International and Domestic Trade Since 1980: Growth and Crises

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To Anette, Bernd and Gregor

Acknowledgements

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Robert Zymek, Barcelona, June 2011

Abstract

This thesis sheds light on several macroeconomic aspects of international and domestic goods trade during the last three decades. The first chapter investigates the nature of the growth of world trade during this period and shows that it is best understood from a factor-proportions perspective. The second chapter analyses the decline in trade experienced by countries in the wake of sovereign debt crises. Empirical evidence suggests that it is due to a reduction in exporters' access to foreign credit. The third and final chapter provides an explanation for the procyclicality of input trade among domestic firms. I argue that periods of economic expansion affect vertically integrated producers asymmetrically, providing incentives for intermediate-goods trade between fast-growing and slow-growing firms.

Keywords: international trade, international capital flows, China, factor proportions, sovereign debt crises, input trade, business cycles

Resumen

Aquesta tesis posa en relleu varis aspectes macroeconòmics del comerç internacional i domèstic en les últimes tres dècades. El primer capítol investiga les causes del creixement del comerç mundial en aquest període i demostra que s'entén millor des de la perspectiva dels proporcions dels factors. El segon capítol analitza la caiguda del comerç experimentada per països arran de crisis del deute sobirà. L'evidencia empírica suggereix que aquest declivi es deu a la reducció en l'accés dels exportadors al crèdit extern. El tercer i últim capítol ofereix una explicació per la prociclicitat del comerç d'inputs entre empreses domèstiques. En períodes d'expansió econòmica els productors integrats verticalment es veuen afectats d'una forma asimètrica, proporcionant així incentius pel comerç de bens intermedis entre empreses que creixen a diferent ritme.

Conceptes clau: comerç internacional, fluxos de capital internacional, Xina, proporcions dels factors, crisis del deute sobirà, comerç d'inputs, cicles econòmics

Foreword

What are the gains motivating trade between different economic actors, and why may trade occasionally break down? These are two fundamental questions of economic analysis, and they form the unifying theme of the present thesis. In three self-contained chapters, I study several aspects of the patterns of international and domestic trade during the last 30 years from a macroeconomic perspective. For the first two chapters, I focus on trade between countries. The third chapter turns to the issue of trade between firms.

Chapter 1 investigates the nature of the growth in world trade during the last three decades. Most of the recent expansion of global trade has been of the North-South kind – between capital-abundant developed and labour-abundant developing countries. Based on this observation, I argue that it is best understood from a factor-proportions perspective. The argument is underpinned by novel evidence documenting that differences in capital-labour ratios across countries have increased in the wake of two shocks to the global economy: i) the opening up of China and ii) financial globalisation and the resulting capital flows towards capital-abundant regions, sometimes referred to as "South-North capital flows".

The chapter analyses the impact of these shocks on the volume of trade in a dynamic model which combines factor-proportions trade in goods with international trade in financial assets. "South-North" capital flows arise endogenously in this setting: since goods trade equalises factor returns but different regions of the world face idiosyncratic technology shocks, agents' optimal portfolio choices channel investment towards safe regions which increases factor-proportions dif-

ferences, specialisation and trade. Calibrating my model, I find that it can account for more than 50% of world trade growth between 1980 and 2007, most of which reflects the emergence of labour-abundant China. Furthermore, the model is capable of predicting international investment patterns which are consistent with the data.

Chapter 2 sheds new light on the decline in trade following sovereign debt crises. It asks whether these "trade costs" of sovereign default documented in earlier studies are the result of a reduction in exporters' access to foreign credit. Using an annual panel of 28 industries in 95 countries between 1980 and 2007, I provide evidence that default leads to a stronger contraction in the exports of sectors which are more dependent on external financing, consistent with this hypothesis. This finding is robust across different econometric specifications, and of economically significant magnitude.

Much of the recent literature on sovereign borrowing treats the threat of capital-market exclusion and the risk of a punishment through trade flows as substitutable explanations for why countries choose to honour their obligations to foreign creditors. Based on my empirical analysis, this notion is is mistaken: if default does not reduce the defaulting country's access to international lending, the "trade costs" of default may also fail to materialise.

The final chapter documents that input trade has been strongly procyclical in the major economies during the last 30 years. I propose an explanation for this phenomenon based on the notion that periods of economic expansion generate differences between ex-ante similar sectors, providing an impetus for trade in inputs between fast-growing and slow-growing firms. The broad predictions of this theory

are consistent with two further aspects of the observed cyclical pattern of trade in intermediate goods: that it is mainly driven by input trade across industries, rather than within-industry trade, and that there appears to be no long-run trend in the ratio of input purchases to total output.

Taken together, the chapters highlight two important recent features of international and domestic trade: the growing heterogeneity of the group of trading economies and the cyclical volatility of trade in intermediate goods. The former breathes new life into a classical theory of comparative advantage. The latter calls for new models of input trade over the business cycle. At the same time, Chapter 1 and Chapter 2 showcase that the increasing interplay between international trade in goods and in financial assets opens up exciting new avenues for research to international economists.

Contents

1 Factor Proportions and the Growth of World Trade

1.1 Introduction

The rapid growth of world trade has been one of the most striking developments in the global economy over the last three decades. Figure 1 shows that the traded share of world output rose by 8 percentage points between 1980 and 2007, from 14% to 22%. This surge follows a period from the mid-1970s to the late 1980s during which the growth in global trade appeared to have levelled off, and it exceeds the increase which accompanied the GATT rounds of the 1960s and 1970s. Most of the recent rise in world trade has taken place between capital-abundant countries − the "North" − and capital-scarce countries − the "South" −, as Figure 2 illustrates.[1] Starting from this observation, this paper puts forward the view that factor-proportions differences are the key to explaining the expansion of global trade since 1980.

Earlier attempts to explain world trade growth in the post-War era have focused on the impact of tariff declines among a relatively homogenous group of countries. Yet in this context, as extensively documented by Yi (2003), the modest decline in average tariff rates among the largest economies implies that trade models cannot match the nature and extent of the growth in world trade during the last 30 years, which poses a "quantitative and qualitative puzzle" for international trade theory. Subsequent attempts to determine why world trade has increased have struggled to account for the sheer magnitude

[1] Figure 2 is based on the regional trading patterns between 1980 and 2007 among 27 large economies, accounting for 85% of global output during this period.

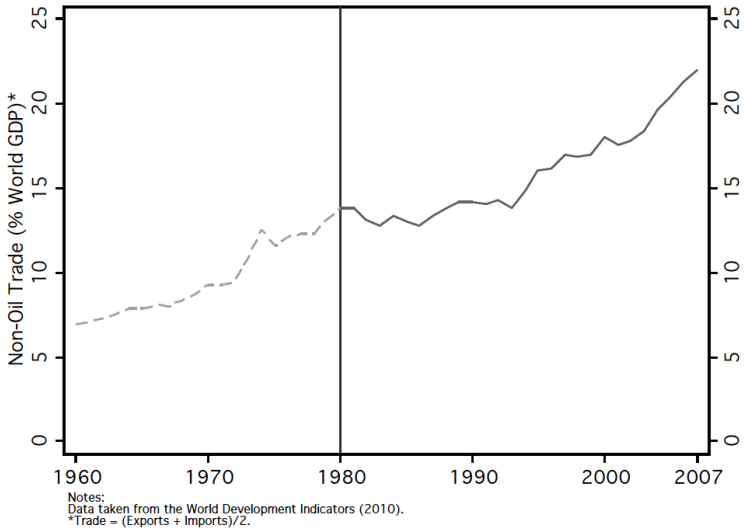


Figure 1.1: The Growth of World Trade, 1960-2007

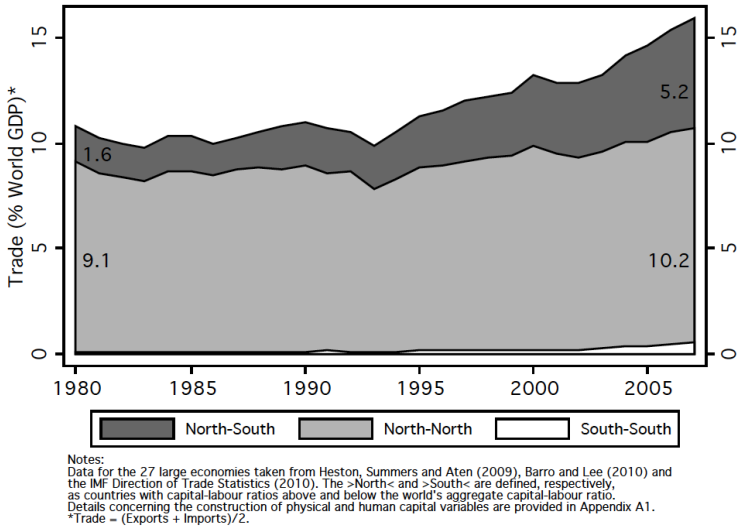


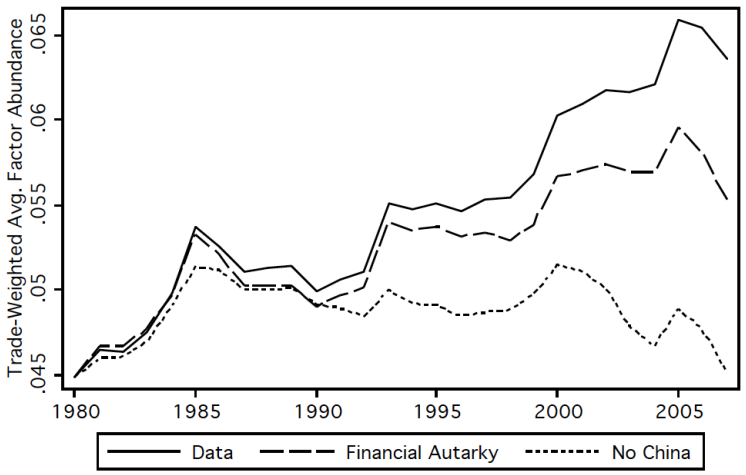
Figure 1.2: World Trade by Region, 1980-2007

of the phenomenon.

In this paper I argue that world trade has grown because the group of open economies has become less homogenous. In particular, I document that differences between the capital-labour ratios of the largest trading countries have increased due to the opening up of China – a large and very labour-abundant economy – and the pattern of net financial flows from capital-scarce to capital-abundant countries, sometimes referred to as "global imbalances" or "South-North capital flows". Classical trade models predict that countries specialise in industries which best suit their relative endowments of production factors, and that this specialisation gives rise to gains from international commodity trade. I calibrate such a model using estimates of countries' endowments of human and physical capital and show that it can explain 80% of the growth in North-South trade between 1980 and 2007, amounting to more than half of the overall growth in world trade.

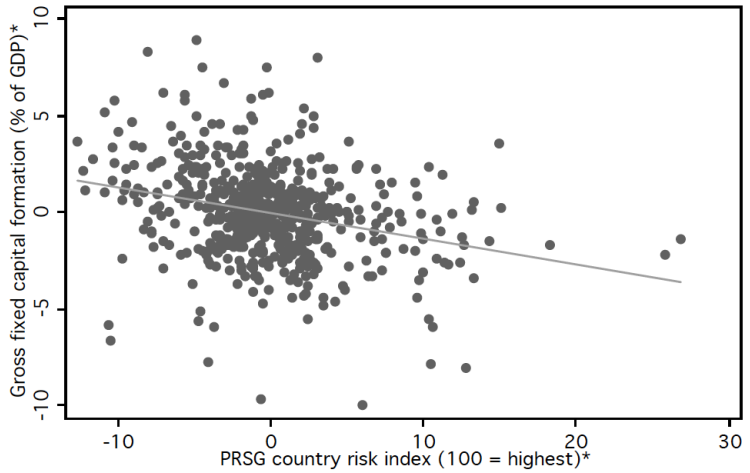
Figure 3 depicts the evolution of the world distribution of capital stocks per effective worker, henceforth referred to as "capital-labour ratios" or "K/H-ratios" for brevity, by plotting the trade-weighted average factor abundance – a measure of the dispersion of capital-labour ratios among open economies.[2] The figure highlights that the dispersion of factor proportions has increased steadily (solid line), but that this increase would not have occurred if China's share of global trade had remained unchanged since 1980 (dotted line). It also shows that the increase would have been significantly smaller in financial

[2]The trade-weighted average factor abundance is calculated as $\sum_c \left| \frac{K_{ct}}{K_t} - \frac{H_{ct}}{H_t} \right| \frac{X_{ct}+M_{ct}}{X_t+M_t}$, where K_{ct} is country c's stock of physical capital, H_{ct} its stock of human capital and X_{ct} and M_{ct} represent the value of its exports and imports, respectively. I drop the subscript c for world variables. Details on data sources and construction are provided in Appendix A1.



