $Estb_{js}$ is the number of establishments, controlling for which we can disentangle the effect of financial constraints on trade from that on overall production. Moreover, we need to add P_{ist} — importer's price level in sector s— proxied by the country's CPI and its interaction with sector fixed effects. FE captures various configurations of fixed effects including exporter, importer, year and sector fixed effects. Lastly, all the standard errors are clustered at country pairs. Table 3.2 reports the coefficients of regression (1) and (2) where financial development is measured by the availability of bank loans and total debt respectively.

The first two columns in Table 3.2 report the effect of bank loans on trade before and after controlling for the selection into domestic production. In both columns, the regressor 'bank loans' by itself has a positive effect on sectoral trade volumes. But in this difference-in-difference approach, the coefficients on the interactions of a country's

Table 3.1: Financial Constraints Trade vs. Production

Fin Devt Def as	Bank Loans		Total Debt	
	Total Effect	Controlling for Domestic Production	Total Effect	Controlling for Domestic Production
Fin Devt	0.167	0.225	0.181	0.044
	(6.23) ***	(3.64) ***	(5.21) ***	(1.04)
Fin Devt × Fin Dep	1.752	1.343	1.352	1.080
	(113.80) ***	(29.01) ***	(44.51) ***	(29.57) ***
	[0.134]	[0.102]	[0.120]	[0.096]
Fin Devt × Tang	-2.624	-2.204	-2.015	-1.689
	(-65.48) ***	(-16.64) ***	(-25.38) ***	(-16.32) ***
(log) Num Establish		0.321		0.318
		(39.89) ***		(39.42) ***
p_{is}		0.008		0.008
		(6.86) ***		(7.02) ***
LGDPE	0.957	1.071	0.938	1.053
	(36.96) ***	(16.05) ***	(16.32) ***	(15.69) ***
LGDPI	0.949	1.040	0.953	1.045
	(41.38) ***	(16.36) ***	(16.56) ***	(16.38) ***
LDIST	-1.374	-1.418	-1.374	-1.418
	(-489.30) ***	(-70.27) ***	(-79.03) ***	(-70.29) ***
R-squared	0.57	0.58	0.57	0.58
Num observations	861380	579485	861,380	579,485

Note: T-statistics in parentheses and standardized coefficients in brackets. ***significant at 1%, **significant at 5%, *significant at 10%. The dependent variable is bilateral trade at the sectoral level. The independent variables include exporter's financial development, its interaction with sectoral dependence on external finance and tangibility, importer's and exporter's GDPs, the distance between the two countries, the number of establishments in a sector, importer's CPI and its interaction with sector fixed effects, fixed effects including exporter, importer, year and sector effects. All the standard errors are clustered at country pairs. The table reports coefficients in the cases before and after controlling for domestic production.

financial development and a sector's financial vulnerability are of greater importance to quantify causality. Since the coefficients on Fin devt × Fin Dep are positive, we can establish that financial constraints interfere with trade activity, and this effect is more pronounced in sectors with greater dependence on external finance. For instance, given a sector's financing need, if a country's financial development measured by the ratio of bank credit to GDP increases by 1 standard deviation, sectoral trade will increase by .134 standard deviations. If instead financial development is proxied by the ratio of total debt to GDP, sectoral trade will increase by .12 standard deviations. Moreover, the coefficients in the regressions enables us to isolate the effect of financial constraints on exports. After conditioning on the number of establishments and the importers' sectoral price, we find the coefficient on Fin devt × Fin Dep falls from 1.752 in Column 1 to 1.343 in column 2. This result indicates that $1 - 1.343/1.752 = 23.34\%$ of the impact of limited bank loans on trade is driven by the reduction in output. The second two columns report the effect of total debt. The signs of coefficients are the same as those in the first two columns with bank loans as the explanatory variable, meaning including corporate debt does not alter the direction in which financial resources influence trade. When we divide the coefficients of Fin devt × Fin Dep in these two columns, we find that 17.29% of the impact of limited corporate debt on trade is driven by reductions in total output. This number is smaller than that in the case of bank loans (23.34%), which is consistent with our hypothesis: since big productive firms are the main issuers of corporate bonds as well as the major players in export markets, increasing their bond issuance opportunities will mainly help them in increasing the trade volumes. On the other hand, small firms are more focused on domestic production and heavily reliant on bank loans. So an additional unit of bank loans will exert greater effect on domestic production than on trade compared to the case of total corporate debt.

In the next step, I further decompose the effect of financial market imperfections on trade into (ii) extensive margin effects (selection of firms into exporting) and (iii) inten-

Table 3.2: Financial Constraints Extensive Margin vs. Intensive Margin

Fin Devt Def as	Bank Loans		Total Debt	
	OLS	Ctrl for Selection into Exporting	OLS	Ctrl for Selection into Exporting
Fin Devt	-0.019	0.578	-0.109	0.011
	(-0.24)	(0.71)	(-2.00) **	(0.18)
Fin Devt × Fin Dep	1.101	0.209	0.932	0.220
	(15.38) ***	(1.46)	(18.29) ***	(1.93) *
	[0.084]	[0.016]	[0.083]	[0.020]
Fin Devt × Tang	-1.334	-0.649	-1.405	-0.816
	(-6.64) ***	(-2.83) ***	(-10.50) ***	(-4.87) ***
(log) Num Establish	0.314	0.305	0.310	0.303
	(33.00) ***	(31.54) ***	(32.85) ***	(31.38) ***
z_{ijs}		1.086		1.087
		(5.99) ***		(6.01) ***
z_{ijs}^2		0.102		0.105
		(3.80) ***		(3.94) ***
z_{ijs}^3		-0.022		-0.022
		(-10.81) ***		(-11.14) ***
η_{ijs}		1.397		1.385
		(6.40) ***		(6.37) ***
LDIST	-1.427	-0.619	-1.428	-0.611
	(-57.95) ***	(-4.56) ***	(-58.05) ***	(-4.50) ***
R-squared	0.60	0.62	0.60	0.62
Num observations	428444	398726	428,444	398,726

Note: T-statistics in parentheses and standardized coefficients in brackets. ***significant at 1%, **significant at 5%, *significant at 10%. The dependent variable is bilateral trade at the sectoral level. The independent variables include exporter's financial development, its interaction with sectoral dependence on external finance and tangibility, importer's and exporter's GDPs, the distance between the two countries, the number of establishments in a sector, importer's CPI and its interaction with sector fixed effects, fixed effects including exporter, importer, year and sector effects, and lastly the polynomials of probability as well as the inverse Mills ratio in the first-step Probit model. All the standard errors are clustered at country pairs. The table reports coefficients in the cases before and after controlling for selection into export.

sive margin effects (firm level reduction in trade volume). First, I use a Probit model to study the effects of financial resources on the existence of bilateral trade in a particular sector:

$$ln(D_{ijst}) = \beta_0 + \beta_1 X_{jt} + \beta_2 X_{jt} \times FinDep_{st} + \beta_3 X_{jt} \times Tang_{st}$$

$$+\beta_4 ln(GDP_{it}) + \beta_5 ln(GDP_{jt}) + \beta_6 ln(Dist_{ij}) + \beta_7 P_{ist} + Costs_{ij} + FE + OtherVar_{ijt} + \epsilon_{ijst} \tag{3.3}$$

where D_{ist} is a dummy variable which takes the value of one if country j exports to i in sector s at time t. $Costs_{ij}$ are various measures of bilateral trade entry costs *Manova* (2013) considers including the number of days, the number of procedures, and the monetary cost to an entrepreneur of legally starting a business (normalized by GDP per capita); $OtherVar_{ijt}$ are factor endowments, institutions, GDP per capita, and their interactions. All the other independent variables are the same as those in Equation 1 and 2.

After running the Probit model and getting the predicted probability of exporting $\hat{\rho}_{ijst}$, we calculate the latent variable $\hat{z}_{ijst} = \Phi^{-1}(\hat{\rho}_{ijst})$ and the inverse Mills ratio $\hat{\eta}_{ijs} = \phi(\hat{z}_{ijs})/\Phi(\hat{z}_{ijs})$. The inverse Mills ratio is used for Heckman correction for unobserved heterogeneity. Moreover, I follow *Manova* (2013) in including a cubic polynomial of $\hat{z}_{ijst}$ to control for selection when isolating the effect on firm level trade volume. The second-step regression is

$$ln(T_{ijst}) = \beta_0 + \beta_1 X_{jt} + \beta_2 X_{jt} \times FinDep_{st} + \beta_3 X_{jt} \times Tang_{st}$$

$$+\beta_4 ln(GDP_{it}) + \beta_5 ln(GDP_{jt}) + \beta_6 ln(Dist_{ij}) + \beta_7 P_{ist} + \beta_8 \eta_{ijst}$$

$$+\sum_{k=1}^{3} \beta_{k+8} z_{ijst}^{k} + Costs_{ij} + FE + OtherVar_{ijt} + \epsilon_{ijst} \tag{3.4}$$

Table 3.2 presents the regression results. Column 1 and 3 list the coefficient estimates without the correction for selection effects, while Column 2 and 4 represent the case where we control for selection by including $\hat{z}_{ijst}$ and its polynomials as well as $\hat{\eta}_{ijs}$ as independent variables. Comparing the first two columns with the second two, we find bank loans and total debt show the same coefficient signs of coefficient estimates for the interaction terms, indicating that they play similar roles: the availability of external financing increases exports, especially in the sectors with greater financial dependence and less tangibility.

If we divide the coefficient of Fin devt $\times$ Fin Dep when we control for selection by that in the OLS case, we can disentangle extensive-margin from overall effects. In the case of bank loans, we find $.209/1.101 = 18.96\%$ of the effect of financial constraints on trade lies in firms' limited entry into exporting[2], while the other 81.04% reflects reductions in firm-level exports. In the case of total corporate debt, 23.63% is limited entry and 76.37% is contractions in firm-level exports. Consequently, we can conclude that extensive margin effects are stronger when we take heterogeneous debt structures into consideration. To elucidate this result, I reason that small firms' limited capacity prohibits them from gaining access to corporate bonds. This limited financing in turn exacerbates their disadvantage when competing with big firms in gaining momentum to export. In other words, heterogeneous debt structures place disproportional financial burdens on small firms, which further limits their ability to export. This accounts for why extensive margin effects are more pronounced in the case with multiple debt instruments.

To conclude, Table 3.2 summarizes the results in this section. There are two major findings in the empirical analysis if we consider corporate bonds in addition to bank loans when examining the effect of financial market imperfections on trade. First, reductions in output drive less impact. Second, more of the effect lies in the extensive margin of trade relative to the intensive margin. These new empirical findings call for a theoretical model that embeds corporate debt choices in the Melitz trade model, which I turn to in the next section.

[2] The number is smaller than that in *Manova* (2013)'s paper, since our independent variables in the regressions can be slightly different. She unfortunately does not specify and report the OLS regression in the paper, which makes replication a bit difficult.