Notes:
Data for the 27 large economies taken from Heston, Summers and Aten (2009), Barro and Lee (2010) and the IMF Direction of Trade Statistics (2010). Details concerning the construction of physical and human capital variables are provided in Appendix A1.

Figure 1.3: Dispersion of K/H-ratios Over Time



Notes:
Panel of 27 large economies for 1980-2007. Data taken from the World Development Indicators (2010), with country risk based on PRSG surveys. For the formal regression results, please refer to Appendix A2.
*Controlling for gross domestic savings, country and time fixed effects.

Figure 1.4: Investment and Country Risk, 1980-2007

autarky (dashed line).[3] Correspondingly, my calibration suggests that 60% of the growth in North-South trade can be explained as a result of the opening up of labour-abundant China, while a further 10% are due to financial globalisation and the resulting flow of capital to capital-abundant regions.

The emergence of China as a large trading economy is generally recognised as the result of an exogenous policy shock – the program of "reform and opening up" initiated by the Communist Party of China under Deng Xiaoping in 1978. Its significance for any factor-proportions-based view of international goods trade derives from the country's size and labour-abundance. Although China's comparative advantage in labour-intensive industries is widely acknowledged,[4] to the best of my knowledge this paper provides the first quantitative assessment of China's contribution to the growth in world trade from a factor-proportions perspective.

While my main objective is to provide an explanation for the growth in world trade during the last three decades, the prominent role of China in my calibrations implies that this paper also touches on the issue of China's economic transition. Song, Storesletten and Zilibotti (2011) document that China's economic transformation in the last 30 years has been characterised by high output growth, reallocation within the manufacturing sector, sustained returns to capital, and a large trade surplus. They construct a one-good model with heterogeneous firms and credit market frictions to account for these

[3] I estimate counterfactual "financial autarky" capital stocks by cumulating countries' gross domestic savings, rather than the usual investments, since domestic investment equals saving in financially closed economies. The assumptions underlying the construction of this data are discussed in greater detail in Appendix A1.

[4] See, for example, Rodrik (2006) and Amiti and Freund (2010).

stylised facts. My model predicts China's transition to proceed in a similar manner, albeit for different reasons: factor-proportions trade in goods delivers output growth, manufacturing reallocation and sustained capital returns, while a large trade surplus emerges on account of agents' desire to mitigate domestic investment risk through foreign asset purchases.

The pattern of South-North capital flows − and the resulting increase in factor-proportions differences − constitutes a well-established puzzle for the theory of international finance.[5] Traditional one-good models of international investment have tended to emphasise locally diminishing returns to capital as the main motive for international financial flows. Barring a strong positive correlation between savings rates and total factor productivities, such models would predict capital to flow from capital-abundant to capital-scarce regions in search of higher returns, thereby reducing factor-proportions differences. I allow for international asset trade in my model and demonstrate that the increased prevalence of factor-proportions trade may explain why it has increased factor-proportions differences, contrary to the conventional view.

Trade theory has established that, under well-defined conditions, trade in goods with different factor intensities may eliminate local diminishing returns to production factors, and thus the main theoretical reason for capital to flow from North to South. Suppose therefore that instead of return differentials, diversification and risk sharing are the dominant motives for international asset trade. In that case, barring a strong negative correlation between savings rates and country risk, capital should flow from risky to safe regions which may exacerbate

[5]See, among others, Prasad, Rajan, and Subramanian (2006), Gourinchas and Jeanne (2006) and Caballero, Farhi and Gourinchas (2008)

factor-proportions differences, raising specialisation and trade.

Empirical tests verify that country-specific investment risk has been an important determinant of international investment patterns over the last three decades. In a panel of the 27 large economies, a measure of country risk − based on historical country risk scores from the Political Risk Services Group (PRSG) − is strongly and negatively correlated with the GDP-share of investment after controlling for domestic savings and country and time fixed effects (see Figure 4 and the formal regressions in Appendix A2). As part of my calibration exercise, I show that a model in which factor-proportions trade eliminates local diminishing returns and financial globalisation allows agents to hedge idiosyncratic investment risk can match the patterns of international asset trade remarkably well.[6]

My paper adds to a long literature on the quantitative implications of international trade models for the level and growth of world trade. The development of the so-called "new" trade theory by Krugman (1979), Lancaster (1980) and Helpman (1981) was motivated in part by the failure of traditional, comparative-advantage-based models to explain the volume of world trade and its concentration among a small group of industrialised nations. Helpman (1987) demonstrates that, beyond this, new trade theory has implications for trade growth, linking it to the similarity of countries' incomes. However, subsequent work by Hummels and Levinsohn (1995), Baier and Bergstrand

[6] Antras and Caballero (2009) and Jin (2009) are two recent attempts to explain South-North capital flows in the context of a Heckscher-Ohlin model. My model relates more closely to the "portfolio approach" to the current account − pioneered by Kraay and Ventura (2003), Ventura (2003) and Kraay et al. (2005). I expand on their partial-equilibrium international portfolio model by embedding it in a many-good general-equilibrium framework in which local diminishing returns disappear endogenously as a result of factor-proportions trade in commodities.

(2001) and Bergoeing and Kehoe (2003) has uncovered little evidence that this channel has played a quantitatively important role in the recent growth of world trade, shifting attention towards declining trade frictions.

Yi (2003) shows that the decline in world tariffs in the last decades of the 20th century has been too small to match the observed growth in trade using a Ricardian or new trade model with plausible assumptions about the elasticity of substitution between goods. He attempts to explain this puzzle as the result of an increase in vertical specialisation, whereby goods cross borders several times during the production process, but his model leaves at least half of world trade growth unaccounted for. My paper is complementary with Yi's insofar as he assumes the pattern of vertical specialisation to be determined by classical comparative advantage due to productivity differences. My calibrations also assume a comparative-advantage motive for trade but show that horizontal specialisation alone, driven by factor-proportions differences, can explain a substantial part of the recent growth in world trade.

A recent paper by Cuñat and Maffezzoli (2007) is most closely related to the present work. The authors study the growth of U.S. trade from a dynamic factor-proportions perspective. In their setting trade integration raises the return to capital in capital-abundant countries and lowers it in capital-scarce countries, thus eliciting more capital accumulation in the former, and reducing it in the latter. They suggest that this dynamic implication of tariff reductions can explain why small tariff reductions have had a large impact on U.S. trade with the rest of the world. Unlike Cuñat and Maffezzoli (2007), I study the growth in global rather than U.S. trade and analyse the impact of an asymmetric increase in the trade openness of capital-scarce regions.

Moreover, I dispense with their assumption of financial autarky, showing that international capital flows have played a significant part in increasing specialisation and trade.[7]

The remainder of the paper is structured as follows. Section 2 describes the theoretical model and shows how it can be applied to study the impact on factor-proportions trade of i) the arrival of a new, labour-abundant country and ii) the occurrence of financial globalisation. Section 3 calibrates the model to real-world data in order assess how much of the growth in North-South trade over the last three decades it can explain. It also considers the empirical realism of the model-implied determinants of international capital flows. Section 4 concludes.

1.2 The Model

Below I outline a tractable general equilibrium model to illustrate the relationship between capital-labour ratios, the patterns of specialisation and the volume of trade. The dynamic nature of the model allows me to examine the determinants of capital accumulation under different assumptions about the feasibility of cross-border asset trades.

Throughout, I emphasise the Heckscher-Ohlin view of international commodity trade: differences in regional factor proportions are a source of comparative advantage. Different regions of the world trade in K-intensive and H-intensive intermediate goods, and regions specialise in the type of good which uses their abundant factor intensively.

[7] My estimates suggest that the U.S. capital stock in 2007 would have been 15% lower in financial autarky. In fact, without capital inflows the U.S. investment rate would have declined over the last 30 years − contrary to the prediction of Cuñat and Maffezzoli (2007).

I impose assumptions that guarantee that commodity trade equalises factor prices and derive an expression which relates the traded share of world output to the distribution of factor endowments. I then proceed to analyse two cases of interest for my subsequent calibrations: the arrival of a new country (in Section 2.b) and the impact of financial globalisation, modelled as the removal of all barriers to international asset trade (in Section 2.c).

The model highlights that the stylised facts described in the previous section can be understood from the perspective of a neoclassical, frictionless world hit by two exogenous shocks. First, a labour-abundant country − China − has opened up to international goods trade. Second, financial globalisation has occurred and asset trades between small (in terms of the size of their effective workforce) but safe regions and large but risky regions have exacerbated factor-proportions differences.

a Basic Setup

a.1 Endowments and Preferences

Consider a world consisting of large regions, $c = 1, \ldots, C$, and inhabited by two overlapping generations, the young and the old. Generations in region c have a constant size L_c. In youth, agents in c are endowed with h_c units of human capital which they supply inelastically in their regional labour market, at the given wage rate w_{ct}. A fraction $1-S_c$ of these agents is impatient and derives utility only from consumption in youth. A fraction S_c is patient and derives utility only from consumption in old age. At t, the region's aggregate savings, B_{ct},

and consumption, C_{ct}, are thus given by:

$$B_{ct} = w_{ct} S_c H_c \ , \tag{1.1}$$

$$C_{ct} = w_{ct}(1 - S_c)H_c + r_{ct} B_{ct-1} \ , \tag{1.2}$$

where r_{ct} is the rate of return to savings in c at t and $H_c \equiv h_c L_c$.

a.2 Production

Final consumption and investment are identical Cobb-Douglas composites of two intermediate goods:

$$C_{ct} + I_{ct} = Q_{ct} = Q_{cKt}^{\theta} Q_{cHt}^{1-\theta} \text{ with } \theta \in [0, 1] \, , \tag{1.3}$$

where I_{ct} denotes aggregate investment in c at t, Q_{ct} represents aggregate industrial output and Q_{cjt} is the input of intermediate good $j \in \{K, H\}$ used in aggregate production. Intermediate goods are assembled using two factors of production − physical capital, K_{ct}, and human capital, H_{ct} − according to

$$Q_{cjt} = K_{cjt}^{\alpha_j} H_{cjt}^{1-\alpha_j} \text{ with } \alpha_j \in [0, 1] \, , \ j \in \{K, H\} \, . \tag{1.4}$$

In the following, I will assume that $\alpha_K > \alpha_H$. Put plainly, production of the intermediate good of the K-type uses physical capital relatively intensively, while production of the intermediate good of the H-type uses human capital relatively intensively. I also assume that final-good, intermediate-good and factor markets are perfectly competitive and that final-good and intermediate-good firms choose their inputs to maximise profits.

a.3 Savings, Investment and Capital Formation

Agents in c have exclusive access to an investment technology which allows them to turn I_{ct} units of investment in t into K_{ct+1} units of capital in $t+1$, according to

$$K_{ct+1} = A_{ct+1} I_{ct}, \tag{1.5}$$

where A_{ct+1} is stochastic with

$$\begin{array}{c} E_t\left(A_{ct+1}\right) = 1 \\ Var\left(A_{ct+1}\right) = \sigma_c^2 \\ Cov\left(A_{ct+1}, A_{c't+1}\right) = 0 \; \forall \; c' \neq c \end{array} . \tag{1.6}$$

Capital depreciates fully in one period.

Since the final consumption good is assumed to be perishable, agents can only transfer consumption to the future by making risky investments in physical capital stock. Investment risk is perfectly idiosyncratic.[8] I shall therefore refer to σ_c as a measure of c's country risk.

a.4 Goods Trade and Factor Price Equalisation

I introduce commodity trade between different regions by assuming that intermediate goods are perfectly tradable, while factors and final goods cannot be traded. For now − in common with most trade models − I do not allow agents in c to trade assets with residents of other regions, so that domestic capital investments remain their only means of transferring consumption to the future.

The source of gains from commodity trade in the present model are differences in factor proportions. Given world prices, countries choose

[8] This assumption is not crucial but it greatly simplifies the subsequent analysis.

the production vector $\{Q_{cKt}, Q_{cHt}\}$ which best suits their relative endowment of production factors. By the force of the Heckscher-Ohlin theorem, this leads K-abundant regions to specialise in, and export, the $K-$intensive intermediate and import the H-intensive intermediate, while H-abundant regions will exhibit the reverse pattern of specialisation.

Since intermediate goods can be traded freely,

$$P_{cjt} = P_{jt} \; \forall \; c \text{ and } j \in \{K, H\}.$$

Defining P_{ct} as region c's the aggregate price level, synonymous with the price of consumption and investment, intermediate goods trade implies

$$P_{ct} \equiv \left(\frac{P_{cKt}}{\theta}\right)^{\theta} \left(\frac{P_{cHt}}{1-\theta}\right)^{1-\theta} = P_t \; \forall \; c.$$

I impose the normalisation $P_t = 1$ and drop the subscript c for all world variables.

It is a well-established feature of models of factor-proportions trade that trade in goods may also equalise the return to production factors across regions even when factors themselves cannot move to exploit potential return differentials. This is referred to as the Factor Price Equalisation (FPE) theorem. In the present setting, FPE requires that

$$\frac{\alpha_H}{1-\alpha_H}\frac{1-\alpha}{\alpha}\frac{K_t}{H_t} \leq \frac{K_{ct}}{H_c} \leq \frac{\alpha_K}{1-\alpha_K}\frac{1-\alpha}{\alpha}\frac{K_t}{H_t} \; \forall \; c, \tag{1.7}$$

where $\alpha \equiv \alpha_K\theta + \alpha_H(1-\theta)$. Condition (7) states that, given α_K, α_H and θ, FPE will arise as long as regions' relative factor endowments are not too extreme compared to the world ratio of physical to human capital. I will assume, crucially, that (7) applies throughout.[9]

[9]See Ventura (2005) for a comprehensive discussion of the necessary conditions

Assuming that (7) holds,

$$Q_t = K_t^{\alpha} H^{1-\alpha}, \tag{1.8}$$

$$r_{ct} = r_t = \alpha \frac{Q_t}{K_t} \; \forall \; c, \tag{1.9}$$

$$w_{ct} = w_t = (1-\alpha) \frac{Q_t}{H} \; \forall \; c, \tag{1.10}$$

$$K_{t+1} = \sum_{c=1}^{C} A_{ct+1} I_{ct} = \sum_{c=1}^{C} A_{ct+1} s_c Q_{ct}, \tag{1.11}$$

where $s_c \equiv (1-\alpha) S_c$. The world economy behaves like a Solow model while the output of each region c is described by

$$Q_{ct} = \left[\alpha \frac{K_{ct}}{K_t} + (1-\alpha) \frac{H_c}{H} \right] Q_t. \tag{1.12}$$

a.5 Specialisation

Define M_{cjt} as the value of region c's net imports of the j-intermediate. Since trade is balanced

$$M_{cHt} = \frac{\alpha (1-\alpha)}{\alpha_K - \alpha_H} \left(\frac{K_{ct}}{K_t} - \frac{H_c}{H} \right) Q_t = -M_{cKt}. \tag{1.13}$$

for FPE to arise as a result of trade in commodities. While the possibility of trade-induced factor price equalisation is a feature of many trade models, the question whether it is also a feature of reality has not yet been answered conclusively. Trefler (1993) documents the empirical validity of a conditional version of the FPE theorem. More recently, Caselli and Feyrer (2007) show that, despite large differences in capital-labour ratios and the absence of large capital flows from capital-abundant to capital-scarce regions, the marginal product of capital does not appear to differ greatly across countries.

So long as $K_{ct}/K_t - H_c/H > 0$, c will be a net importer of the H-good and a net exporter of the K-good. If $K_{ct}/K_t - H_c/H < 0$, the reverse will be the case. The larger is $|K_{ct}/K_t - H_c/H|$, the more c will trade with the rest of the world, and we may take this term as a measure of c's specialisation. It is easy to show that, while (7) remains satisfied, regions with a larger $|K_{ct}/K_t - H_c/H|$ produce proportionally more of the intermediate good of which they are a net exporter, and less of the other intermediate good. This is the classic Rybczynski theorem.

Traditional trade theory takes the distribution of K_{ct} and H_c as given and analyses the resulting patterns of specialisation. I shall go one step further by analysing the deeper causes of specialisation which underlie the observed distribution of factor endowments. Two extreme cases are of particular interest.

Let $s = \sum_c s_c H_c/H$ be the world savings rate. Assume $s_c \approx s$ and σ_c is large for all c. Then,

$$\left| \frac{K_{ct}}{K_t} - \frac{H_c}{H} \right| \approx \left| \frac{A_{ct}}{\sum_c A_{ct} \frac{H_c}{H}} - 1 \right| \frac{H_c}{H}. \tag{1.14}$$

Under this assumption, the pattern of specialisation is determined purely by luck. Regions which receive large positive investment shocks relative to the world average will be capital-abundant, while regions which receive small shocks will be capital-scarce. Moreover, as the patterns of specialisation are essentially random, regions which specialise in capital-intensive exports in one generation may be specialised in labour-intensive exports in the next. Clearly this view of the fundamental forces behind trade specialisation is of limited empirical appeal. I shall therefore focus on an alternative case.

Assume that s_c differs across countries and $\sigma_c \approx 0$. Then,

$$\left|\frac{K_{ct}}{K_t} - \frac{H_c}{H}\right| \approx \left|\frac{s_c}{s} - 1\right| \frac{H_c}{H}. \tag{1.15}$$

Under this assumption, the pattern of specialisation is determined by savings behaviour. High-savings region will accumulate large capital stocks relative to low-savings regions and specialise in capital-intensive products. Low-savings regions will specialise in labour-intensive products. This is the view of the fundamental causes of differences in capital-labour ratios implicit in most traditional models of factor-proportions trade. In Section 2.c, I will show that it crucially depends on the assumption of financial autarky. Once international asset trades are feasible, the determinants of specialisation are fundamentally altered.

a.6 The Traded Share of World Output

While the model predicts region c's net imports and net exports, gross trade flows are indeterminate. To pin down the latter, I assume that positive but infinitesimal transport costs cause agents to minimise gross trade flows − which are then equal to net flows − and I will refer to "imports/exports" and "*net* imports/exports" interchangeably from now on.

Based on (13), the traded share of world output is

$$\frac{\sum_c (|M_{cKt}| + |M_{cHt}|)}{2Q_t} = \frac{\alpha(1-\alpha)}{\alpha_K - \alpha_H} \sum_c \left|\frac{K_{ct}}{K_t} - \frac{H_c}{H}\right|. \tag{1.16}$$

Equation (16) will be crucial in the remainder of the paper. It shows that the bigger the differences between regional shares in the world

stocks of physical and human capital and, hence, the greater the extent of countries' specialisation in equilibrium, the larger will be the overall volume of trade.

b Opening Up of a New Country

b.1 A Labour-Abundant Country Opens Up

Imagine there is a country called *China* which remains closed off from international goods markets. Normalising the final-good price level in *China* to 1, its output at t is given by

$$Q_{China,t} = K_{China,t}^{\alpha} H_{China}^{1-\alpha}. \tag{1.17}$$

While China remains in autarky, the traded share of world output is

$$\frac{\sum_c \left(|M_{cKt}| + |M_{cHt}|\right)}{2\left(Q_t + Q_{China,t}\right)} =$$

$$\frac{\alpha(1-\alpha)}{\alpha_K - \alpha_H} \sum_c \left| \frac{K_{ct}}{K_t} - \frac{H_c}{H} \right| \left[1 + \left(\frac{K_{China,t}}{K_t} \right)^{\alpha} \left(\frac{H_{China}}{H} \right)^{1-\alpha} \right]^{-1}, \tag{1.18}$$

where C now denotes the set of open regions, and K_t and H_t represent their aggregate stocks of physical and human capital at t. Suppose further that *China* is a labour-abundant country, i.e.

$$\frac{K_{China,t}}{K_t + K_{China,t}} < \frac{H_{China}}{H + H_{China}}. \tag{1.19}$$

In the remainder of this section, I will analyse the impact on the patterns of specialisation and the traded share of world output if *China* emerges from complete autarky at t and begins to trade freely in intermediate goods with other regions of the world.

b.2 Impact on Specialisation

Clearly, the opening up of *China* has an impact on world trading patterns. *China* itself will be an importer of the K-intermediate and an exporter of the H-intermediate, which follows directly from (13) and (19).

Consider now the impact on specialisation in another country called *Germany*, for which

$$\frac{K_{Germany,t}}{K_t} - \frac{H_{Germany}}{H} > 0, \tag{1.20}$$

i.e. *Germany* is capital-abundant. For *Germany*,

$$\left|\frac{K_{Germany,t}}{K_t} - \frac{H_{Germany}}{H}\right| - \left|\frac{K_{Germany,t}}{K_t + K_{China,t}} - \frac{H_{Germany}}{H + H_{China}}\right| > 0,$$

which is a direct consequence of (19) and (20): the opening of *China* makes *Germany* more capital-abundant relative to the group of trading countries, causing it to shift its production more towards the K-intermediate, and to import more of the H-intermediate.

By contrast, consider what happens to specialisation in a third country called *Indonesia*, for which

$$\frac{K_{Indonesia,t}}{K_t} - \frac{H_{Indonesia}}{H} < 0, \tag{1.21}$$

i.e. *Indonesia* is labour-abundant. For this country,

$$\left|\frac{K_{Indonesia,t}}{K_t} - \frac{H_{Indonesia}}{H}\right| - \left|\frac{K_{Indonesia,t}}{K_t + K_{China,t}} - \frac{H_{Indonesia}}{H + H_{China}}\right| \lesseqgtr 0.$$

The opening up of *China* makes *Indonesia* less labour-abundant relative to all other trading countries, causing it to shift its production more towards the K-intermediate, and to exports less of the H-intermediate. If *Indonesia* remains labour-abundant despite *China*'s

arrival, the overall effect is a reduction in *Indonesia*'s trade with the rest of the world. However, there may be another labour-abundant country – call it *Korea* – which is similar to, but less labour-abundant than, *Indonesia* and which may become capital-abundant as a result of *China*'s opening. This country may experience a fall, a rise or no change in its trade with the rest of the world.

China's integration into the global economy thus increases the extent of specialisation among K-exporters, but has an ambiguous impact on countries which used to export the H-good before *China*'s arrival.

b.3 Impact on World Trade

The change in the traded share of world output due to *China*'s opening is given by

$$\triangle \ln \frac{\sum_c \left(|M_{cKt}| + |M_{cHt}|\right)}{2Q_t} =$$

$$= \ln \frac{\sum_c \left| \frac{K_{ct}}{K_t + K_{China,t}} - \frac{H_c}{H + H_{China}} \right| + \left| \frac{K_{China,t}}{K_t + K_{China,t}} - \frac{H_{China}}{H_t + H_{China}} \right|}{\sum_c \left| \frac{K_{ct}}{K_t} - \frac{H_c}{H} \right|}$$

$$- \ln \frac{\left(K_t + K_{China,t}\right)^{\alpha} \left(H + H_{China}\right)^{1-\alpha}}{K_t^{\alpha} H^{1-\alpha} + K_{China,t}^{\alpha} H_{China}^{1-\alpha}}, \tag{1.22}$$

where the second term is unambiguously negative, due to Jensen's inequality, and the first term may be positive or negative.

For *China*'s opening to increase the traded share of world output, the first term of equation (22) needs to be positive and large, which will be the case if the regions in C have relatively similar factor endowments and *China* is sufficiently labour-abundant. As the calibrations in Section 3 show, this description perfectly characterises the

context in which China's opening up did take place during the last three decades.

c Financial Globalisation

c.1 International Asset Trade and Country Risk

Section 2.a.5 illustrates that, if investment risk is small, savings behaviour is the main determinant of capital accumulation and export specialisation in financial autarky. Yet in the face of the large and rising volume of international capital flows observed during the last three decades, this view of the causes of specialisation appears increasingly dated. The panel regressions in Appendix A2 suggest that the savings retention coefficient among large economies was as low as 0.5 in in the period 1980-2007, and that perceptions of country risk were a potentially important source of countries' ability to attract investment finance in increasingly global capital markets. In the light of this, I now analyse the determinants of capital-labour ratios − and the resulting patterns of specialisation − when domestic savings no longer need to be invested exclusively in domestic assets, and country-specific investment risk provides a strong motive for international risk sharing.