Table 3.3: Decomposing Channels Financial Constraints Affect Trade (in %)

	Bank Loans	Total Debt
Reduction in production	23.34	17.29
Selection of firms into exporting	14.53	19.54
Firm level reduction in trade volume	62.13	63.17

3.3 Model

The purpose of this model is to capture heterogeneous debt structures across firms: small firms heavily rely on bank loans while big firms have access to corporate bonds. I use the Melitz model to argue that financial constraints place disproportional burden on small firms, which further limits their production and exports. Consequently, the extensive margin of trade becomes more important relative to the intensive margin when we add heterogeneous debt structures into the analysis of how financial constraints impede trade.

The setup of the model is as follows. Households in country i have Cobb-Douglas utility over their consumption in different sectors $U_i = \Pi_k Q_{ik}^{\theta_k}$ with sectoral weights $\theta_k \in (0,1)$ and $\sum_k \theta_k = 1$. In each sector k, consumption composite Q_{ik} is a CES bundle of different varieties $q_{ik}(\omega)$ with elasticity of substitution ϵ

$$Q_{ik} = [\int_0^1 q_{ik}(\omega)^{\frac{\epsilon-1}{\epsilon}} d(\omega)]^{\frac{\epsilon}{\epsilon-1}}$$

Under the CES specification, country i's expenditure on product ω is a function of its total expenditure X_i:

$$x_{ik}(\omega) = X_i \theta_k (\frac{p_{ik}(\omega)}{P_{ik}})^{1-\epsilon}$$

where P_{ik} is the sectoral price $P_{ik} = [\int_0^1 p_{ik}(\omega)^{1-\epsilon} \mu(\omega) dj]^{\frac{1}{1-\epsilon}}$.

Productivity $1/a_{ik}(\omega)$ is drawn after a firm pays sunk cost $f_E c_{is}$ from a distribution

$F(a)$ with lower and upper bounds $[1/a_H, 1/a_L]$. The firm sets its price $p_{ik}(\omega)$ and quantity $q_{ik}(\omega)$ given cost $c_{ik}(\omega)$ and productivity $1/a_{ik}$ to maximize its profit. Let its revenue in market $x \in \{d, f\}$ (d for domestic and f for foreign) be $\pi_{ikx}(\omega) = p_{ikx}(\omega)\ q_{ikx}(\omega) - \tau_x c_{ik}(\omega) a_{ik}(\omega) q_{ikx}(\omega)$. Its optimal price is given by

$$p_{ikx}(\omega) = \frac{\epsilon}{\epsilon - 1} \tau_x c_{ik}(\omega) a_{ik}(\omega)$$

where $\tau_x, x \in \{d, f\}$ denotes the iceberg trade cost, $\tau_d = 1, \tau_f = \tau > 1$. It is easy to see that a firm's revenue increases in its productivity: $\frac{\partial \pi_{ikx}(\omega)}{\partial 1/a_{ik}(\omega)} > 0$. In addition, the firm needs to fund fixed cost of entering a market $f_x, x \in \{d, f\}$ with both internal funding and external wealth through borrowing. Sectors are different in external financing needs, measured by t_k, which is the proportion of the cost covered by external borrowing of a sector.

There are two forms of external borrowing — bank loans and corporate bonds. They are different in three aspects. First, issuing corporate bonds entails higher flotation costs, reflecting greater transaction barriers such as legal fees and registration fees. Second, bank loans are flexible in the sense that banks can renegotiate terms with firms in case of financial distress. This feature helps explain the coexistence of the two debt contracts for big companies. Third, creditors' cost of holding bank loans is higher than that of holding corporate bonds because banks incur higher monitoring cost. This opportunity cost translates to the higher variable cost of bank loans compared to corporate bonds.

These modeling features are standard in the corporate finance literature. For instance, *Rajan* (1992) discusses the benefits and costs of bank financing in providing flexible financial arrangements. Meanwhile, *Diamond* (1991) examines and compares the monitoring decisions of different types of lenders. Lastly, empirical studies like *Denis and Mihov* (2003) and *Krishnaswami et al.* (1999) support the existence of flotation costs of public debt. I combine all these important distinctions between bank loans and market bonds when I set up the debt market.

In the model, there is an exogenous probability ρ for a firm to be in financial stress where it is forced to be fully or partially liquidated. If distress does not happen, the firm retains its revenue net of financial repayment

$$\max_{s} \ \pi_{ikx}(\omega) - m_{ikx}(\omega) - b_{ikx}(\omega) - G_i(s(\omega))t_k f_x c_{ik}(\omega)$$

s is the share of corporate bonds in external finance and $1-s$ is the share of bank loans. $G_i(s)$ captures the additional per-unit flotation costs of market bonds in country i. $G_i(0) = 0$ for $s = 0$, meaning the firm doesn't incur the cost if it does not use bonds. For $s > 0$, $G_i(s) = g_i + g(s)$. g_i is a constant positive number, reflecting the fixed cost of issuing bonds like registration fees in country i. $g(s)$ is assumed to be a continuously differentiable function that captures bonds' variable cost, whose second order derivative is positive $g''(s) > 0$; the convex function reflects diminishing returns to using corporate bonds.

If instead the firm liquidates when financial distress happens, the firm gets a share of the liquidation value $\chi L, \chi \in (0,1)$, with the rest going to the creditors based on their funding shares $(1-s)(1-\chi)L$ and $s(1-\chi)L$.[3] I further assume a firm's liquidation value is proportional to its revenue $L = \gamma\pi, \ \gamma \in (0,1)$.

Alternatively, firms can renegotiate their debt with creditors to avoid loss from full liquidation. Yet, corporate bonds are not flexible, so firms partially liquidate debt with bond holders, who get $s(1-\chi)L$. This in turn affects the final revenue of the firm: $\pi(\omega)$ falls to $\eta\pi(\omega), \eta \in (0,1)$. γ is smaller than η in value because full liquidation involves greater revenue loss. This assumption also ensures that the surplus from renegotiation is positive, regardless of the value of s. On the other hand, the debt contract between the

[3]Some other studies have different assumptions about priority structures for firms to allocate claims to multiple types of lenders during liquidation. For instance, *Rajan* (1992) and *Crouzet* (2014) discuss the case with bank debt seniority. Nevertheless, it is typically difficult to obtain closed-form solutions under such structures.

bank and the firm is renegotiated provided the surplus ϕ to both parties is positive. ϕ will be divided by the bargaining power μ and $1-\mu$, $\mu \in (0,1)$. The firm gets $\mu\phi$ from renegotiation and the bank gets $(1-\mu)\phi$, where ϕ takes the form of

$$\phi = \eta\pi - [\chi L + (1-s)(1-\chi)L] = [\eta + (s-1-s\chi)\gamma]\pi$$

Suppose lenders' per-unit opportunity cost is denoted as $r_i, i \in \{b, m\}$, which is exogenously pinned down by macroeconomic conditions and creditors' monitoring efforts. Due to the higher monitoring costs, banks charge a higher rate on their loans $r_b > r_m$. This modeling feature that there exists a wedge between the two debt rates is consistent with both empirical evidence and theoretical studies, including *Rauh and Sufi* (2010) and *Houston and James* (1996).

Based on the information above, we can write down the participation constraints of all the agents in the model. I assume both borrowers and lenders are risk neutral, and the supply of funds is perfectly competitive. Creditors' return should at least cover the opportunity cost of lending

$$\rho(1-\chi)sL + (1-\rho)m \geq stfc(1+r_m)$$

$$\rho[(1-\chi)(1-s)L + (1-\mu)\phi] + (1-\rho)b \geq (1-s)tfc(1+r_b)$$

Since the debt market is assumed to be perfectly competitive, the two participation constraints bind, allowing us to back out the expression of debt repayment

$$m = \frac{stfc(1+r_m) - \rho(1-\chi)sL}{1-\rho}, \qquad b = \frac{(1-s)tfc(1+r_b) - \rho(1-\chi)(1-s)L - \rho(1-\mu)\phi}{1-\rho}$$

Using this expression of debt repayment, we rewrite firm's problem as

$$\max_{s,p,q}(1-\rho)(\pi - m - b) + \rho(\chi L + \mu\phi) - G(s)tfc$$

For simplicity, I assume a firm's debt structure does not affect its variable production cost c in the baseline case. Given the firm's problem, the optimal value of s (denoted as s^*) satisfies

$$\pi\rho\gamma(1-\chi) + tfc(r_b - r_m) = g'(s^*)tfc$$

From this expression, we find s^* increases in a firm's revenue under its optimal price and quantity π. This finding suggests that big productive firms use more corporate bonds, which is consistent with empirical observation. Moreover, the expression yields the following comparative statics about s^*. s^* increases in the spread between r_b and r_m. When bank loans become relatively more expensive, firms are more likely to resort to corporate bonds, the cheaper source of funding. The higher flotation costs are overshadowed in importance by the variable cost spread. Second, s^* increases in γ. When the full liquidation value increases, firms' benefit from renegotiation decreases. As a result, firms are more tempted to use corporate bonds.

Next, we find the cutoff revenue for a firm to enter the domestic and foreign goods market. This cutoff will help us analyze the extensive versus intensive margin effects under heterogeneous debt structures across firms. As previously described, a financially-unconstrained firm's optimal price and quantity are

$$p_{ik}(\omega) = \frac{\epsilon}{\epsilon - 1}\tau_x c_{ik}(\omega)a_{ik}(\omega), \qquad q_{ik}(\omega) = \frac{x_{ik}}{P_{ik}^{1-\epsilon}}[\frac{\epsilon}{\epsilon - 1}\tau_x c_{ik}(\omega)a_{ik}(\omega)]^{-\epsilon}$$

The cutoff revenue of a firm to enter a market (denoted as $\bar{\pi}_x$) is found when we set a firm's revenue under its optimal price and quantity from either the domestic or foreign market equal to its cost:

$$(1-\rho)(\pi_x - m_x - b_x) + \rho(\chi L_x + \mu\phi_x) - G_i(s)t_k f_x c = 0$$

π, m, b are all subscripted $x \in \{d, f\}$, indicating debt repayments are different between domestic and exporting firms depending on their distinct revenues. Similarly, fixed costs to enter the domestic or foreign market are denoted as $f_x, x \in \{d, f\}$ with $f_d < f_f$.

Consequently, the company's revenue cutoff satisfies

$$\bar{\pi}_x = t_k f_x c \frac{G_i(s) + [1 + r_b + (r_m - r_b)s]}{1 - \rho + \eta\rho + \rho\gamma s(1 - \chi)}$$

Comparative static analysis provides some important insights. First, everything else equal, the higher fixed cost in the foreign market over that in the domestic market $f_f > f_d$ requires that the revenue of the cutoff exporting company should be higher than that of the cutoff domestic company ($\bar{\pi}_f > \bar{\pi}_d$), so the Melitz selection effect is observed. Second, the cutoff revenue increases in both production costs c and financial borrowing costs r_m, r_b. The higher the costs, the more earning is required for a firm to break even.

Another important implication of this result is that the cutoff revenue is higher for countries with greater flotation costs in the bond market: $\frac{\partial \bar{\pi}_x}{\partial G_i} > 0$. Since $G_i(s) = g_i + g(s)$, we also have $\frac{\partial \bar{\pi}_x}{\partial g_i} > 0$ if we assume $g(s)$ is common across countries. This result implies that if country i's flotation costs are greater than country j's for exogenous reasons like higher legal or registration fees (captured by higher g_i), we should expect to see stricter selection of firms into both production and exporting. Furthermore, $\frac{\partial^2 \bar{\pi}_x}{\partial g_i \partial t_k} > 0$ indicates that the selection effect is more pronounced in financially vulnerable sectors (i.e. sectors that require a higher share of external finance).