The most widespread view of the motive for international capital flows, based on macroeconomic models with a single tradable good, emphasises diminishing returns to capital. In this view, the return to capital investments is generally higher in regions with low capital-labour ratios, and capital flows from capital-abundant to capital-scarce regions in search of these higher returns. Unless regional factor productivities are strongly positively correlated with region's autarky capital stocks, the effect of international capital flows should be to *reduce* the dispersion of world capital-labour ratios. While this explanation for

cross-border capital movements has considerable theoretical appeal, it has been known since at least Lucas (1990) that it is at odds with the empirical pattern of international financial flows.

The model outlined above provides an explanation why local diminishing returns to capital may be weak in open economies, even if the marginal product of capital in aggregate production is declining in the installed capital stock: once capital is installed in a given location, the possibility of trading commodities in international goods markets may substitute for capital movements in equalising the marginal product of capital across different regions. With local diminishing returns thus out of the picture, the following will stress a different motive for international asset trade: the desire to share country-specific risk.

So far, it has been assumed that domestic capital constitutes the only store of value for the patient young in region c. This has made it unnecessary to specify how such agents might allocate their funds between competing investment opportunities. In this section I permit agents to trade freely in state-contingent assets across borders which allows them, indirectly, to access the investment technologies of different regions. In doing so, I assume that the patient young choose mean-variance efficient asset portfolios,[10] maximising

$$E_t\left(C_{t+1}\right) - \frac{1}{2}\gamma Var\left(C_{t+1}\right) \text{ with } \gamma \geq 0, \tag{1.23}$$

where γ is the parameter of relative risk aversion.

Suppose the number of countries, C, is large. Then, since country

[10]This behavioural assumption is common in modern finance, and provides a good approximation to expected utility maximisation if the distribution of asset returns is characterised well by its first two moments.

risk is perfectly idiosyncratic,

$$K_{t+1} = I_t = B_t = sQ_t,$$

i.e. the evolution of the world capital stock is deterministic. This implies that

$$r_{t+1} = \alpha \left(\frac{H}{sQ_t} \right)^{1-\alpha},$$

so that all uncertainty about the return to investment in a given c arises from realisation of the local investment shock.

Young residents of region c in period t are willing to supply a state-contingent asset that promises $r_{t+1}A_{ct+1}$ units of consumption in $t+1$ at price 1 perfectly elastically. The reason is that they can hedge any amount of such claims by investing in a corresponding amount of domestic capital, also at price 1. It is easy to show that the possibility of buying and selling C of these regional assets exhausts all desirable asset trades in the world economy described here. Let $\phi^c_{c'}$ denote the share of savings of the patient young in c invested in assets of region c'. The patient young solve:

$$\max_{\left\{\phi^c_{c'}\right\}_{c'=1}^{C}} E_t \left(r_{t+1} B_{ct} \sum_{c'} A_{c't+1} \phi^c_{c'} \right) - \frac{1}{2} \gamma Var \left(r_{t+1} B_{ct} \sum_{c'} A_{c't+1} \phi^c_{c'} \right)$$

$$= r_{t+1} B_{ct} - \frac{1}{2} \gamma \left(r_{t+1} B_{ct} \right)^2 \sum_{c'} \left(\sigma_{c'} \phi^c_{c'} \right)^2$$

s.t.

$$\sum_{c'} \phi^c_{c'} = 1.$$

Note that, while the final consumption good itself cannot be traded across regions, residents of region c can fulfil a promise to supply 1 unit

of consumption to foreigners in a given state by supplying the necessary quantities of perfectly tradable intermediate goods to assemble 1 unit of final good in that state. This may require within-period factor-proportions trade with a third party before the required bundle of K- and H-good can be shipped to the final claimant.

c.2 The Pattern of International Capital Flows

Since the patient young in all regions face the same optimisation problem, it follows that

$$\frac{I_{ct}}{B_t} = \phi_c = \frac{1}{\sigma_c^2}\left(\sum_{c'}\frac{1}{\sigma_{c'}^2}\right)^{-1}. \tag{1.24}$$

Investment in region c thus depends negatively on c's country risk relative to a measure of world risk. This finding is more general than the specific choice of objective function and the assumed return distribution would seem to suggest: given identical return expectations, any risk-averse agent will favour safer over riskier assets in their portfolio, but will invest in assets of different risk classes if this provides hedging benefits.[11]

[11] In the limiting case in which $\sigma_c \to 0 \; \forall \; c$ investment patterns are indeterminate. Mundell (1957) first showed that net financial flows across borders are indeterminate if factor-proportions trade equalises factor returns and return differentials are the only incentive for international asset trade. To my knowledge, Grossman and Razin (1984) constitutes the only other paper to point out that the "substitutability" between commodity trade and capital flows in Heckscher-Ohlin models may break down if uncertainty is introduced into the model. However, their paper does not explore the dynamic macroeconomic implications of this possibility.

Region c is a net recipient of international capital flows if

$$\frac{1}{\sigma_c^2}\left(\sum_{c'}\frac{1}{\sigma_{c'}^2}\right)^{-1} > \frac{s_c\frac{H_c}{H}}{s}. \tag{1.25}$$

Let us consider the example of a world in which factor-proportions trade is prevalent, regional savings rates are similar but the safest regions are small (in terms of H_c/H). In this world, financial globalisation should be accompanied by capital flows from capital-scarce to capital-abundant countries as well as large and persistent net foreign asset positions. As Caballero, Farhi and Gourinchas (2008) have shown, among others, this is fairly accurate description of the recent pattern of international capital flows. In Section 3.c I will assess whether my model can deliver predictions about international investment patterns which are consistent with the data.

c.3 Impact on Specialisation

Consider now the following thought experiment. Suppose that for all $t < \bar{t}$ regions had been able to trade in intermediate varieties but not in final goods or factors, nor in financial assets. This is the world described in Sections 2.a and 2.b. Assume now that in period $\bar{t}$ all costs and frictions impeding international financial transactions disappear and global asset markets become fully integrated.

The feasibility of international asset trade implies that commodity trade no longer needs to be balanced for any c or $t \geq \bar{t}$. Defining

$$-NX_{ct} \equiv M_{cHt} + M_{cKt} \tag{1.26}$$

and noting that

$$r_t K_{ct} + w_t H_c = C_{ct} + I_{ct} + NX_{ct}, \tag{1.27}$$

it can be shown that for all $t \geq \bar{t}$

$$\frac{|M_{cKt}| + |M_{cHt}|}{2Q_t} = \frac{1}{2}\left|\frac{\alpha(1-\alpha)}{\alpha_K - \alpha_H}\left(\frac{K_{ct}}{K_t} - \frac{H_c}{H}\right) + \theta\frac{NX_{ct}}{Q_t}\right|$$

$$+\frac{1}{2}\left|\frac{\alpha(1-\alpha)}{\alpha_K - \alpha_H}\left(\frac{K_{ct}}{K_t} - \frac{H_c}{H}\right) - (1-\theta)\frac{NX_{ct}}{Q_t}\right|. \qquad (1.28)$$

Equation (28) highlights that the presence of trade imbalances may obscure or reinforce the relationship between a region's true comparative advantage and its export-import patterns, depending on the values of θ and NX_{ct}. By way of example, consider the case of a capital-abundant region ($K_{ct}/K_t > H_c/H$) which is a large net importer ($NX_{ct} < 0$) and let θ be close to 1. While the region will be specialised in producing the K-intermediate, its net imports − due, for example, to net capital inflows − cause it to consume disproportionately more of the K-good. This reduces its exports in the K-sector while leaving its H-imports almost unchanged, and it reduces the sum of its exports and import overall.

The reverse would be true i) if c were a net exporter ($NX_{ct} > 0$) or ii) if θ were close to 0. In these cases, the presence of a trade imbalance would increase the region's trade with the rest of the world by i) increasing the region's exports of the good in which it has a comparative advantage or ii) increasing the region's imports of the good in which it has a comparative disadvantage.

Irrespective of the impact of trade imbalances on export-import patterns, capital-abundant regions will continue to be specialised in the production of K-intermediates and labour-abundant regions in the production of H-intermediates. Yet the determinants of capital-abundance or -scarcity are changed by the nature of international asset

trades: assuming, once again, that the absolute size of investment shocks is small ($\sigma_c \approx 0$), then

$$\frac{K_{ct}}{K_t} - \frac{H_c}{H} \approx \frac{1}{\sigma_c^2}\left(\sum_{c'} \frac{1}{\sigma_{c'}^2}\right)^{-1} - \frac{H_c}{H}. \tag{1.29}$$

With factor-price equalising commodity trade and fully integrated international asset markets, savings rates are no longer the most relevant underlying cause of specialisation. Instead, relatively safe regions receive the largest share of capital investments out of the sum of world savings and, as a result, these regions will specialise in capital-intensive products.

c.4 Impact on World Trade

Note that if $\theta = 1/2$ and

$$|NX_{ct}| < 2\frac{\alpha\,(1-\alpha)}{\alpha_K - \alpha_H}\left|\frac{K_{ct}}{K_t} - \frac{H_c}{H}\right| Q_t \;\forall\; c, \tag{1.30}$$

equation (28) reduces to (16), i.e. regardless of whether trade imbalances are present or not, the traded share of world output is the same as if trade were balanced. The reason is simple: as long as trade imbalances are not so large as to turn a country into a net importer or exporter of both intermediate goods − that is, as long as (30) is satisfied − a trade surplus with $\theta = 1/2$ increases a country's exports by the same amount by which it reduces its imports (and a trade deficit reduces its exports by the same amount by which it increases its imports), leaving the sum of its exports and imports unchanged. In the aggregate, therefore, the traded share of world output is unaffected

by trade imbalances. I will first analyse this special but familiar case, then proceed to the more general case in which $\theta \neq 1/2$.

Assume $\theta = 1/2$ and (30) holds. It is now straightforward to determine the conditions under which this sudden shift from financial autarky to financial globalisation causes countries to become more specialised overall, namely:

$$\sum_{c} \left| \left(\frac{H_c \sigma_c^2}{H} \sum_{c'} \frac{1}{\sigma_{c'}^2} \right)^{-1} - 1 \right| > \sum_{c} \left| \frac{s_c}{s} - 1 \right|. \tag{1.31}$$

Financial globalisation increases specialisation if capital flows exacerbate any mismatch between human and physical capital that existed under autarky, i.e. if differences in regional savings rates are small ($s_c \approx s \ \forall \ c$), and country risk is positively correlated with country size ($Cov \left\{ \sigma_c, \frac{H_c}{H} \right\} > 0$). The result is an increase in world trade.

Suppose now that $\theta \neq 1/2$. The impact of financial globalisation on regions' specialisation patterns will be as in the previous case. Yet even if (31) is true, whether and by how much financial globalisation increases world trade relative to financial autarky depends on the value of θ and the incidence of trade surpluses and deficits. Without loss of generality, consider the case in which $\theta < 1/2$. If deficit countries are capital-abundant on average and surplus countries are labour-abundant, trade imbalances will cause financial globalisation to increase global trade more than if $\theta = 1/2$. If deficit countries are labour-abundant on average and surplus countries are capital-abundant, financial globalisation increases global trade less.

1.3 Calibrations

In this section I assess the extent to which factor-proportions differences can explain the growth in world trade between 1980 and 2007 by taking the model developed above to the data. Since the model only captures trade due to factor-proportions differences – i.e. trade between capital-abundant and labour-abundant countries – I calibrate it to capture the empirical patterns of North-South trade.

First, I let the model match the *volume* of North-South trade in 1980. I then assess how much of the *growth* in this type of trade during the last 30 years it can explain, assuming that the world remains in financial autarky but allowing for the opening up of China between 1980 an 2007. My calibration predicts 70% of the growth in North-South trade between 1980 and 2007 – 50% of the overall growth in world trade. The model also correctly identifies most of the countries whose trade with the rest of the world was diminished by China's entry onto the world stage.

Second, I allow for financial globalisation and show that, under the assumption of fully integrated international asset markets, the model over-predicts the growth in North-South trade. The reason turns out to be that countries' capital stocks as predicted by the model under the assumption of financial globalisation are a poor match for their "true" capital stocks estimated from investment data. Introducing a country-specific foreign investment friction allows me to reconcile the model's predictions with the data, while the implied size of investment frictions is strongly correlated with *de jure* and *de facto* measures of countries' financial openness. Under this assumption of partial financial globalisation, the model predicts 80-90% of the growth in North-South trade – up to 62% of the overall growth in world trade.

a Basic Data and Parameterisation

a.1 Data

The model of Section 2 is characterised by an overlapping-generations structure and assumes full depreciation of capital between periods. To remain true to the spirit of the theory, I treat the years 1980 and 2007 as consecutive periods of my model. I use data for 27 large economies between 1980 and 2007, accounting for 85% of world GDP in this period. Their stocks of human and physical capital are estimated in accordance with the methodology explained in Appendix A1, which also provides a full list of countries' estimated shares in the stocks of world production factors. The main data sources for the construction of human and physical capital stocks are Heston, Summers and Aten (2010) and Barro and Lee (2010).

In the model, differences in factor-proportions are the only reason for countries to trade goods internationally. Yet, it is clear that factor-proportions trade can at best account for a fraction of global trade: Figure 2 shows that bilateral trade between capital-abundant countries − which is entirely absent from my model! − continues to account for the largest share of international trade. Therefore, I assess my model only against its ability to predict the growth in the subset of international trade flows it was designed to capture: exports and imports between the capital-abundant "North" and the labour-abundant "South".

The total volume of North-South trade is defined as one half times the total volume of exports and imports between capital and labour-abundant countries, based on the estimated human and physical capital stocks. Data on aggregate trade flows and country GDP is taken from the IMF Direction of Trade Statistics and the World

Development Indicators, respectively.

a.2 Parameters

I assume that the world was in financial autarky in 1980,[12] and that China was completely closed off from international goods markets. Using (18), the traded share of world output in 1980 is given by

$$\frac{\sum_c \left(|M_{cK1980}| + |M_{cH1980}|\right)}{2\left(Q_{1980} + Q_{China,1980}\right)} =$$

$$\frac{\alpha(1-\alpha)}{\alpha_K - \alpha_H} \sum_c \left| \frac{K_{c1980}}{K_{1980}} - \frac{H_{c1980}}{H_{1980}} \right| \left[1 + \left(\frac{K_{China,1980}}{K_{1980}} \right)^{\alpha} \left(\frac{H_{China,1980}}{H_{1980}} \right)^{1-\alpha} \right]^{-1}. \tag{1.32}$$

To discipline the model, I would like to match the volume of North-South trade relative to world GDP in 1980. Let $\alpha = 0.33$, as per convention, and suppose $\alpha_K - \alpha_H = 1$, the maximum feasible difference between these two parameters. In this case, given $\{K_{c1980}\}_c$ and $\{H_{c1980}\}_c$ from the data described in Appendix A1, the model predicts North-South trade to be 6.4% world GDP. In the data, however, North-South trade only amounted to 1.6% of world GDP in 1980. In other words, even under the most conservative parameterisation, the model *overpredicts* the volume of North-South trade in 1980.

To address this problem, I generalise the model in Section 2 by introducing a nonhomotheticity in the consumption demand for the H-good. A similar assumption is first introduced in Markusen (1986) to explain the relatively low volume of North-South trade.[13] The

[12] This assumption is highly realistic as the absolute magnitude of international financial flows between 1950 and 1980 was sufficiently small to have had almost no perceptible impact on the patterns of capital accumulation among my sample countries.

[13] I provide the full details of this change to the model in Appendix A3.

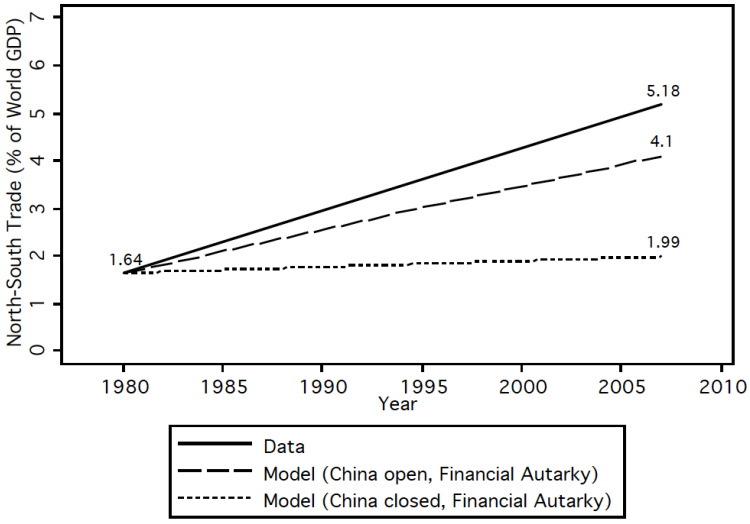


Figure 1.5: Calibration Results - Opening Up of China

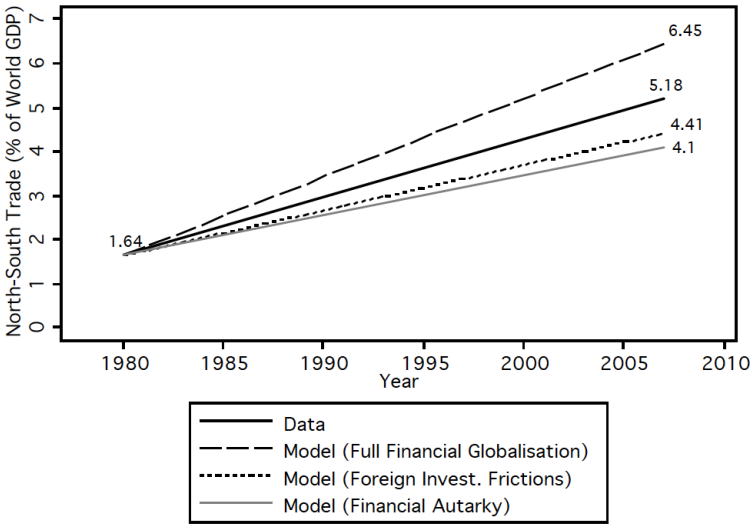


Figure 1.6: Calibration Results - Financial Globalisation

Parameter/ Data	Baseline Value	Source
α	0.33	-
θ	0.50	Minimal impact of trade balance shocks on the global volume of trade, following Eaton, Kortum, Neiman and Romalis (2010).
τ	0.88	Set to match the ratio of North-South trade to world GDP in 1980.
σ^2_c	-	Average PRSG composite country risk score for 1980-2007. Listed in Appendix A1, Table A1.
H_{ct}	-	Size of the workforce times "quality adjustment" for the average number of years of education in the population of working age. For details, see Appendix A1.
K_{c1980}	-	1980 capital stock constructed using the perpetual inventory method (first year: 1950) and investment data. For details, see Appendix A1.
K_{c2007}	-	2007 capital stock constructed using the perpetual inventory method (starting from K_{c1980}) and investment data. For details, see Appendix A1.
K^{FA}_{c2007}	-	2007 capital stock constructed using the perpetual inventory method (starting from K_{c1980}) and savings data year. For details, see Appendix A1.

Table 1.1: Parameter Values and Data Sources

presence of this nonhomotheticity does not fundamentally alter the structure of my model, but it delivers a slightly different expression for the traded share of world output in 1980:

$$\frac{\sum_c \left(|M_{cK1980}| + |M_{cH1980}|\right)}{2\left(Q_{1980} + Q_{China,1980}\right)} =$$

$$\theta(1-\alpha)\frac{1-\tau}{1-\alpha\tau}\sum_c \left|\frac{K_{c1980}}{K_{1980}} - \frac{H_{c1980}}{H_{1980}}\right| \left[1 + \left(\frac{K_{China,1980}}{K_{1980}}\right)^{\alpha}\left(\frac{H_{China,1980}}{H_{1980}}\right)^{1-\alpha}\right]^{-1}. \tag{1.33}$$

The new expression allows me to match the ratio of North-South trade to world GDP in 1980 using τ, after selecting $\alpha = 0.33$ and $\theta = 0.50$. The latter choice is motivated by the following consideration. As the only role of θ in the model is to determine the impact

of trade imbalances on the volume of trade, the value of θ should reflect the empirical impact of shocks to trade balances on import and export volumes. Evidence by Eaton, Kortum, Neiman and Romalis (2010) from the recent financial crisis − which saw a large, temporary contraction in global trade imbalances − suggests that the effect of trade balance shocks on the global volume of trade is minimal. Setting $\theta = 0.50$ ensures that my model is consistent with their finding.

Table 1 summarises the key parameter values and data sources.

b Opening Up of China

b.1 Calibration Results

Under the assumption of continued financial autarky, and without the opening up of China, the model-predicted ratio of North-South trade to world GDP in 2007 is given by

$$\frac{\sum_c \left(|M_{cK2007}| + |M_{cH2007}|\right)}{2\left(Q_{2007} + Q_{China,2007}\right)} =$$

$$\theta(1-\alpha)\frac{1-\tau}{1-\alpha\tau}\sum_c \left|\frac{K^{FA}_{c2007}}{K_{2007}} - \frac{H_{c2007}}{H_{2007}}\right| \left[1 + \left(\frac{K^{FA}_{China,2007}}{K_{2007}}\right)^{\alpha}\left(\frac{H_{China,2007}}{H_{2007}}\right)^{1-\alpha}\right]^{-1}, \tag{1.34}$$

where $\left\{K^{FA}_{c2007}\right\}_c$ represent countries' capital stocks in 2007 under the assumption of financial autarky. I construct these "financial autarky" capital stocks using the perpetual inventory method but letting domestic investment equal domestic savings between 1980 and 2007. A more detailed description of the construction of $\left\{K^{FA}_{c2007}\right\}_c$ is provided in Appendix A1.

As can be seen from Figure 5, the model predicts a modest increase North-South trade relative to world GDP in this case, from

1.6% to 2.0%. Even in the absence of China's rise to global prominence and without international capital flows, growing differences between the capital-labour ratios of my sample countries would have caused a modest increase in global trade. This divergence of factor proportions alone can account for 10% of the overall increase in North-South trade relative to world GDP.

Retaining the assumption of financial autarky, but letting China join international goods markets, the model-predicted ratio of North-South trade to world GDP in 2007 is:

$$\frac{\sum_c \left(|M_{cK2007}| + |M_{cH2007}|\right)}{2Q_{2007}} = \theta(1-\alpha)\frac{1-\tau}{1-\alpha\tau}\sum_{c,China}\left|\frac{K^{FA}_{c2007}}{K_{2007}} - \frac{H_{c2007}}{H_{2007}}\right|. \quad (1.35)$$

The predicted ratio of North-South trade to world GDP in 2007 jumps to 4.1%, allowing the model to capture a full 70% of the expansion of North-South trade (see Figure 5, dashed line). As the surge in North-South trade since 1980 accounts for 70% of the rise in the traded share of output overall, my factor-proportions model allows me to explain roughly half of the total growth in world trade.

The exercise highlights the significance of China for any factor-proportions-based view of international goods trade, which is due to its size and labour-abundance: as Table A1 shows, China accounted for 36% of the human capital among my sample countries in 2007, but only for 16% of their physical capital.

Aside from predicting a substantial share of the growth in North-South trade since 1980, the model also accurately captures the patterns of North-South trade for the largest economies: it predicts China's trade with the North in 2007 to be 1.4% of world GDP (Data: 1.3%), and the United States', Japan's and Germany's trade with the South to be 0.6% (Data: 1.0%), 0.5% (Data: 0.4%) and 0.2% (Data: 0.2%).

b.2 Impact on Other Labour-Abundant Countries

As discussed in Section 2.b, a model of factor-proportions trade would predict the arrival of a labour-abundant country like China to reduce the trade between other labour-abundant economies and the capital-abundant North. Here, I explore the empirical validity of this prediction at a macroeconomic level.