On the other hand, we find that the revenue cutoff increases in the spread between corporate bonds and bank loans: $\frac{\partial \bar{\pi}_x}{\partial (r_m - r_b)} > 0$, especially in sectors with greater external financing needs: $\frac{\partial^2 \bar{\pi}_x}{\partial (r_m - r_b) \partial t_k} > 0$. The intuition behind the result is that the benefit of using corporate bonds diminishes when the spread rises. With less affordable sources of financing, firms need to be more productive to start producing and exporting.

In the next step, I compare the result above to that in the case where bank loans are the only source of external financing. In this scenario, if firms liquidate when they are in financial distress, the firms' owners still gets χL while banks get $(1 - \chi)L$. Alternatively, firms can renegotiate with banks and split the new surplus $\psi = (\eta - \gamma)\pi$ with μ going to owners and $1 - \mu$ going to banks. Banks break even in equilibrium:

$$(1-\rho)b + \rho[(1-\chi)L + (1-\mu)\phi] = tfc(1+r_b)$$

Using this condition, we can back out the expression of bank repayment:

$$b = \frac{tfc(1+r_b) - \rho\pi[(1-\chi)\gamma + (1-\mu)(\eta-\gamma)]}{1-\rho}$$

If we plug this result into the zero profit condition, we obtain the cutoff revenue to enter a market

$$\tilde{\pi}_x = t_k f_x c \frac{1+r_b}{1-\rho+\eta\rho}$$

When we compare $\bar{\pi}_f$, the cutoff revenue to export in the case with two forms of debt, and $\tilde{\pi}_f$, the cutoff revenue in the case with bank loans alone, we find that $\tilde{\pi}_f > \bar{\pi}_f$ as long as g_i the flotation costs in country i are sufficiently big. In the case where $g_i > \frac{(1+r_b)\rho\gamma(1-\chi)}{1-\rho+\rho\eta} + (r_b - r_m)$, the bond market unambiguously exacerbates the selection of firms into exporting. This resonates with the empirical finding that extensive margin effects become more important in accounting for the impact of nonlinear credit constraints on trade.

So far, I have discussed cases under the assumption that a firm is big enough to issue corporate bonds ($m > 0$). I find that stricter access to the bond market in country i, in terms of higher flotation costs g_i, will deter firms from producing and exporting. A subsequent natural question to ask is what is the effect of g_i on small firms that do not use corporate bonds? A greater value of g_i will affect trade volumes by limiting the capacity of small firms who can potentially benefit from bond issuance. Limiting capacity involves both prohibiting firms from exporting (extensive margin effects) and lowering trade levels (intensive margin effects). Under this circumstance, firms may not be able to set their first-best prices and quantities as before, and their revenues become a function of their debt choices s. To quantify intensive margin effects, I define $\Delta\pi_f$ as the difference between export revenue with and without using bonds: $\Delta\pi_f \equiv \pi_f^{s^*} - \pi_f^{s=0}$. s^* is firms' optimal share of corporate bonds in their debt structure; it is the solution to $\pi_f \rho\gamma(1-\chi) + t_k f_f c(r_b - r_m) = g_i'(s) t_k f_f c$. Similarly, I also define $\Delta\phi_f \equiv \phi_f^{s^*} - \phi_f^{s=0}$ as the difference between net profit for firm owners with and without using bonds. Flotation costs g_i affect the intensive margin of trade by limiting the trade volumes of firms with $\Delta\pi_f > 0$ and $\Delta\phi_f < 0$. i.e. firms that would increase export revenues but were limited by flotation costs to tap into the bond market. The question boils down to a system of equalities

$$\pi_f^{s=0} < t_k f_f c \frac{g'(s^*) + (r_m - r_b)}{\rho\gamma(1-\chi)}$$

$$g_i > \{[1-\rho+\rho\eta+\rho\gamma(1-\chi)s^*]\pi_f^{s^*} - (1-\rho+\eta\rho)\pi_f^{s=0}\}\frac{1}{t_k f_f c} + s^*(r_b - r_m) - g(s^*)$$

Since productivity is drawn from a bound distribution, there exists a solution to the system of inequalities above as long as the flotation costs g_i are sufficiently big. In this case, credit constraints cause reductions in firms' level of exports. In other words, intensive margin effects exist.

Extensive margin effects are in the same spirit as the analysis above. Nonlinear financial constraints affect small firms who would start exporting if they were given the chance to use corporate bonds. These companies are characterized by $\pi_f^{s^*} > 0 > \pi_f^{s=0}$ and $\phi_f^{s^*} < 0$. Hence, as long as

$$\pi_f^{s=0} < 0, \qquad g'(s^*) > r_b - r_m$$

$$g_i > [1-\rho+\rho\eta+\rho\gamma(1-\chi)s^*]\pi_f^{s^*}\frac{1}{t_k f_f c} - s^*(1+r_m) - (1-s^*)(1+r_b) - g(s^*)$$

for some values of productivity $1/a \in [1/a_H, 1/a_L]$, we observe additional extensive margin effects on small firms due to their limited access to the bond market.

Given this analysis, we can conclude:

1) Flotation costs to enter the bond market make bonds a scarce financial resource, which will limit a country's trade volume through both extensive and intensive margins. The effect is more pronounced in sectors with greater external financing needs.

2) Compared to the case with bank loans alone, a mixed debt market with corporate bonds and bank credit exerts more extensive margin effects on trade.

3.4 Conclusion

This chapter introduces heterogeneous debt structures to the Melitz trade model and re-examines how financial constraints interrupt trade activity. I use and extend the cross-country cross-sector empirical analysis of *Manova* (2013) to quantify the mechanisms through which financial constraints impede trade. However, this country-level analysis is not the most direct way to capture the distinctions between small firms and big firms in terms of their debt structures and trade patterns. Future research with a focus on firm-level analysis will complement the findings in this chapter. *Foley and Manova* (2014) surveys some efforts in this direction, but more work needs to be done to examine whether and how big firms' access to bonds gives them additional advantages over small firms when competing for production and exports.

APPENDICES

APPENDIX A

Appendices for Chapter One

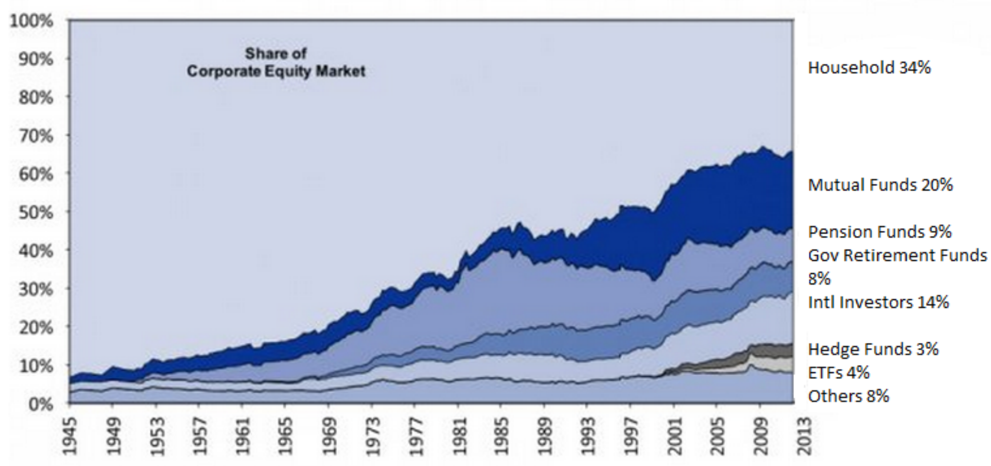
A.1 Tables and Charts

Table A1: Top Twenty U.S. Institutional Investors by Assets

Name	Equity Assets ($)	Location
The Vanguard Group, Inc.	1,607,502,939,834	PA
BlackRock Fund Advisors	1,216,454,636,413	CA
SSgA Funds Management, Inc.	1,000,113,734,436	MA
Fidelity Management & Research Co.	818,423,292,122	MA
T. Rowe Price Associates, Inc.	505,493,540,323	MD
Capital Research & Management Co.	458,524,984,616	CA
Wellington Management Co. LLP	410,550,019,151	MA
Capital Research & Management Co.	405,170,640,206	CA
Northern Trust Investments, Inc.	343,990,576,944	IL
Massachusetts Financial Services Co.	267,025,899,324	MA
JPMorgan Investment Management, Inc.	247,083,106,467	NY
Dimensional Fund Advisors LP	234,054,032,158	TX
BlackRock Advisors LLC	193,125,056,156	NY
Mellon Capital Management Corp.	191,980,125,222	CA
TIAA-CREF Investment Management LLC	187,726,247,974	NY
Geode Capital Management LLC	173,264,747,809	MA
Invesco Advisers, Inc.	170,566,991,974	GA
Columbia Management Investment Advisers LLC	155,105,284,565	MA
Dodge & Cox	153,491,210,142	CA
OppenheimerFunds, Inc.	147,243,417,222	NY

Note: This table lists the name, asset size and location of the top twenty US institutional investors as of 2014Q3. The data source is Factset/Lionshare.

Figure A1: Ownership of the US Corporate Equity Market



Note: This figure shows the historical trend for the ownership of the US equity market since WWII. The data source is Federal Reserve Board St. Louis. From the figure, institutional investors have replaced households as the main owner of the US equities.

Table A2: Correspondence between Factset and Datastream Industries

Factset Code	Description	ICB	Description
2405 2410	Foods: Major Diversified;	FOODS	Food Producers
2415	Foods: Specialty/Candy; Foods: Meat/Fish/Dairy		
2420 2425	Beverages: Non-Alcoholic; Beverages: Alcoholic	BEVES	Beverages
2430	Tobacco	TOBAC	Tobacco
2440	Apparel; Footware	CLTHG	Clothing & Accessories, Footwear
1130	Forest Products	FORST	Forestry
2230	Pulp & Paper	FSTPA	Paper
2100	Energy Minerals(gas and oil production, coal)	OILGP, COALM	Oil & Gas Producers
2205 2210	Chemicals: Major Diversified ;	CHMCL	Chemicals
2215	Chemicals: Specialty; Chemicals: Agricultural		
2305 2310	Pharmaceuticals: Major;	PHARM	Pharmaceuticals & Biotechnolog
2315	Pharmaceuticals: Other; Pharmaceuticals: Generic		
1105	Steel	STEEL	Iron & Steel
1115 1120	Aluminum; Precious Metals;	NOFMS	Nonferrous Metals
1125	Other Metals/Minerals		
1300	Electronic Technology	ELTNC	Electronics & Electric Equipement
1210	Industrial Machinery	IMACH	Industrial Machinery
1405	Motor Vehicles	AUTMB	Automobiles & Parts
1420	Home Furnishings	FURNS	Furnishings
4700	Utilities(Electric Utilities, Gas Distributors,	UTILS	Utilities
	Water Utilities, Alternative Power Generation)		
3115	Engineering & Construction	HVYCN	Heavy Construction
3500	Retail Trade	RTAIL	Retail
4615 4620	Trucking ; Railroads	TRUCK RAILS	Trucking ; Railroads
4625	Marine Shipping	MARIN	Marine Transportation
4610	Airlines	AIRLN	Airlines
3435 3440	Restaurants; Hotels/Resorts/Cruiselines	RESTS,HOTEL	Restaurants & Bars; Hotels
3420 3425	Publishing: Newspapers;	PUBLS	Publishing
	Publishing: Books/Magazines		
3405 3410	Broadcasting; Cable/Satellite TV;	BRDEN	Broadcasting & Entertainment
3415	Media Conglomerates		
4900	Telecommunications	TELCM	Telecommunications
4800	Finance	FINAN	Financials
4885	Real Estate Development	RLEST	Real Estate

Note: ICB stands for Dow Jones/FTSE's Industry Classification Benchmark. FactSet reports its own industry and sector classifications.