The top panel of Table 2 lists the countries whose trade is hurt in the model calibration as a result of China's opening, as well as the

Model-Predicted Impact of China's Opening:

Country	Chile	Thailand	Argentina	Mexico	Turkey	Brazil	Indonesia	S. Africa
$\Delta Trade_{c,t}/GDP_{c,t}$ (% pts.)	-1.39	-1.33	-1.22	-1.12	-0.83	-0.67	-0.51	-0.43

Regressions:

Dep. Variable: $North\text{-}Trade_{c,t}/GDP_{c,t}$	(1) Chile	(2) Thailand	(3) Argentina	(4) Mexico	(5) Turkey	(6) Brazil	(7) Indonesia	(8) S. Africa
$Trade_{China,t}/World\ Trade_t$	1.75*	-3.11***	-0.25	-4.03**	0.98*	-0.05	-4.94***	-1.76**
	(0.89)	(0.88)	(0.49)	(1.52)	(0.52)	(0.45)	(1.19)	(0.64)
t	0.45*	0.35	-0.49***	0.47	0.78***	-0.21*	-0.58*	-1.02***
	(0.23)	(0.22)	(0.12)	(0.38)	(0.13)	(0.11)	(0.30)	(0.16)
t^2	-0.03*	0.04***	0.02**	0.05*	-0.03***	0.01	0.07***	0.06***
	(0.02)	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)	(0.02)	(0.01)
Constant	9.08***	14.81***	6.65***	12.58***	1.59	5.90***	22.47***	18.16***
	(1.94)	(1.92)	(1.06)	(3.30)	(1.14)	(0.98)	(2.59)	(1.39)
Observations	28	28	28	28	28	28	28	28
Adj. R^2	0.21	0.94	0.59	0.81	0.83	0.22	0.38	0.72

Standard errors in parentheses. Period: 1980-2007.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 1.2: Impact of China on Labour Abundant Countries – Model and Regressions

resulting fall in their trade relative to country GDP (in percentage points). As the table shows, the model predicts the trade of Chile, Thailand, Argentina and Mexico to be most severely affected.

The bottom panel of Table 2 regresses each country's trade with the North as a share of country GDP on a quadratic time trend and China's share of world trade for the period 1980-2007. The quadratic time trend is intended to capture long-term changes in a country's comparative advantage due to, say, changes in its factor endowments relative to the rest of the world, or country-specific changes in tariffs or transportation costs, which my model does not account for. China's share of world trade captures the Chinese economy's weight in global goods markets.

As the table shows, the coefficient on China's share of global trade is negative for six out of the eight countries, and strongly statistically significant for four of them. Moreover, neither of the two positive coefficients in statistically significant at the 5% level. The coefficient on China's trade share is negative for three out of the four countries for which the model predicts the largest trade losses, and two of these negative coefficients are large and strongly statistically significant. Overall, therefore, the empirical evidence appears to support the prediction that there would have been more trade between this group of countries and the global North if China had remained closed off from international goods markets.

b.3 Evidence about Specialisation

A fundamental prediction of the model outlined in Section 2.a is that differences in relative factor endowments should foster specialisation in international goods markets: countries with a large stock of in-

stalled physical capital relative to their endowment of human capital will be exporters of relatively capital-intensive products. There is a long literature which has attempted to verify this prediction of factor-proportions models, with very mixed results.[14]

Typically, studies of the factor content of trade proceed by careful analysis of countries' trade and production patterns, using detailed data from economy-wide input-output tables.[15] As they tend to be extremely data intensive, there is as yet little evidence about the factor content of trade in the first decade of the 2000s, when China's transition had started to gather pace. However, basic evidence suggests that relative factor endowments have become a more significant determinant of the type of goods imported by the United States from its major trading partners. I present this evidence in Appendix A2.

c Financial Globalisation

c.1 Calibration Results

Let us now relax the assumption that there is no international asset trade between 1980 and 2007 and assume, instead, that financial globalisation occurred some time inbetween these two years. As I have set $\theta = 0.50$, the ratio of North-South trade to world GDP should be unaffected by the presence of trade imbalances in 2007 as long as equation (30) is satisfied in my sample countries. I take $\{NX_{c2007}\}_c$, country-level imbalances in North-South trade for the year 2007, from the IMF Direction of Trade Statistics and verify that this is the case.

[14] See Helpman (1999) for a comprehensive survey.

[15] See Davis and Weinstein (2001) for a recent, careful empirical analysis confirming the model's prediction that countries export goods which use their abundant factors intensively.

Hence, the model-predicted ratio of North-South trade to world GDP in 2007 under full financial globalisation is given by

$$\frac{\sum_c (|M_{cK2007}| + |M_{cH2007}|)}{2Q_{2007}} = \theta(1-\alpha)\frac{1-\tau}{1-\alpha\tau}\sum_{c,China}\left|\frac{1}{\sigma_c^2}\left(\sum_{c',China}\frac{1}{\sigma_{c'}^2}\right)^{-1} - \frac{H_{c2007}}{H_{2007}}\right|, \tag{1.36}$$

where I use the average PRSG composite country risk score for 1980-2007 as a proxy for idiosyncratic country risk, $\{\sigma_c^2\}_c$. These averages are reported in Table A1 of Appendix A1.

As illustrated in Figure 6, North-South trade rises to 6.5% of world GDP in 2007 once fully integrated international asset market are assumed (dashed line). In the light of the analysis of the model under full financial globalisation in Section 2.c, the finding of a rise in trade due to financial integration highlights an empirical mismatch between idiosyncratic country risk and human capital stocks, which causes the model to predict larger factor-endowment differences as a result of international capital flows. This is consistent with the evidence on South-North capital flows reported in the International Finance literature. However, the model now overpredicts the growth in North-South trade in the last 30 years.

To determine why, I correlate country's shares in the world capital stock as predicted by the model under full globalisation with $\{K_{c2007}/K_{2007}\}_c$, where $\{K_{c2007}\}_c$ is constructed using investment data between 1980 and 2007, and represents the standard estimate of a country's stock of physical capital.[16] Figure 7 plots the results. As is immediately evident, the fit is rather poor: the correlation between the

[16]Note that national accounting identities imply that investment equals savings plus the current account − so that $\{K_{c2007}\}_c$ accounts for net international asset trades in the patterns of capital accumulation.

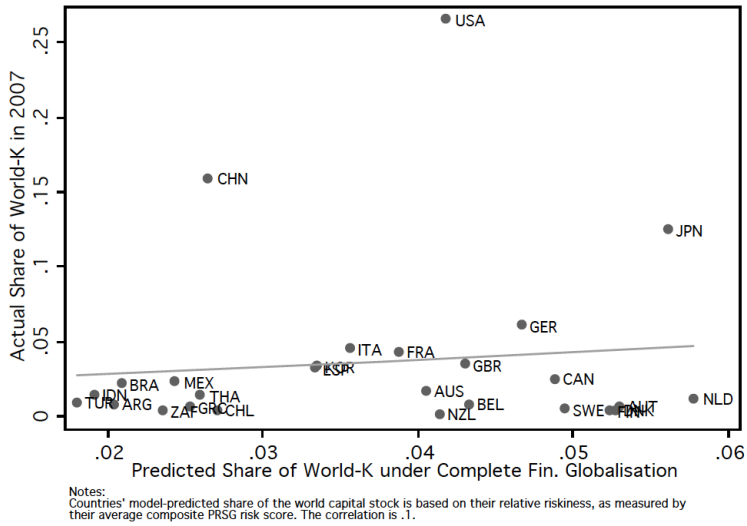


Figure 1.7: Model-Implied and Actual Shares in the World Capital Stock

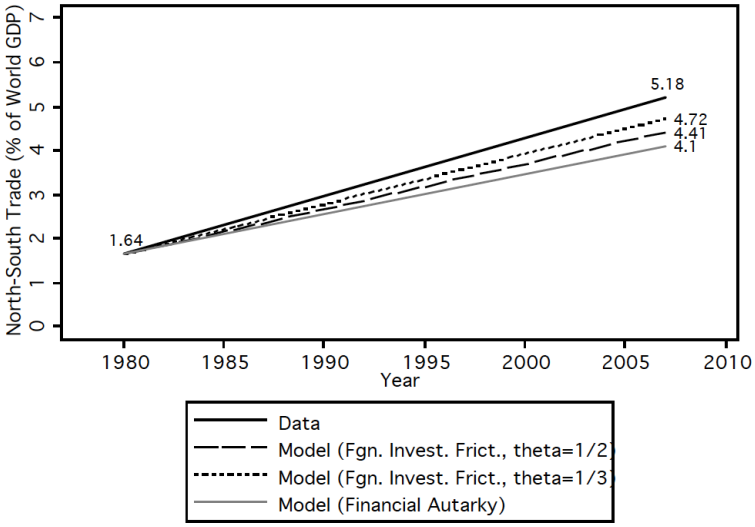


Figure 1.8: Calibration Results - Financial Globalisation ($\theta \neq 0.50$)

two variables is a mere 0.1. The model predicts a smaller dispersion of capital stocks than is found in the data, and it assigns unrealistically low shares in the global capital stock to the large economies of the United States, China and Japan.

Upon second examination, this finding should come as no surprise. The risk-investment regressions referred to in the Introduction (and described in full in Appendix A2), highlight the continued importance of domestic savings as a determinant of domestic investment. In accordance with these findings, economies with a larger pool of domestic savings would be expected to have larger capital stocks for a given level of country risk. By contrast, in the benchmark model in Section 2.c domestic savings play no role at all in determining investment in financially open economies. Thus, the model underpredicts the share of the world capital stock located in the largest economies

c.2 Partial Financial Globalisation

The reason the model predicts countries' shares in the global stock of capital poorly − and the reason it overpredicts the growth of trade under financial globalisation − is that I have taken an extreme view of financial globalisation so far: trading in foreign assets is no more costly than buying or selling domestic assets for agents in a given c. Suppose, instead, that for each unit of spending by an agent in c on assets from region $c' \neq c$, the agent can only appropriate the returns to $1 - f_c$ units of the foreign asset.[17] This additional cost of foreign asset purchases reduces the expected returns from, and hence the relative

[17] One could think of f_c as a tax on foreign transactions by c's government, or an agency or information cost specific to c which is higher for foreign than for domestic investments.

attractiveness of, foreign assets and causes a "home bias" in investment portfolios. As a result, the optimal investment portfolio is no longer universal, and it can be shown that for agents in c

$$\phi_{c'}^{c} = \max\left\{\frac{1}{\sigma_{c'}^{2}}\left(\sum_{c'}\frac{1}{\sigma_{c'}^{2}}\right)^{-1}\left(1-\frac{f_c}{\gamma\sigma_{c}^{2}}\right),0\right\}\ \forall\ c'\neq c, \tag{1.37}$$

$$\phi_{c}^{c} = 1-\sum_{c'\neq c}\phi_{c'}^{c}. \tag{1.38}$$

If $f_c \geq \theta\sigma_c^2$, agents in c will choose not to purchase foreign assets at all. If $f_c \to 0$, (37) and (38) approach the optimal frictionless world portfolio described by equation (24). An immediate implication of (37) and (38) is that the higher the average f_c (and hence the average ϕ_c^c), the greater the role for domestic savings as a determinant of domestic investments.

Introducing a set of financial frictions permits me to use $\{\sigma_c^2\}_c$ from the data and set $\{f_c\}_c$ to match $\{K_{c2007}/K_{2007}\}_c$. As agents now face a risk-return trade-off, I need to specify a value for γ, the coefficient of relative risk aversion. In line with the RBC literature, I let $\gamma = 2$. With the introduction of foreign investment frictions, the model no longer overpredicts the rise in North-South trade relative to world GDP. Nevertheless, allowing for partial financial globalisation means the model can explain an additional 10% of the expansion in North-South trade, and 80% overall (see Figure 6, dotted line). This suggests that a significant portion of the expansion of trade between capital-abundant and labour-abundant countries in the last three decades may be the result of the observed net capital flows towards the global North.

This leaves the question whether the model's new implications for financial openness are more consistent with empirical reality than the

	f_c	Capital Account Restrictions, Schindler (2009)	Avg. $\lvert CA_{ct}/GDP_{ct}\rvert$, 1980-2007	GFA_{ct}/GDP_{ct}, 2007
f_c	1.0000			
Capital Account Restrictions, Schindler (2009)	0.4415	1.0000		
Avg. $\lvert CA_{ct}/GDP_{ct}\rvert$, 1980-2007	-0.2690	0.1418	1.0000	
GFA_{ct}/GDP_{ct}, 2007	-0.5231	-0.5769	-0.1698	1.0000

Table 1.3: Model-Implied Investment Friction and Measures of Fin. Openness

capital stocks implied by the frictionless model. I turns out that the system of 27 equations described by

$$\frac{K_{c2007}}{K_{2007}} = \sum_{c'=1}^{C} \phi_c^{c'} \left(\{f_c\}_c\right)$$

has a unique interior solution in which $f_c \geq 0$ for all c. The resulting set of model-implied financial frictions provides an inverse measure of financial openness for my sample countries: the smaller f_c, the more open is c to foreign asset trade.