Table A3: Correspondence between My Industry Code and ISIC 4

Industry Name	My Code	ISIC 4
Food Producers	1	151, 153, 1520, 154
Beverages	2	155
Tobacco	3	1600
Clothing & Accessories, Footwear	4	1810, 1820
Forestry	5	202
Paper	6	210
Oil & Gas Producers,Coal	7	2310, 2320
Chemicals	8	241, 242
Pharmaceuticals	9	2423
Iron & Steel	10	2710
Nonferrous Metals	11	2720
Electronics & Electric Equipement	12	3110, 3190, 3210
Industrial Machinery	13	291, 292
Automobiles & Parts	14	3410, 3420, 3430
Furnishings	15	3610
Trucking ; Railroads	20	3520
Marine Transportation	21	351
Publishing	24	221

Note: ISIC Rev.4. stands for International Standard Industrial Classification of All Economic Activities, Rev.4.

Table A4: Sectoral Home Bias

sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
AU	0.46	0.69		0.86	0.31	0.63	0.93	0.59	0.67	0.93	0.92	0.25	0.28	0.31		0.63	0.83	0.88	0.78	0.91	0.69	0.95	0.26	0.93	0.63	0.65
BA	0.00	0.00		0.13			0.00	0.16	0.01	0.56		0.02	0.38	0.07		0.11	0.13		0.31			-0.01	0.01			0.10
BD																	0.28	0.02	0.08				0.99			0.91
BG	0.02	0.33		0.10				0.30	0.10		0.25	0.10	0.00			0.00	0.21	0.24	0.16		0.43		0.00	0.07	0.00	0.13
BR	0.68	0.72	0.98	0.98		1.00	0.55	0.81		0.87		0.79	0.85	0.88		0.76	0.72	0.45	0.61	0.99		0.33			0.15	0.42
CA	0.22	0.09	-0.01	0.40	0.90	0.05	0.82	0.64	0.10	0.04	0.72	0.23		0.58	0.42	0.37	0.60	0.36	0.28	0.87		0.26	0.19	0.23	0.39	0.54
CL	0.53	0.75	0.51	0.96	1.00	-0.06	0.00	0.49	0.95	0.54	0.80					0.73	0.88	0.69	0.90		1.00	0.98				0.77
CN	0.94	0.93	0.00	0.96	1.00	1.00	0.84	0.95	0.96	1.00	0.70	0.99	0.98	0.99	1.00	0.80	0.99	0.89	0.55	1.00	0.65	0.95	0.80	0.64	0.92	0.54
CZ	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00							-0.01	0.00	0.00	0.00		0.00		0.00		0.00	0.00
DK	-0.01	0.31		0.27				0.10	0.30			0.09	-0.03			0.00	0.42	0.00	0.16	0.34	0.50			0.13		0.13
ES	0.39	0.25				0.99	0.00	0.64	0.08	0.77	0.69	0.82	0.77	0.00		0.74	0.91	0.61	0.61		0.78	0.83		0.66		0.25
FN	0.61	0.32		0.63		0.16	0.02	0.31	0.31	-0.03	0.06	0.16	-0.06	0.34		0.35	0.75	0.40	0.70	0.20	-0.03	0.31	0.34	0.27	0.24	0.40
FR	0.03	0.00		0.18	0.04	-0.03	0.00	0.50	0.18	0.11	0.01	-0.01	0.23	0.66	-0.01	0.23	0.26	0.07	0.28	0.00		0.52		0.06	0.04	0.13
GR	0.15	-0.01	0.00	0.00			0.00	0.00	0.00	0.03	0.05		0.32			0.14	0.36	0.29	0.58			0.08	0.06	0.08	0.00	0.13
HK	0.34	0.01		0.19	-0.04	0.11	0.34	0.13	0.07	0.00	0.00	0.10	0.06	0.01	0.24	0.38	0.05	0.48	0.63		0.17	0.11	0.35	0.18	0.11	0.31
HN	0.00	0.61		0.06			0.00	0.58	0.22				0.00	0.00		0.26		0.00	0.16				0.59		0.00	0.36
IR	0.39	0.05					0.07		0.00						0.03		0.00	0.00	0.00			0.48	0.00	0.23		0.00
IS	0.60			0.91			0.81	0.94	0.46			0.82	0.84			0.86	0.98	0.64	0.90			0.72	0.50		0.44	0.57
IT	0.08	0.07		0.40		0.07	-0.03	0.02	0.01	-0.04	0.00	0.02	0.31	0.18	0.47	0.50	0.28	0.01	0.07	0.00	0.20	0.00	0.38	0.46	0.37	0.08
JP	0.53	0.32	0.14	0.45		0.57	0.09	0.60	0.34	0.65	0.20	0.40	0.78	0.77	0.20	0.35	0.87	0.44	0.77	0.69	0.94	0.39	0.23	-0.03	0.33	0.25
KO	-0.01	0.00	-0.02	0.00		0.00	-0.01	-0.02	0.00	-0.09	-0.01	-0.05	-0.04	-0.04	-0.01	-0.01	-0.06	-0.01	0.00		-0.03	-0.02	0.00		0.00	-0.02
KW	0.25						0.10	0.11				0.00					0.07	0.00	0.49			0.00	0.00			0.77
LX	0.00	0.00								-0.02		0.00				0.00		0.00	0.00			0.00			-0.03	0.00
MX		0.99	0.94	0.27	1.00	0.98	0.01	0.98		0.98		0.93	0.76	1.00		1.00	0.98	0.54	0.98		1.00	1.00	0.97	0.93	0.98	0.98

Note: This table lists the sectoral home bias index. The formula of the index is $HB_{i,s}$=1-Share of Sector s Foreign Equities in Country i Equity Holdings/Share of sector s Foreign Equities the World Market Portfolio. The data are from Factset/Lionshare and Datastream. The index covers 26 sectors from 43 countries. There are 834 observations in total, with mean 0.39 and std. dev. 0.36. The histogram is shown in Figure 1.2.2.

Table A5: Sectoral Home Bias (Continued)

sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
MY		0.98						0.94	0.86	0.45	0.95			-0.03		0.13	1.00	1.00	0.96			0.14	1.00		1.00	0.99
NL	0.18	0.14		0.00		0.03		0.11	0.00	-0.05		0.05	0.05	0.03	0.01		0.20	0.16	0.01		-0.02		0.00	0.61	0.00	0.08
NW	0.52	0.19		0.00	0.87	-0.01	0.19	0.63	0.03	0.31		0.10	0.17	0.00		0.80		0.60	0.66	0.00		0.82	0.51	0.00	0.73	0.82
NZ	0.05					0.31	0.01	0.13	0.00			0.01	-0.01		0.53	0.07	0.13	0.00	0.12		0.45	0.09		0.35		0.11
OE	0.17	-0.01					0.72		0.00		0.44	0.06				0.39		0.14	0.69			0.18	0.00		0.02	0.59
PH	0.95	0.86		0.92		1.00	0.92	0.92	0.62	0.88	0.99	0.55	0.95	0.91		0.73	0.98	0.90	0.82	0.92			0.98	0.95	0.68	0.96
PO	0.00	0.10				0.98	0.00	0.00	0.00	0.00		0.03		0.10		0.76	0.56	0.50	0.00		0.00		0.16	0.76	0.87	0.63
PT																0.00		0.00	1.00		1.00					0.94
QA	1.00	0.87		0.00		1.00	1.00	0.93	1.00	0.91		0.29	0.90	1.00		1.00	0.94	0.55	0.97				1.00			
RM	1.00						0.62	1.00	1.00	0.40	0.13		1.00	1.00		1.00	1.00	1.00	0.10		1.00	1.00				0.90
RS	0.06	-0.01		0.00			0.00	0.00	0.00	0.00	0.00	0.09	0.04		0.12	0.00	0.08	0.02	0.40		0.13	0.49	0.13	0.38	0.00	0.09
SA	0.51	0.74		0.00			0.00	0.75	0.93			0.00	0.00	0.18	0.00		0.12	0.79		0.66			0.57	0.00		0.52
SD	0.97	0.01				0.90	1.00	0.96	0.82	0.98		0.53			1.00	0.00	0.99	0.86	0.51		1.00			0.20	0.83	0.76
SG	0.34	0.32	-0.02	0.16	0.67	0.25	0.03	0.05	0.14	0.65	0.00	0.02	0.11	0.05		0.77	0.82	0.01	0.75			-0.01	0.56	0.08	0.49	0.51
SJ	0.08		0.43			0.47	0.18	0.00	0.08	0.57	0.19	0.54	0.91	0.04	0.60	0.00	0.77	0.69	0.61			0.29	0.11	0.00	0.53	0.45
SW	0.26			-0.17	0.57	0.11	0.00	0.24	0.17	0.02		0.03	0.20	0.05		-0.01	0.02	0.07	0.25		0.30	-0.01	0.00	0.03		0.04
TA	0.55			0.49			0.00	0.66		0.72		0.86	0.57	0.45				0.28	0.22		0.68	0.60				0.74
UAE	0.00	0.05							0.00							0.00	0.43		0.43			0.85	0.45			0.54
UK	0.26	0.34	0.52	0.27		0.21	0.14	0.20	0.46	0.01		0.08	0.32	0.12	0.19	0.44	0.41	0.41	0.28	0.03	0.12	0.17	0.61	0.62	0.28	0.50
US	0.76	0.67	0.76	0.81	0.77	0.75	0.82	0.73	0.62	0.47	0.29	0.81	0.61	0.47	0.92	0.81	0.65	0.79	-0.02	0.67	0.48	0.62	0.78	0.40	0.81	0.52
avg	0.35	0.33	0.32	0.34	0.65	0.44	0.28	0.45	0.31	0.41	0.35	0.29	0.39	0.36	0.36	0.40	0.52	0.38	0.44	0.52	0.48	0.41	0.38	0.34	0.37	0.44

Note: This table lists the sectoral home bias index. The formula of the index is $HB_{i,s}$=1-Share of Sector s Foreign Equities in Country i Equity Holdings/Share of sector s Foreign Equities the World Market Portfolio. The data are from Factset/Lionshare and Datastream. The index covers 26 sectors from 43 countries. There are 834 observations in total, with mean 0.39 and std. dev. 0.36. The histogram is shown in Figure 1.2.2.