Table 3 correlates the model-implied foreign investment frictions with one *de jure* and two *de facto* measure of countries' financial openness. It shows that the set of implied frictions is strongly positively correlated with the index of capital account restrictions by Schindler (2009), negatively correlated with a countries' average absolute current account share in GDP and strongly negatively correlated with their foreign asset holdings relative to GDP. All in all, assuming that financial globalisation allows agents to hedge idiosyncratic investment risk subject to country-specific foreign investment frictions allows me to match the patterns of international financial integration remarkably well.

c.3 A Role for Trade Imbalances

So far I have set $\theta = 0.50$ to minimise the impact of trade imbalances on the overall volume of trade, in line with empirical evidence. In this section I analyse the effect of choosing $\theta \neq 0.50$. As I continue to assume that the world was in financial autarky in 1980 and choose τ to match the ratio of North-South trade to world GDP in 1980, this only affects the extent of North-South trade in 2007.

As can be seen from Figure 8 (dotted line), setting $\theta = 0.33$ increases the share of North-South trade growth explained by the calibrated model by a further 8 percentage points. The model now captures a full 88% of the expansion of North-South trade, amounting to 62% of the total growth in world trade.

The reason for this impact of trade imbalances is as follows. With $\theta < 0.50$, a trade deficit increases domestic demand for capital-intensive products less than for labour-intensive products. Conversely, a trade surplus decreases domestic demand for capital-intensive products less than for labour-intensive products. Consequently, if deficit countries are − on average − capital-abundant and surplus countries labour-abundant, trade imbalances will increase global trade. The increase in trade growth predicted by the model is thus largely due to the substantial North-South trade deficit of the United States in 2007 (amounting to 0.71% of world GDP) and the sizable North-South trade surplus of China (about 0.78% of world GDP). If, on the other hand, $\theta > 0.50$ had been chosen, the pattern would be reversed: the model would predict the observed pattern of trade surpluses and deficits to reduce North-South trade, and it would predict a smaller portion of recent trade growth.

1.4 Summary and Conclusion

In this paper I document that a classical model of comparative advantage due to differences in countries' relative endowments of production factors can explain most of the recent growth of world trade. This largely reflects a rise in the volume of trade between countries with very different capital-labour ratios but also, to a significant extent, a pattern of international capital flows which has exacerbated factor-proportions differences, increasing the incentives for specialisation. My model and calibrations highlight that the growing prevalence of factor-proportions trade may explain why financial globalisation has taken this unexpected turn: if international commodity trade reduces factor-return differentials − a well-established prediction of factor-proportions models −, the importance of country risk as a determinant of international investment patterns is enhanced. Net financial flows to relatively safe countries may drive capital-labour ratios further apart if these countries also account for a small portion of the world's effective workforce.

Throughout the paper I have focused exclusively on factor-proportions differences as a motive for countries to engage in goods trade. Adopting this perspective has allowed me to highlight its relevance for understanding some important recent features of globalisation. Yet there are others which it cannot capture adequately.

Figure 2 highlights the continued concentration of a large share of international trade among a small group of relatively similar and affluent countries. By most accounts, this portion of global trade is better explained by the scale economies of new trade theory than by differences in countries' capital-labour ratios. My evidence on the importance of factor-proportions differences for the growth of world trade

since 1980 does not preclude any role for new trade motives in explaining rises in the traded share of world output. Helpman's (1987) original argument that increased income similarity across countries should cause greater volumes of trade has had little quantitative traction because the world income distribution has remained remarkably stable during most of the post-War era.[18] However, high growth rates in China and other developing countries may yet cause the world income distribution to narrow, opening the door to another channel through which their transition should affect the expansion of global trade.

My paper investigates the growth of world trade over a thirty-year period. Yet its unexpectedly large decline, and subsequent recovery, during the downturn of 2008-2009 has also renewed interest in the causes of short-run fluctuations in global trade flows. A pure factor-proportions model is unsuited to analysing this issue as factor endowments evolve over the span of decades, rather than years. Explaining the responsiveness of trade flows to the global business cycle requires a careful investigation of the transmission of real and financial shocks in the world economy for a given pattern of comparative advantage. Nevertheless, it is noteworthy that the existing literature on international business cycles has relied on a very specific set of assumptions about the motives for trade.[19] My findings suggest that a more eclectic theoretical approach to international goods exchange may well enhance the ability of international business cycle models to predict the short-run patterns of trade and capital flows among an increasingly heterogenous set of open economies.

[18] See, for example, Acemoglu and Ventura (2002).

[19] Following Backus, Kehoe and Kydland (1994), papers in this literature tend to assume Armington trade in intermediate goods which are aggregated by means of a CES production into a composite final good,

I have attributed a large share of the recent growth of world trade to the transition of China, and to financial globalisation which has given rise to the observed pattern of capital flows towards capital-abundant countries. As neither of these processes is concluded, this paper is unlikely to prove the last word on their significance for the patterns of specialisation and global trade flows. Both will continue to shape the international economy for some time to come.

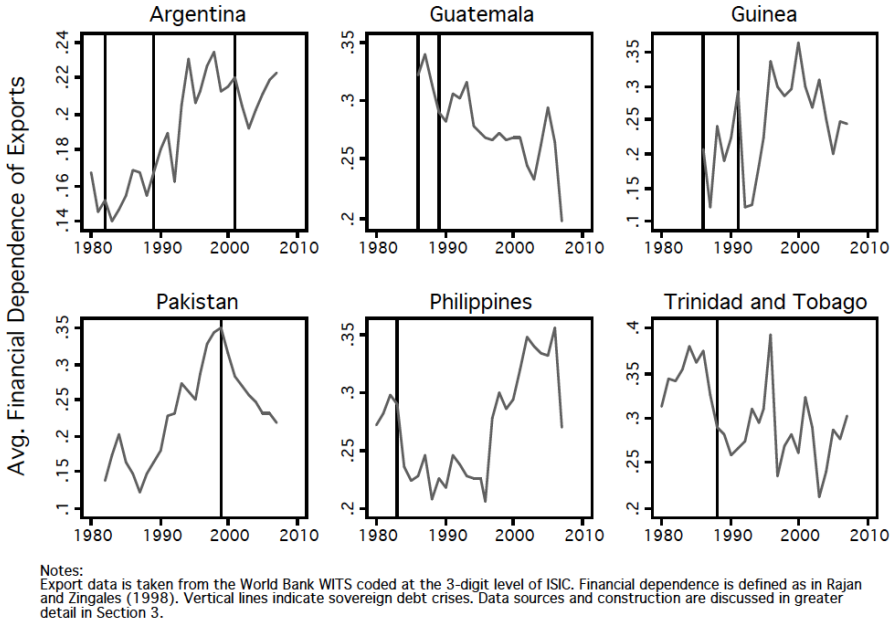
2 Sovereign Default, International Lending and Trade

2.1 Introduction

This paper sheds new light on the nature of the supposed "trade costs" of sovereign default. I employ a large panel of developed and emerging markets to analyse the impact of default episodes on countries' sectoral export behaviour. The key finding is that default leads to a stronger reduction in the exports of sectors which are more dependent on external financing. I argue that this empirical pattern is consistent with a decline in credit supply to domestic exporters. My estimates suggest that most of the adverse impact of sovereign default on trade found in earlier studies is explained by this credit channel. They contradict the widespread notion that reduced access to international goods markets constitutes a cost of sovereign default. Instead, shifting trading patterns may be a symptom of reduced access to international capital markets.

Figure 1 plots the time-series pattern of a measure of the financial dependence of exports for six countries which experienced at least one sovereign default episode between 1980 and 2007.[1] Vertical lines indicate the timing of these episodes. Sovereign defaults tend to coincide with, or to be followed by, declines in the average financial dependence of exports, indicating a shift in the composition of exports away from highly financially dependent and towards less financially vulnerable

[1] I calculate country c's average financial dependence of exports in year t as $\sum_i FinDep_i Exp_{cit} / \sum_i Exp_{cit}$ where Exp_{cit} are sector-i exports by country c in year t, and $FinDep_i$ is a measure of the financial dependence of production in sector i. Data sources and definitions are discussed in greater detail in Section 5.



Notes:
Export data is taken from the World Bank WITS coded at the 3-digit level of ISIC. Financial dependence is defined as in Rajan and Zingales (1998). Vertical lines indicate sovereign debt crises. Data sources and construction are discussed in greater detail in Section 3.

Figure 2.1: Default and the Average Financial Dependence of Exports, Selected Countries

goods. The main contribution of this paper to establish the generality of this observation econometrically, and to highlight that it may be understood as a result of a temporary comparative disadvantage inflicted upon exporters by a reduction in capital-market access.

The view that the economic costs of sovereign default manifest themselves partly in the pattern of trade flows has a long tradition in the literature on sovereign borrowing. For example, in their seminal paper about sovereign lending in the presence of strategic default Eaton and Gersovitz (1981) justify the assumption that defaulters incur a direct output cost by appealing to "retaliatory interference by

the creditors or their governments with commodity trade". Similarly, Bulow and Rogoff (1989) argue that foreign lenders' ability to interfere with debtor's trade flows poses a credible threat, claiming that fear of "trade sanctions can plausibly explain the actual repayments that do occur".

These examples reflect a wider, as yet unanswered, question about the incentives for sovereign debtors to honour their obligations towards foreign creditors. By definition, loan contracts with sovereign entities suffer from limited legal enforceability. Yet for decades large volumes of such international loans have been extended, and subsequently repaid. Much research has been dedicated to uncovering the economic penalties for default which may sustain these cross-border financial transactions, and "trade costs" are one among several explanations which have been put forward. The threat of exclusion from international capital markets is a prominent alternative explanation. While there is extensive evidence that countries which default on their international debt obligations experience reduced access to international capital markets,[2] the impact of sovereign default on the debtor economy's trade with the rest of the world has only recently started to receive formal empirical attention.

Rose (2005) is the first to document that debt renegotiations are followed by a significant and sustained decline in trade between the debtor country and its foreign creditor nations. Applying a gravity regression to an unbalanced panel of over 150 countries in the period 1948-1997, he finds a significant 7% annual decline in exports and imports between countries involved in debt renegotiation, lasting for 15 years. Although he remains agnostic about the precise explanation for

[2]See Gelos et al. (2003), Arteta and Hale (2008), Fuentes and Saravia (2010) and Mendoza and Yue (2008) for recent examples.

this observation, Rose interprets his findings as consistent with deliberate trade sanctions by creditor nations designed to punish obstinate debtors. Subsequent work by Martinez and Sandleris (2008) casts doubts on this interpretation: using the same methodology and data, they cannot reject the hypothesis of an equal decline in the debtor country's trade with all its trading partners, whether sovereign creditors or not. They also note the absence of a single known instance in which sovereign default was punished with overt trade sanctions in the last 30 years.[3]

Since Rose (2005) uses aggregate trade data and fails to pinpoint a clear causal link between default and the decline in trade, his findings are open to the criticism of reverse causality and omitted variable bias. For this reason, Borensztein and Panizza (2010) take a different approach to identifying the "trade costs" of default. The authors use a panel of 28 industries in 24 countries for the period 1980-2000 and show that sovereign default causes a larger decline in the value-added growth of export-oriented sectors. Since their study exploits the differential impact of default at the sector level it is less likely to suffer from reverse causality and omitted variable bias, providing further evidence that debt crises "hurt" exporters. However, just as its precursors, it does not explain why this might be the case.

This paper is closely related to Borensztein and Panizza (2010). Like them, I employ a difference-in-difference approach in the spirit of Rajan and Zingales (1998) to study the impact of sovereign default at the sector level.[4] Unlike them, I test directly for a particular causal

[3]By contrast, Mitchener and Weidenmier (2005) document that between 1870 and 1914, disgruntled creditors did resort to gunboat diplomacy to punish instances of sovereign default, and that such "supersanctions" triggered a decline in trade.

[4]Following their seminal paper on financial development and growth, the Rajan-

link between sovereign default and trading patters – namely that default reduces exporters' access to external financing. My identification strategy, which is firmly grounded in modern trade theory, predicts a differential impact of default on the volume of exports. This allows me to ascertain how much of the decline in trade flows attributed to default in earlier studies can be explained as a result of the credit-channel emphasised here. The present empirical analysis also benefits from a significantly larger sample, covering 28 industries and 95 countries between 1980 and 2007.