Table A6: Country and Sector Codes

Country/Region	Code	Country/Region	Code	Sector	Code
Australia	AU	New Zealand	NZ	Food Producers	1
Austria	OE	Norway	NW	Beverages	2
Bahrain	BA	Philippines	PH	Tobacco	3
Belgium	BG	Poland	PO	Clothing & Accessories, Footwear	4
Brazil	BR	Portugal	PT	Forestry	5
Canada	CN	Qatar	QA	Paper	6
Chile	CL	Romania	RM	Oil & Gas Producers,Coal	7
China	CA	Russia	RS	Chemicals	8
Czech Republic	CZ	Singapore	SG	Pharmaceuticals	9
Denmark	DK	South Africa	SA	Iron & Steel	10
Finland	FN	Spain	ES	Nonferrous Metals	11
France	FR	Sweden	SD	Electronics & Electric Equipement	12
Germany	BD	Switzerland	SW	Industrial Machinery	13
Greece	GR	Taiwan	TA	Automobiles & Parts	14
Hong Kong	HK	U.A.E.	AE	Furnishings	15
Hungary	HN	United Kingdom	UK	Utilities	16
Ireland	IR	United States	US	Heavy Construction	17
Israel	IS			Retail	18
Italy	IT			Real Estate	19
Japan	JP			Trucking ; Railroads	20
Korea	KO			Marine Transportation	21
Kuwait	KW			Airlines	22
Luxembourg	LX			Restaurants & Bars; Hotels	23
Malaysia	MY			Publishing	24
Mexico	MX			Broadcasting & Entertainment	25
Netherlands	NL			Telecommunications	26

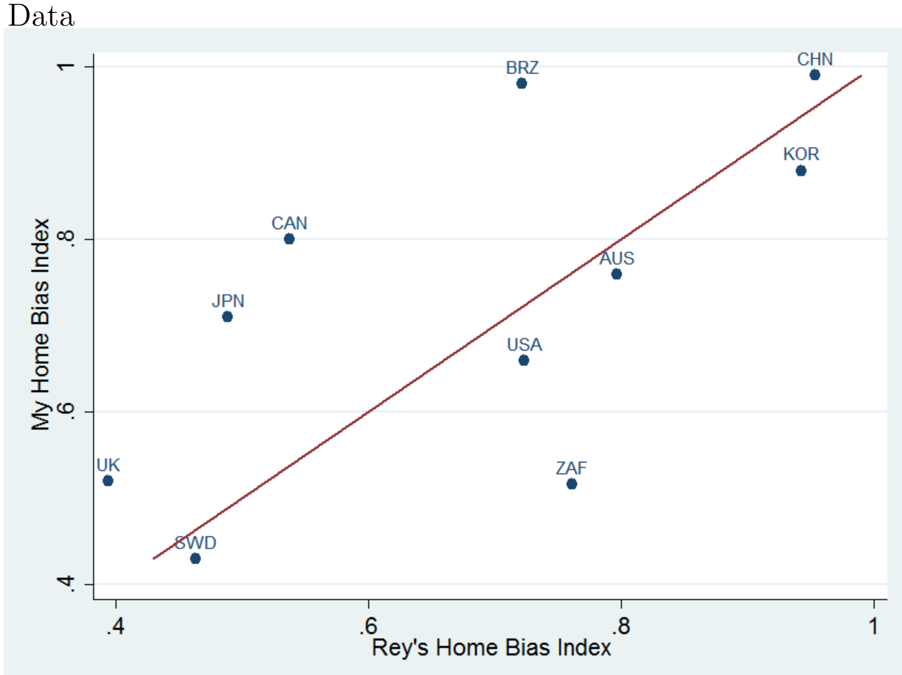
Note: This table defines the abbreviation of countries and sectors listed in Table A4.

Table A7: National Home Bias

Australia	0.797	France	0.362	Malaysia	0.984	Russia	0.958
Austria	0.099	Germany	0.209	Mexico	0.939	Singapore	0.124
Bahrain	0.927	Greece	0.354	Netherlands	0.096	Slovenia	0.818
Belgium	0.138	Hong Kong	0.184	New Zealand	0.658	South Africa	0.761
Brazil	0.722	Hungary	0.418	Norway	0.087	Spain	0.410
Canada	0.538	Ireland	0.319	Philippines	0.570	Sweden	0.463
Chile	0.747	Israel	0.896	Poland	0.939	Switzerland	0.158
China	0.954	Italy	0.272	Portugal	0.758	Taiwan	0.773
Czech	0.254	Japan	0.489	Qatar	0.459	United Arab Emirates	0.836
Denmark	0.144	Korea	0.943	Romania	0.998	United Kingdom	0.394
Finland	0.599	Kuwait	0.377			United States	0.724

Note: This table lists the national home bias index. The formula of the index is HB_i=1-Share of Foreign Equities in Country i Equity Holdings/Share of Foreign Equities the World Market Portfolio. The data are from Factset/Lionshare and Datastream.

Figure A7: Comparison of Home Bias Constructed with Factset/Lionshare Data and IFS Data



Note: This figure plots my national home bias index against that in *Coeurdacier and Rey* (2013). I use Factset/Lionshare data to construct the index while they use IFS data. Most of the points are close to the 45 degree line, so the two indices are consistent. Our datasets do cover different time periods, which may account for much of the discrepancy.

A.2 Empirical Robustness Checks

A.2.1 Clustering

In this section, I cluster standard errors at country and sector levels. This exercise is to control for the within-group correlations between observations. In Table A.2.1, we find the negative correlation between sectoral home bias and sectoral productivity still holds.

Table A8: Sectoral Home Bias and Sectoral Productivity

Dependent Variable: Sectoral Home Bias

Clustered at Country Level	(1)	(2)	(3)
TFP	-0.038 **	-0.037 **	-0.045 **
	(0.019)	(0.019)	(0.021)
constant	0.472 ***	0.441 ***	0.438 ***
	(0.115)	(0.111)	(0.107)
Country FE	No	Yes	No
Sector FE	No	No	Yes
Observations	350	350	350
Adj R^2	0.043	0.045	0.056
Clustered at Sector Level	**(1)**	**(2)**	**(3)**
TFP	-0.038 ***	-0.037 ***	-0.045 ***
	(0.008)	(0.009)	(0.009)
constant	0.472 ***	0.441 ***	0.438 ***
	(0.053)	(0.064)	(0.054)
Country FE	No	Yes	No
Sector FE	No	No	Yes
Observations	350	350	350
Adj R^2	0.043	0.045	0.056

Note: Robust standard errors in parentheses and standardized coefficients in brackets.***significant at 1%, **significant at 5%. The dependent variable is sectoral home bias. The independent variables are productivity in natural logs. Standard errors are clustered at country and sector levels.

A.2.2 Intermediate Imports and Outbound FDI

In this section, I do robustness checks by including intermediate imports and outbound foreign direct investment as independent variables in the regressions which test the relationship between sectoral home bias and sectoral productivity.

The data of sectoral intermediate imports are available in the OECD statistics library. The data of outbound foreign direct investment are available at the International Trade Centre. The regression results are listed in Table A.2.2.

Table A9: Sectoral Home Bias and Sectoral Productivity

Dep. Var: Sectoral HB	(1)	(2)	(3)
TFP	-0.038 ***	-0.038 ***	-0.040 ***
	(0.010)	(0.011)	(0.011)
intermediate imports	-0.004	-0.006	-0.007
	(0.007)	(0.007)	(0.008)
constant	0.521 ***	0.474 ***	0.542 ***
	(0.114)	(0.119)	(0.117)
Country FE	No	Yes	No
Sector FE	No	No	Yes
Observations	308	308	308
R^2	0.045	0.059	0.046
Dep. Var: Sectoral HB	(1)	(2)	(3)
TFP	-0.082 ***	-0.082 ***	-0.084 ***
	(0.021)	(0.020)	(0.022)
outbound FDI	0.003	0.000	0.003
	(0.014)	(0.014)	(0.014)
constant	0.697 ***	0.631 ***	0.684 ***
	(0.183)	(0.182)	(0.183)
Country FE	No	Yes	No
Sector FE	No	No	Yes
Observations	89	89	89
R^2	0.145	0.178	0.148

Note: Robust standard errors in parentheses and standardized coefficients in brackets.***significant at 1%. The dependent variable is sectoral home bias. The independent variables are productivity, imports of intermediate goods and outbound FDI, all in natural logs. The table reports coefficients in the ordinary least squares (OLS), country fixed effect, sector fixed effect and country-sector fixed effect models.

Sectoral home bias is negatively correlated with sectoral TFP in all the specifications. The coefficients of intermediate imports and outbound FDI are not significant, indicating that these two factors are not important drivers for sectoral home bias. My hypothesis that sectoral home bias is weaker in more productive sectors still holds.

A.3 Proofs

A.3.1 Model Log-linearization

In this section, I log-linearize the model around its steady state and evaluate the effect of sectoral productivity shocks on wages and exchange rates. The answer enables us to determine the equity portfolio by helping us understand the roles that different assets play in risk-hedging.

In the benchmark case, I assume the two countries are symmetric for simplification purposes. Not only do they have the same amount of labor, their within-country relative productivity and preference over goods are also symmetric. The assumptions make it easier to derive analytical solutions and allow us to concentrate on the main mechanism of the model. Many of the assumptions can be relaxed in extended models.

I assume the productivity levels in the steady state are

$$\bar{T}_{H,b} = \bar{T}_{F,a} = 1, \qquad \bar{T}_{H,a} = \bar{T}_{F,b} = T > 1$$

Since there is no trade cost, goods prices are the same across countries with the law of one price (LOOP). The price of sector a goods relative to sector b goods follows

$$s \equiv \frac{P_a}{P_b} = [\frac{T_{H,a}w_H^{-\theta} + T_{F,a}w_F^{-\theta}}{T_{H,b}w_H^{-\theta} + T_{F,b}w_F^{-\theta}}]^{-\frac{1}{\theta}} = [\frac{T_{H,a}w^{-\theta} + T_{F,a}}{T_{H,b}w^{-\theta} + T_{F,b}}]^{-\frac{1}{\theta}}$$

Given the CPI-based real exchange rate $e = \frac{P_H}{P_F}$, we can find the link between the fluctuation in the relative sectoral price s and the variation in the exchange rate e under the CES utility:

$$\hat{e} = (2\psi - 1)\hat{s}$$

where $\hat{x} = log\frac{x_t - \bar{x}}{x}$ is the log-deviation of a variable from its steady state.

Based on *Backus and Smith* (1993), the changes in the relative marginal utility across countries are proportional to the changes in the consumption-based real exchange rate as

$$-\sigma(\hat{C}_H - \hat{C}_F) = \hat{e}$$

Hence, the relative price-adjusted aggregate consumption $\frac{P_H C_H}{P_F C_F}$ follows

$$\hat{PC} = \hat{P} + \hat{C} = (1 - \frac{1}{\sigma})\hat{e} = (2\psi - 1)(1 - \frac{1}{\sigma})\hat{s}$$

Now let us focus on the the covariance between financial returns. In our model, asset returns of country i sector s at time t are equal to the sum of dividends and changes in the price of equities

$$r_{i,s,t} = \frac{q_{i,s,t} + d_{i,s,t}}{q_{i,s,t-1}}$$

Coeurdacier et al. (2010) and *Coeurdacier* (2009) show that a 'static' budget constraint condition is equivalent to a dynamic budget constraint condition (Equation1.1,1.2) up to a first order approximation. In the static budget constraint with no future variables, the prices of equities q disappear and the covariance between financial returns is solely dependent on the covariance between dividends.

Within a sector, the relative dividend at home versus abroad ($d_s = \frac{d_{H,s}}{d_{F,s}}, s \in \{a, b\}$) is equal to the relative market shares of the two countries in sector s.

$$\hat{d}_s = \hat{T}_s - \theta\hat{w}$$

Within a country, the relative dividend in sector a versus sector b ($d_i = \frac{d_{i,a}}{d_{i,b}}, i \in \{H, F\}$) becomes

$$\hat{d}_i = \hat{T}_i + [\theta - \phi + 1 + (2\psi - 1)^2(\phi - \frac{1}{\sigma})]\hat{s}$$

From the expressions, we find the covariances between dividends not only depend on productivity shifts themselves, but also on their impact on the relative wage and exchange rate.

Denote the difference between the productivity shocks of the two countries' productive sectors as $\hat{T}_1 \equiv \hat{T}_{H,a} - \hat{T}_{F,b}$ and that of the unproductive sectors as $\hat{T}_2 \equiv \hat{T}_{H,b} - \hat{T}_{F,a}$. With the Eaton-Kortum framework which links goods supply to labor cost, a pair of productivity shocks $(\hat{T}_1, \hat{T}_2)$ is uniquely mapped to a pair of wages and prices changes $(\hat{w}, \hat{s})$. The relative wage at home is equal to the relative price-adjusted aggregate production, thus

$$\hat{w} = \frac{1}{1+\theta}\{\frac{T-1}{T+1}[1 + \theta - \phi + (2\psi - 1)^2(\phi - \frac{1}{\sigma})]\hat{s} + \frac{T}{T+1}\hat{T}_1 + \frac{1}{T+1}\hat{T}_2$$

Moreover, the log-linearization of the relative price yields

$$\hat{s} = \frac{T-1}{T+1}\hat{w} + \frac{1}{\theta}\frac{1}{T+1}[-T\hat{T}_1 + \hat{T}_2]$$

Hence, sectoral productivity shocks affect relative labor income and real exchange rate with

$$\hat{s} = \{(T+1)^2(1+\theta) - (T-1)^2\lambda\}^{-1}\{[(T-1)T - \frac{\theta+1}{\theta}(T+1)T]\hat{T}_{H,a} + [T-1+\frac{\theta+1}{\theta}(T+1)]\hat{T}_{H,b}$$

$$+[(T-1)(-1) - \frac{\theta+1}{\theta}(T+1)]\hat{T}_{F,a} + [-(T-1)T + \frac{\theta+1}{\theta}(T+1)T]\hat{T}_{F,b}\}$$

$$\hat{w} = \{(T+1)^2(1+\theta) - (T-1)^2\lambda\}^{-1}\{[(T+1)T - \frac{\lambda}{\theta}(T-1)T]\hat{T}_{H,a} + [(T+1) - \frac{\lambda}{\theta}(T-1)(-1)]\hat{T}_{H,b}$$

$$+[(T+1)(-1) - \frac{\lambda}{\theta}(T-1)]\hat{T}_{F,a} + [(T+1)(-T) - \frac{\lambda}{\theta}(T-1)(-T)]\hat{T}_{F,b}\}$$

where $\lambda \equiv 1 + \theta - \phi + (2\psi - 1)^2(\phi - \frac{1}{\sigma})$.[1]

There are two parts in each of the coefficients. The first one denotes the direct effect of sectoral productivity shocks on s or w, and the second denotes the indirect effect induced by demand changes. For instance, the coefficient of $\hat{T}_{H,a}$ in $\hat{w}$ consists of $T(T+1)$ (direct

[1] Since the elasticity of substitution between tradable goods is above unity (Literature including *Levchenko and Zhang* (2011) set it equal to 2), $\lambda < \theta$ always holds.

effect) and $-\lambda\frac{T(T-1)}{\theta}$ (indirect effect). With the direct effect, the productivity boost raises the domestic income. With the indirect effect, domestic labor income decreases due to the lower price of exports. The overall influence of the shock depends on which effect dominates.

A.3.2 Proof of Proposition I.1

The difference between the two countries' budget constraints follows

$$\frac{1}{\alpha}\hat{PC} - \frac{1-\alpha}{\alpha}\hat{wL} = [\mu S_a - (1-\mu)(1-S_b)]\hat{d}_a + [(1-\mu)S_b - \mu(1-S_a)]\hat{d}_b + (2\mu-1)\hat{d}_F$$

$\chi(x_1, x_2)$ is the covariance between x_1 and x_2. $\chi^2(x)$ is the variance of variable x. I also denote the sum of the covariances of variable $\hat{x}$ with $\hat{d}_a, \hat{d}_a$ as $\sum\chi(\hat{x})$. When we take the covariance between $\hat{d}_s$ and all the other variables, we find

$$\begin{aligned}
\frac{1}{\alpha}(1-\frac{1}{\sigma})\chi(\hat{e},\hat{d}_a) - \frac{1-\alpha}{\alpha}\chi(\hat{wL},\hat{d}_a) &= [\mu S_a - (1-\mu)(1-S_b)]\chi^2(\hat{d}_a) \\
&+ [(1-\mu)S_b - \mu(1-S_a)]\chi(\hat{d}_b,\hat{d}_a) + (2\mu-1)\chi(\hat{d}_F,\hat{d}_a) \\
\frac{1}{\alpha}(1-\frac{1}{\sigma})\chi(\hat{e},\hat{d}_b) - \frac{1-\alpha}{\alpha}\chi(\hat{wL},\hat{d}_b) &= [\mu S_a - (1-\mu)(1-S_b)]\chi(\hat{d}_a,\hat{d}_b) \\
&+ [(1-\mu)S_b - \mu(1-S_a)]\chi^2(\hat{d}_b) + (2\mu-1)\chi(\hat{d}_F,\hat{d}_b)
\end{aligned}$$

$$\Rightarrow \frac{1}{\alpha}(1-\frac{1}{\sigma})\Sigma\chi(\hat{e}) - \frac{1-\alpha}{\alpha}\Sigma\chi(\hat{wL}) = (2\mu-1)\Sigma\chi(\hat{d}_F)$$
$$+[\mu S_a - (1-\mu)(1-S_b) + (1-\mu)S_b - \mu(1-S_a)](\chi^2 + \chi(\hat{d}_a,\hat{d}_b))$$

Sectoral technological shocks are i.i.d. and countries are symmetric, so the following equations hold

$$\chi^2(\hat{d}_a) = \chi^2(\hat{d}_b) = \chi^2, \qquad \Sigma\chi(\hat{d}_F) = \Sigma\chi(\hat{d}_H)$$

Plug them back and rearrange the equation, I obtain the aggregate domestic share as

$$\mu S_a + (1-\mu)S_b = \frac{1}{2} + [\frac{\sigma-1}{2\sigma\alpha}\sum\chi(\hat{e}) - \frac{1-\alpha}{2\alpha}\sum\chi(\hat{wL}) - \frac{2\mu-1}{2}\sum\chi(\hat{d}_H)][\chi^2 + \chi(\hat{d}_a,\hat{d}_b)]^{-1}$$

Next, I determine the sign of $\chi^2 + \chi(\hat{d}_a,\hat{d}_b)$:

$$\chi^2 + \chi(\hat{d}_a,\hat{d}_b) = [(2\theta T(1-\frac{\lambda\frac{T-1}{T+1}}{\theta}) - 1]^2 + [2\theta(1+\frac{\lambda\frac{T-1}{T+1}}{\theta}) - 1]^2 > 0$$

Since it has a positive sign, the coefficient of labor income in Equation 1.5 is negative and the coefficient of real exchange rate is positive when $\sigma > 1$.

A.3.3 Proof of Proposition I.3

The difference between domestic and foreign budget constraints can be written as

$$\frac{1}{\alpha}\hat{PC} - \frac{1-\alpha}{\alpha}\hat{wL} = [\mu S_a - (1-\mu)(1-S_b)]\hat{d}_1 + [(1-\mu)S_b - \mu(1-S_a)]\hat{d}_2$$

where $\hat{d}_1$ and $\hat{d}_2$ can represent $\hat{d}_1 = \hat{d}_{H,a} - \hat{d}_{F,b} = \lambda s + \hat{T}_1 - \theta\hat{w}, \quad \hat{d}_2 = \hat{d}_{H,b} - \hat{d}_{F,a} = -\lambda\hat{s} + \hat{T}_2 - \theta\hat{w}$. Moreover, a pair of $(\hat{T}_1, \hat{T}_2)$ is uniquely mapped to a pair of $(\hat{s}, \hat{w})$ via

$$\hat{T}_1 = \frac{1}{2T}[(1-T)\lambda - (T+1)\theta]\hat{s} + \frac{1}{2T}[(1+\theta)(T+1) + \theta(T-1)]\hat{w}$$

$$\hat{T}_2 = \frac{1}{2}[(T+1)\theta - \lambda(T-1)]\hat{s} + \frac{1}{2}[(1+\theta)(T+1) - \theta(T-1)]\hat{w}$$

Let $\Omega_1 = \mu S_a - (1-\mu)(1-S_b)$ and $\Omega_2 = (1-\mu)S_b - \mu(1-S_a)$. Plug this in the original budget constraint, and we will get an equation with $(\hat{s}, \hat{w})$ only:

$$(1-\frac{1}{\sigma})(2\psi-1))\hat{s} = (1-\alpha)\hat{w} + \alpha\Omega_1(\lambda\hat{s} + \hat{T}_1 - \theta\hat{w}) + \alpha\Omega_2(-\lambda\hat{s} + \hat{T}_2 - \theta\hat{w})$$

$$\Rightarrow (1-\frac{1}{\sigma})(2\psi-1))\hat{s} = \{1-\alpha-\theta\alpha\Omega_1-\theta\alpha\Omega_2+\frac{\alpha\Omega_1}{2T}[(\theta+1)(T+1)+\theta(T-1)]+\frac{\alpha\Omega_2}{2}[(\theta+1)(T+1)$$

$$-\theta(T-1)]\}\hat{w} + \{\alpha\lambda\Omega_1 - \alpha\lambda\Omega_2 + \frac{\alpha\Omega_1}{2T}[(1-T)\lambda - (T+1)\theta] + \frac{\alpha\Omega_2}{2T}[(1-T)\lambda + (T+1)\theta]\}\hat{s}$$

Optimal portfolio ensues regardless of the w and s shocks to be realized in the economy. By matching the coefficients of $\hat{s}$ and $\hat{w}$, we get the expressions of Ω_1 and Ω_2.

$$\Omega_1 \equiv \mu S_a - (1-\mu)(1-S_b) = \frac{T}{T+1}\frac{\alpha-1}{\alpha} + \frac{T}{T+1}\frac{1}{\alpha}\frac{(1-\frac{1}{\sigma})}{\lambda-\theta}$$

$$\Omega_2 \equiv (1-\mu)S_b - \mu(1-S_a) = \frac{1}{T+1}\frac{\alpha-1}{\alpha} - \frac{1}{T+1}\frac{1}{\alpha}\frac{(1-\frac{1}{\sigma})}{\lambda-\theta}$$

A.4 Comparative Statics with σ and ψ

Home Bias and σ

Domestic households buy the domestic unproductive sector's assets ($\nu_{H,b} > 0$) and sell the domestic productive sector's assets ($\nu_{H,a} < 0$). Home bias in sector a is weaker than that in sector b. With the increase in the coefficient of risk aversion σ, the two asset positions gradually converge. The more risk-averse the households are, the greater tendency they have to smooth consumption by cutting the holdings of risky assets. This explains why the absolute values of the four equity assets all decrease in σ.

Home Bias and ψ

For most values of ψ, $\nu_{H,a}$ lies below $\nu_{H,b}$. Nevertheless, at the right end of ψ, the relationship flips and the holdings of $f_{H,a}$ shoot up. When there is less diversification need in consumption since a domestic agent places dominant weights on a goods, there is limited risk-hedging role for sector b to play. As a result, sectoral home bias is very volatile at the tails of ψ.

Figure A9: Comparative Statics: σ

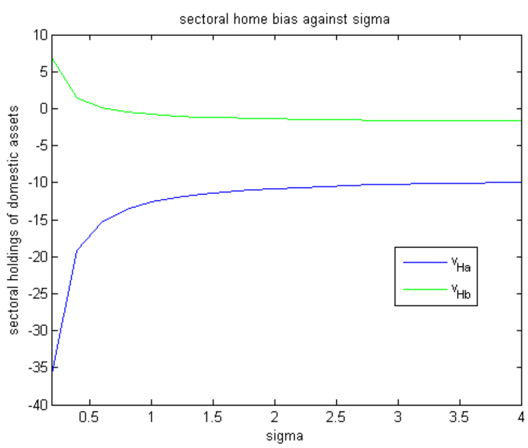
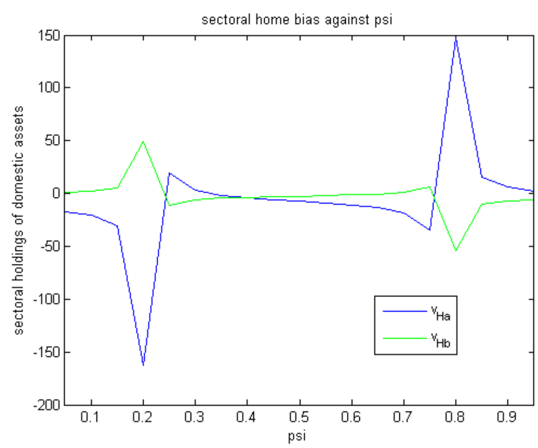


Figure A9: Comparative Statics: ψ



Note: This figure presents sectoral home bias under different values of coefficient of risk aversion σ and weight of productive sectors' goods in consumption ψ. Parameter values of σ and ψ are on the vertical axes and equity holdings are on the horizontal axes.

APPENDIX B

Appendices for Chapter Two

B.1 Tables and Charts

Table A10: IMF Programs

IMF SBA	IMF Standby Arrangement agreed
IMF EFF	IMF Extended Fund Facility Arrangement agreed
IMF SAF	IMF Structural Adjustment Facility Arrangement agreed
IMF PRGF	IMF Poverty Reduction and Growth Facility Arrangement agreed
IMF SBA 5	IMF Standby Arrangement in effect for at least 5 months in a particular year
IMF EFF 5	IMF Extended Fund Facility Arrangement in effect for at least 5 months in a particular year
IMF SAF 5	IMF Structural Adjustment Facility Arrangement in effect for at least 5 months in a particular year
IMF PRGF 5	IMF Poverty Reduction and Growth Facility Arrangement in effect for at least 5 months in a particular year

Table A11: Effect of Debt Renegotiations on Trade Volumes

	bilateral FE	bilateral RE	trade 1to2 FE	trade 1to2 RE	trade 2to1 FE	trade 2to1 RE
paris	-0.0115	-0.0114	0.0259	0.0124	-0.0496	-0.0459
	(-0.30)	(-0.32)	-(0.54)	(-0.25)	(-1.08)	(-0.99)
parisl1	-0.0438	-0.0515	-0.0432	-0.0639	-0.102*	-0.106*
	(-1.14)	(-1.32)	(-0.89)	(-1.30)	(-2.19)	(-2.25)
parisl2	-0.0358	-0.044	-0.0194	-0.0392	-0.0832	-0.0882
	(-0.92)	(-1.11)	(-0.39)	(-0.79)	(-1.76)	(-1.85)
parisl3	-0.057	-0.0746	-0.0732	-0.103*	-0.0705	-0.0861
	(-1.45)	(-1.87)	(-1.48)	(-2.05)	(-1.48)	(-1.79)
parisl4	-0.0376	-0.059	-0.0183	-0.0516	-0.0724	-0.0937
	(-0.95)	(-1.47)	(-0.37)	(-1.02)	(-1.51)	(-1.93)
parisl5	-0.0568	-0.0662	-0.0507	-0.0695	-0.115*	-0.125*
	(-1.43)	(-1.64)	(-1.01)	(-1.36)	(-2.38)	(-2.56)
parisl6	0.0226	-0.00173	0.0153	-0.0228	-0.0317	-0.0539
	(-0.56)	(-0.04)	(-0.3)	(-0.44)	(-0.65)	(-1.10)
parisl7	-0.0389	-0.07	-0.0862	-0.134**	-0.053	-0.0812
	(-0.96)	(-1.71)	(-1.69)	(-2.58)	(-1.08)	(-1.64)
parisl8	-0.0588	-0.0972*	-0.0904	-0.148**	-0.0588	-0.094
	(-1.44)	(-2.35)	(-1.76)	(-2.85)	(-1.19)	(-1.88)
parisl9	-0.0794	-0.112**	-0.116*	-0.167**	-0.043	-0.0737
	(-1.89)	(-2.63)	(-2.19)	(-3.11)	(-0.84)	(-1.43)
parisl10	-0.109*	-0.144***	-0.156**	-0.209***	-0.0897	-0.122*
	(-2.55)	(-3.32)	(-2.89)	(-3.82)	(-1.73)	(-2.33)
parisl11	-0.136**	-0.178***	-0.132*	-0.192***	-0.168**	-0.206***
	(-3.10)	(-4.00)	(-2.39)	(-3.43)	(-3.17)	(-3.84)
parisl12	-0.0615	-0.108*	-0.0911	-0.158**	-0.0728	-0.115*
	(-1.33)	(-2.31)	(-1.56)	(-2.67)	(-1.30)	(-2.04)
parisl13	-0.0779	-0.130**	-0.0963	-0.166**	-0.120*	-0.169**
	(-1.63)	(-2.68)	(-1.60)	(-2.70)	(-2.07)	(-2.87)
parisl14	-0.125*	-0.195***	-0.212***	-0.303***	-0.118*	-0.184**
	(-2.53)	(-3.88)	(-3.40)	(-4.80)	(-1.97)	(-3.03)
parisl15	-0.196***	-0.277***	-0.277***	-0.378***	-0.175**	-0.251***
	(-3.83)	(-5.34)	(-4.31)	(-5.80)	(-2.83)	(-4.01)
imf	-0.128***	-0.155***	-0.201***	-0.233***	-0.144***	-0.170***
	(-28.48)	(-34.03)	(-33.79)	(-38.87)	(-25.29)	(-29.80)
imfl1	-0.0248***	-0.0401***	-0.0366***	-0.0552***	-0.0290***	-0.0432***
	(-5.08)	(-8.11)	(-5.71)	(-8.50)	(-4.73)	(-6.98)
imfl2	-0.00372	-0.0132*	-0.000829	-0.0122	0.00468	-0.00298
	(-0.72)	(-2.53)	(-0.12)	(-1.79)	-0.73	(-0.46)
imfl3	-0.000458	-0.0109*	0.0129	0.000624	0.00785	-0.000803
	(-0.09)	(-2.00)	-1.85	-0.09	-1.18	(-0.12)

imfl4	0.0281***	0.0134*	0.0425***	0.0247***	0.0239***	0.0116
	(-5.1)	(-2.39)	(-5.95)	(-3.41)	(-3.48)	(-1.68)
imfl5	0.104***	0.0720***	0.147***	0.109***	0.125***	0.0981***
	(-19.68)	(-13.48)	(-21.66)	(-15.77)	(-19.09)	(-14.9)
custrict	0.421***	0.398***	0.389***	0.387***	0.296***	0.325***
	(-10.54)	(-10.33)	(-7.43)	(-7.68)	(-5.88)	(-6.7)
ldist	0.255***	-1.334***	0.0988	-1.556***	0.515***	-1.438***
	(-4.04)	(-80.74)	(-1.21)	(-70.94)	(-6.58)	(-66.55)
lrgdp	0.332***	0.543***	0.216***	0.528***	0.487***	0.676***
	(-54.99)	(-119.28)	(-25.7)	(-84.79)	(-61.38)	(-113.06)
lrgdppc	0.155***	0.00498	0.357***	0.102***	0.0924***	-0.0336***
	(-18.36)	(-0.79)	(-30.63)	(-11.97)	(-8.41)	(-4.10)
comlang	-0.0284	0.243***	0.0850**	0.419***	-0.271***	0.107***
	(-1.27)	(-12.56)	(-2.81)	(-16.05)	(-9.51)	(-4.33)
border	0.0191	0.976***	0.0234	0.983***	-0.158	1.177***
	(-0.1)	(-11.27)	(-0.09)	(-8.63)	(-0.62)	(-10.44)
regional	0.295***	0.275***	0.291***	0.264***	0.321***	0.312***
	(-10.39)	(-9.58)	(-8.1)	(-7.28)	(-9.27)	(-8.92)
landl	1.158***	-0.559***	1.202***	-0.623***	0.689***	-0.658***
	(-26.48)	(-27.48)	(-20.6)	(-22.97)	(-12.35)	(-24.75)
island	0.422***	0.197***	0.436***	0.219***	0.456***	0.254***
	(-20.25)	(-11.84)	(-15.76)	(-9.9)	(-16.89)	(-11.74)
lareap	0.496***	0.172***	1.419***	0.259***	0.531***	0.149***
	(-5.67)	(-36.3)	(-12.35)	(-40.79)	(-4.74)	(-23.9)
comcol	0.574***	0.197***	0.551***	0.222***	-0.216*	0.195***
	(-6.99)	(-5.03)	(-4.88)	(-4.22)	(-2.08)	(-3.8)
curcol	0.348***	0.539***	0.374***	0.617***	0.644***	0.797***
	(-4.05)	(-6.39)	(-3.43)	(-5.76)	(-6.13)	(-7.75)
colony	0.314**	1.408***	0.327**	1.534***	0.261*	1.368***
	(-3.23)	(-18.2)	(-2.66)	(-15.43)	(-2.21)	(-14.21)
comctry	-0.701***	-1.077***	-0.670***	-1.132***	-0.776***	-1.146***
	(-12.23)	(-19.33)	(-9.24)	(-16.06)	(-11.11)	(-16.93)
cons	-18.87***	-6.088***	-37.82***	-7.988***	-28.41***	-11.06***
	(-8.99)	(-33.77)	(-13.72)	(-33.16)	(-10.59)	(-47.02)

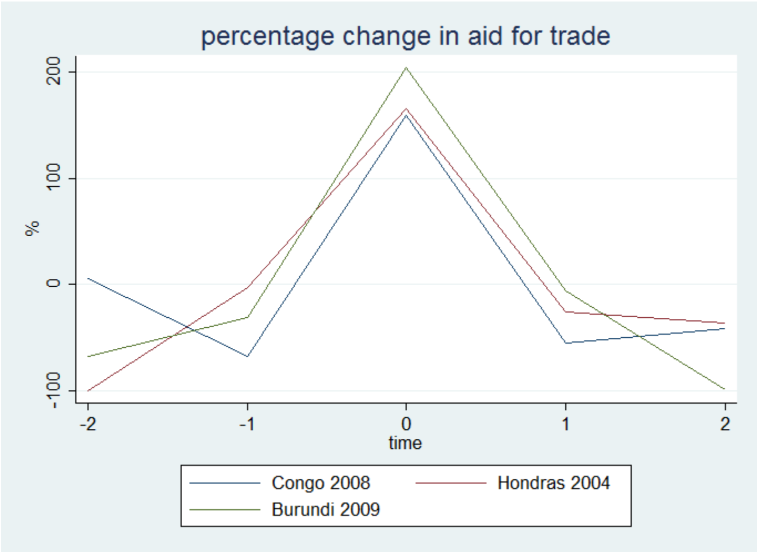
t statistics in parentheses. * significant at 10%, * significant at 1%, * significant at 1%

Country 1 denotes a debtor; country 2 denotes a creditor.

Table A13: Trade Policy, Regulations and Trade-Related Adjustment

CRS Code	Description	Clarifications / Additional notes on coverage
33110	Trade policy and administrative management	Trade policy and planning; support to ministries and departments responsible for trade policy; trade-related legislation and regulatory reforms; policy analysis and implementation of multilateral trade agreements e.g. technical barriers to trade and sanitary and phytosanitary measures (TBT/SPS) except at regional level (see 33130); mainstreaming trade in national development strategies (e.g. poverty reduction strategy papers); wholesale/retail trade; unspecified trade and trade promotion activities.
33120	Trade facilitation	Simplification and harmonisation of international import and export procedures (e.g. customs valuation, licensing procedures, transport formalities, payments, insurance); support to customs departments; tariff reforms.
33130	Regional trade agreements (RTAs)	Support to regional trade arrangements [e.g. Southern African Development Community (SADC), Association of Southeast Asian Nations (ASEAN), Free Trade Area of the Americas (FTAA), African Caribbean Pacific/European Union (ACP/EU)], including work on technical barriers to trade and sanitary and phytosanitary measures (TBT/SPS) at regional level; elaboration of rules of origin and introduction of special and differential treatment in RTAs.
33140	Multilateral trade negotiations	Support developing countries effective participation in multilateral trade negotiations, including training of negotiators, assessing impacts of negotiations; accession to the World Trade Organisation (WTO) and other multilateral trade-related organisations.
33150	Trade-related adjustment	Contributions to the government budget to assist the implementation of recipients own trade reforms and adjustments to trade policy measures by other countries; assistance to manage shortfalls in the balance of payments due to changes in the world trading environment.

Figure A13: Aid-for-trade during Sovereign Defaults



APPENDIX C

Appendices for Chapter Three

Table A14: Financial Resources as Shares of GDP

Country	Bank Loans	Corporate Bonds	Total Debt	Country	Bank Loans	Corporate Bonds	Total Debt
Albania	0.034	0.000	0.034	Grenada	0.441	0.000	0.441
Algeria	0.416	0.000	0.416	Guatemala	0.142	0.000	0.142
Argentina	0.139	0.010	0.149	Guinea-Bissau	0.033	0.000	0.033
Armenia	0.029	0.000	0.029	Guyana	0.214	0.000	0.214
Aruba	0.407	0.000	0.407	Haiti	0.109	0.000	0.109
Australia	0.502	0.214	0.716	Honduras	0.289	0.000	0.289
Austria	0.841	0.277	1.118	Hong Kong	1.329	0.032	1.361
Azerbaijan	0.031	0.000	0.031	Hungary	0.332	0.000	0.332
Bahamas, The	0.382	0.000	0.382	Iceland	0.400	0.165	0.565
Bahrain	0.386	0.000	0.386	India	0.239	0.008	0.247
Bangladesh	0.164	0.000	0.164	Indonesia	0.340	0.000	0.340
Barbados	0.419	0.000	0.419	Iran, Islamic Rep.	0.197	0.000	0.197
Belarus	0.058	0.000	0.058	Ireland	0.451	0.038	0.489
Belgium	0.452	0.528	0.980	Israel	0.520	0.000	0.520
Belize	0.307	0.000	0.307	Italy	0.532	0.283	0.815
Benin	0.101	0.000	0.101	Jamaica	0.229	0.000	0.229
Bhutan	0.008	0.000	0.008	Japan	1.607	0.409	2.016
Bolivia	0.241	0.000	0.241	Jordan	0.584	0.000	0.584
Botswana	0.106	0.000	0.106	Kazakhstan	0.129	0.000	0.129
Brazil	0.280	0.047	0.327	Kenya	0.186	0.000	0.186
Bulgaria	0.532	0.000	0.532	Korea, Rep.	0.465	0.333	0.798
Burkina Faso	0.125	0.000	0.125	Kuwait	0.541	0.000	0.541
Burundi	0.078	0.000	0.078	Lao PDR	0.041	0.000	0.041
Cambodia	0.031	0.000	0.031	Latvia	0.132	0.000	0.132
Cameroon	0.204	0.000	0.204	Lesotho	0.153	0.000	0.153
Canada	0.702	0.175	0.877	Lithuania	0.149	0.000	0.149
Cape Verde	0.067	0.000	0.067	Luxembourg	1.020	0.675	1.695
Central Africa	0.070	0.000	0.070	Macao	0.696	0.000	0.696
Chad	0.097	0.000	0.097	Macedonia, FYR	0.343	0.000	0.343

Note: This table lists credit by bank loans (lending of banks and other financial intermediaries to the private sector) and corporate bonds (private bond market capitalization), as well as them sum(labeled total debt in the table), all as shares of GDP. It covers 149 countries, averaged between 1985 and 1995. The data are from *Beck et al.* (1999).

Table A15: Financial Resources as Shares of GDP (Continued)

Country	Bank Loans	Corporate Bonds	Total Debt	Country	Bank Loans	Corporate Bonds	Total Debt
China	0.739	0.028	0.767	Madagascar	0.151	0.000	0.151
Colombia	0.258	0.005	0.263	Malawi	0.091	0.000	0.091
Congo, Dem. Rep.	0.003	0.000	0.003	Malaysia	0.892	0.226	1.118
Congo, Rep.	0.119	0.000	0.119	Mali	0.102	0.000	0.102
Costa Rica	0.141	0.000	0.141	Malta	0.708	0.000	0.708
Cote d'Ivoire	0.323	0.000	0.323	Mauritania	0.285	0.000	0.285
Croatia	0.246	0.000	0.246	Mauritius	0.324	0.000	0.324
Cyprus	0.873	0.000	0.873	Mexico	0.181	0.014	0.195
Czech Republic	0.679	0.024	0.703	Moldova	0.038	0.000	0.038
Denmark	0.399	0.963	1.362	Mongolia	0.070	0.000	0.070
Djibouti	0.487	0.000	0.487	Morocco	0.220	0.000	0.220
Dominica	0.404	0.000	0.404	Mozambique	0.073	0.000	0.073
Dominican Republic	0.215	0.000	0.215	Myanmar	0.048	0.000	0.048
Ecuador	0.193	0.000	0.193	Nepal	0.120	0.000	0.120
Egypt, Arab Rep.	0.247	0.000	0.247	Netherlands	0.752	0.246	0.998
El Salvador	0.041	0.000	0.041	New Zealand	0.600	0.000	0.600
Equatorial Guinea	0.168	0.000	0.168	Niger	0.133	0.000	0.133
Estonia	0.116	0.000	0.116	Nigeria	0.120	0.000	0.120
Ethiopia	0.037	0.000	0.037	Norway	0.548	0.254	0.802
Fiji	0.317	0.000	0.317	Pakistan	0.239	0.000	0.239
Finland	0.743	0.376	1.119	Panama	0.475	0.000	0.475
France	0.846	0.517	1.363	Papua New Guinea	0.232	0.000	0.232
Gabon	0.146	0.000	0.146	Paraguay	0.174	0.000	0.174
Gambia, The	0.125	0.000	0.125	Peru	0.065	0.009	0.074
Germany	0.941	0.464	1.405	Philippines	0.197	0.000	0.197
Ghana	0.037	0.000	0.037	Poland	0.280	0.000	0.280
Greece	0.335	0.037	0.372	Portugal	0.577	0.079	0.656
Russian Federation	0.076	0.000	0.076	Sweden	0.439	0.529	0.968
Rwanda	0.071	0.000	0.071	Switzerland	1.466	0.542	2.008
Samoa	0.124	0.000	0.124	Syrian Arab Republic	0.068	0.000	0.068
Saudi Arabia	0.190	0.000	0.190	Tanzania	0.041	0.000	0.041
Senegal	0.253	0.000	0.253	Thailand	0.789	0.065	0.854
Seychelles	0.077	0.000	0.077	Togo	0.222	0.000	0.222
Singapore	0.817	0.134	0.951	Tonga	0.285	0.000	0.285
Slovak Republic	0.400	0.000	0.400	Trinidad and Tobago	0.317	0.000	0.317
Slovenia	0.202	0.000	0.202	Tunisia	0.517	0.000	0.517
Solomon Islands	0.155	0.000	0.155	Turkey	0.141	0.005	0.146
South Africa	0.504	0.180	0.684	Uganda	0.023	0.000	0.023
Spain	0.722	0.134	0.856	Ukraine	0.013	0.000	0.013
Sri Lanka	0.157	0.000	0.157	United Kingdom	1.065	0.123	1.188
St. Kitts and Nevis	0.543	0.000	0.543	United States	0.522	0.720	1.242
St. Lucia	0.465	0.000	0.465	Uruguay	0.252	0.000	0.252
St. Vincent & Gren.	0.353	0.000	0.353	Vanuatu	0.362	0.000	0.362
Sudan	0.074	0.000	0.074	Zambia	0.060	0.000	0.060
Suriname	0.305	0.000	0.305	Zimbabwe	0.124	0.000	0.124
Swaziland	0.162	0.000	0.162				

Note: This table lists credit by bank loans (lending of banks and other financial intermediaries to the private sector) and corporate bonds (private bond market capitalization), as well as them sum(labeled total debt in the table), all as shares of GDP. It covers 149 countries, averaged between 1985 and 1995. The data are from *Beck et al.* (1999).

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