My regressions show that default episodes result in the strongest decline in the exports of those sectors which are most dependent on external financing. This finding is robust to additional controls for other financial crises and alternative industry characteristics, and independent of the precise sample composition and the lag structure of the econometric model. It lends strong support to the hypothesis that shocks to foreign credit supply can explain the "trade costs" of sovereign default. Based on my estimates, this credit channel accounts for most of the overall impact of sovereign default on trade.

From the vantage point of the empirical literature on financial development and trade, this paper's findings mirror the study by Manova (2008). Her work examines the impact of financial liberalisation on trade, and finds that it boosts the exports of the most financially vulnerable sectors. Treating default as "inverse" financial liberalisation,

Zingales methodology has been adopted by a number of authors for empirical studies in a variety of contexts. Among others, it has been used to examine the effect of financial development on growth and output volatility (Fisman and Love, 2003; Braun, 2003; Raddatz, 2006), the impact of financial liberalisation on exports and growth (Manova, 2008; Levchenko, Rancière and Thoenig, 2009) and the consequence of banking crises for value added and exports (Kroszner, Laeven and Klingebiel, 2006; Iacovone and Zavacka, 2009).

I find that it leads to the largest contraction in the exports of the sectors which are most dependent on external financing.

The remainder of the paper is structured as follows. Section 2 motivates my identification strategy with a simple model of international lending and trade in a small, open and capital-scarce economy. Section 3 describes the data and presents the empirical results. Section 4 concludes.

2.2 The Model

In the following, I develop a standard model of intra-industry goods trade between countries. I assume that capital is perfectly mobile internationally and introduce the effect of sovereign default as a "black-box" increase in international financial frictions which raises the cost of borrowing in the defaulting economy. The model serves to highlight the key identifying assumptions underlying the regression equations estimated in Section 3.

a Assumptions and Derivations

a.1 Demand

Let the world consist of C countries, $c \in \{1, ..., C\}$, and let there be I industries, $i \in \{1, ...I\}$. Producers in each country have access to a technology for manufacturing a unique, perfectly tradable variety c in each industry i. As a result $C \times I$ goods will be produced and traded in equilibrium.

Denote nominal spending by country c in industry i at time t as E_{cit}. Suppose perfectly competitive producers in c assemble a non-

traded final good in industry i from the set of tradable, country-specific varieties using a production technology described by the minimum-cost function

$$B_{it}\left(Q_{cit}\right) = \left(\sum_{c'=1}^{C} p_{c'it}^{1-\varepsilon}\right)^{\frac{1}{1-\varepsilon}} Q_{cit}, \tag{2.1}$$

where $p_{c'it}$ denotes the price at time t of the perfectly tradable product variety produced by country c' in industry i, Q_{cit} is the desired final-good output of industry i in country c and $\varepsilon > 1$. Final-good output in each industry, therefore, is a CES aggregate of the C country-specific varieties. It is now straightforward to show that total nominal demand for goods produced by country c in industry i is equal to

$$p_{cit}\hat{q}_{cit} = \left(\frac{p_{cit}}{P_{it}}\right)^{1-\varepsilon} E_{it}, \tag{2.2}$$

where $P_{it} = \left(\sum_{c'} p_{c'it}^{1-\varepsilon}\right)^{\frac{1}{1-\varepsilon}}$ and $E_{it} = \sum_{c} E_{cit}$. Demand for each variety c in industry i is directly proportional to world spending on industry-i goods, and inversely proportional to its share in a measure of the industry price level, P_{it}.

a.2 Supply

The unique, country-specific technology for producing variety c in industry i is described by the minimum-cost function

$$b_{cit}(q_{cit}) = \frac{1}{A_{ct}} \left(\frac{R_{ct}}{\alpha_i}\right)^{\alpha_i} \left(\frac{W_{ct}}{1-\alpha_i}\right)^{1-\alpha_i} q_{cit}, \tag{2.3}$$

where q_{cit} is the output of good c in industry i, A_{ct} is a measure of country c's total factor productivity, and R_{ct} and W_{ct} are, respectively,

the cost of capital and the wage rate in c at time t. The parameter $\alpha_i \in [0,1]$ is a measure of industry i's capital intensity. Since all capital is assumed to be loaned, it is also a measure of the industry's credit dependence.

Capital is perfectly mobile across industries and borders. Meanwhile, labour is perfectly mobile across industries within countries, but not across borders. To simplify matters I assume that there exists a homogenous, perfectly tradable good which can be produced only from labour at identical, constant unit cost by all countries. I normalise the price of this good to 1, which implies $W_{ct} = 1 \; \forall \; c$.

Let product and factor markets be perfectly competitive. Then,

$$\hat{p}_{cit} = \frac{R_{ct}^{\alpha_i}}{A_{ct}\alpha_i^{\alpha_i}\left(1-\alpha_i\right)^{1-\alpha_i}}, \tag{2.4}$$

$$\hat{k}_{cit} = \frac{\alpha_i \hat{p}_{cit}\hat{q}_{cit}}{R_{ct}}, \tag{2.5}$$

where $\hat{k}_{cit}$ denotes the demand for capital at time t by industry i in country c.

a.3 A Small, Capital-Scarce Economy

Suppose the ability of country c to rent capital in international markets is impaired by the presence of a borrowing friction. Specifically, letting K_{ct} equal c's own stock of capital,

$$R_{ct} = \begin{cases} R_t & \text{if } \sum_i \hat{k}_{cit}\left(R_{ct}\right) \leq K_{ct} \\ \frac{R_t}{1-\pi_{ct}} & \text{if } \sum_i \hat{k}_{cit}\left(R_{ct}\right) > K_{ct} \end{cases}, \tag{2.6}$$

where R_t is the international rental rate and π_{ct} represents the generic friction. One way to interpret π_{ct} is as the (perceived) risk that due

payments on capital loans from foreigners at t will be expropriated by c's government and redistributed among the residents of country c, or diverted towards other projects. Risk neutral lenders will raise the interest rate on capital loans in anticipation of such expropriation.

If $\sum_i \hat{k}_{cit}(R_{ct}) \leq K_{ct}$, the borrowing friction does not affect c's producers. I will make the assumption that c is capital-scarce, i.e.

$$\sum_i \hat{k}_{cit}(R_{ct}) > K_{ct}. \tag{2.7}$$

Clearly, if $\pi_{ct} = 0$, country c can borrow at the world rental rate while if $\pi_{ct} > 0$, the cost of capital in c is higher than in world markets. My empirical analysis in Section 3 tests the hypothesis that sovereign default raises π_{ct} without providing a microfoundation for this assertion. Nevertheless, it would be possible to provide a number of theoretical justifications from the recent literature.[5]

Define X_{cit} as the value of c's exports in industry i at time t. Using equations (1) to (7),

$$X_{cit} = \left[\frac{(1-\pi_{ct})^{\alpha_i} A_{ct} \alpha_i^{\alpha_i} (1-\alpha_i)^{1-\alpha_i} P_{it}}{R_t^{\alpha_i}}\right]^{\varepsilon-1} (E_{it} - E_{cit}). \tag{2.8}$$

I assume that c is small, so that changes in c do not affect R_t, P_{it}, E_{it} and $E_{it} - E_{cit} \approx E_{it}$.

[5]For example, Sandleris (2008) shows that debt repayment may be used optimally by governments to signal private information about their future stance towards foreign creditors. In his model, default signals a hostile future environment for foreign creditors, and thus reduces foreign investment. Similar informational assumptions can also be used to motivate a rise in π_{ct} following sovereign default.

b Empirical Implications

Under the assumption that country c is small, it is possible to re-write equation (8) approximately as follows:

$$\ln X_{cit} \approx -(\varepsilon - 1)\,\alpha_i \pi_{ct} + \Delta_{it} + \Delta_{ct}, \tag{2.9}$$

where $\Delta_{it} \equiv (\varepsilon - 1)\ln[\alpha_i^{\alpha_i}(1-\alpha_i)^{1-\alpha_i} P_{it} E_{it}^{\frac{1}{\varepsilon-1}} / R_t^{\alpha_i}]$ and $\Delta_{ct} \equiv (\varepsilon - 1)\ln A_{ct}$. According to equation (9), we should expect two effects of a rise in π_{ct} due to default: first, a decline in country c's total exports and, second, a reduction in the exports of sector i which is larger the more financially dependent i (i.e. the larger α_i). In other words, we should observe default as a country-industry-time-specific shock. The next section outlines the paper's empirical strategy which aims to capture the effect of sovereign default on sectoral export patterns implied by equation (9).

2.3 Data and Empirical Results

a Empirical Methodology and Data

a.1 Empirical Methodology

The main empirical objective of this paper is to establish whether the impact of sovereign default on sectoral export patterns is consistent with the hypothesis that default reduces exporters' access to credit. As illustrated in the previous section, this would require us to observe that sovereign default reduces sectoral exports in accordance with their financial dependence. In order to establish whether this is the case, I employ a difference-in-difference approach in the spirit of Rajan and Zingales (1998) extended to an annual panel for the period 1980-2007.

Ideally, one would like to estimate the regression

$$\ln Exp_{cit} = \beta_0 + \sum_{n=0}^{N} \beta_{1n} FinDep_i \times Default_{ct-n} + \sum_{n=0}^{N} \beta_{2n} Default_{ct-n} + \beta_3 FinDep_i + \gamma Z_{cit} + \varepsilon_{cit}, \quad (2.10)$$

where $\ln Exp_{cit}$ is the log of country c's exports in sector i and year t, $FinDep_i$ is a measure of sector i's financial dependence, $Default_{ct-n}$ is a dummy taking value 1 if country c defaulted in $t-n$ and 0 otherwise, and Z_{cit} is a vector of control variables. However, as sovereign debt crises tend to occur in economically tumultuous times any such specification would be open to the criticism of omitted variable bias in the set of key coefficients $\{\beta_{1n}, \beta_{2n}\}_n$. For this reason my baseline regression equation takes the form

$$\ln Exp_{cit} = \beta_0 + \sum_{n=0}^{N} \beta_{1n} FinDep_i \times Default_{ct-n} + \delta_{ct} + \delta_{it} + \gamma Z_{cit} + \varepsilon_{cit}, \quad (2.11)$$

where δ_{ct} and δ_{it} are, respectively, two sets of country-time and industry-time dummies.

The advantage of the specification in equation (11) is that the impact on exports of any time-specific country or industry shocks (such as a decline in domestic GDP, or a fall in world demand for sector-i output) should be controlled for by the large array of fixed effects − insofar as their sectoral impact is not systematically correlated with the industry's financial dependence. As such, it allows for $\{\beta_{1n}\}_n$ to be estimated consistently by exploiting cross-sectional and time-series variation in the occurrence of default among the sample countries, and the cross-industry variation in financial dependence. However, it does not permit me to identify $\{\beta_{2n}\}_n$.

Irrespective of this shortcoming equation (11) can be used to test the hypothesis that sovereign default leads to a temporary rise in exporters' cost of obtaining credit, thereby reducing the exports of highly financially dependent industries relative to those which are less financially vulnerable. If it is correct, we should observe $\beta_{1n} < 0$ for $n = 0, ..., N$. Yet, without knowing $\{\beta_{2n}\}_n$, this finding is in principle consistent with sovereign default reducing or increasing exports overall. For the most part I will focus on the differential impact of default across exporting sectors, but Section 3.c.2 provides two alternative estimates of the overall impact of default on manufacturing exports, discusses their plausibility and compares them to the findings of earlier papers.

A practical difficulty in estimating equation (11) concerns the appropriate number of lags, N, to incorporate in the estimation. It seems reasonable to suppose that any default-induced rise in the economy's cost of foreign borrowing may persist for months or years after the event. In the baseline estimation, I arbitrarily restrict my regression equation to two lags of the default dummy to capture such persistence. However, in Section 3.b.2 I analyse the robustness of my results to the incorporation of additional lags of default.

a.2 Data

Data on the value of countries' sector-level exports between 1980 and 2007 is taken from UN Comtrade, via the World Integrated Trade Solution (WITS). WITS reports export flows annually in current U.S. dollars and coded at the three-digit level of ISIC. I check the data for errors, inconsistencies and changes in definitions and convert it into constant 2000 U.S. dollars, using the U.S. GDP deflator.

To ensure sufficiently long time series, and sufficient within-country variation, I drop all country years in which fewer than fifteen export flows are reported, all sectoral export series with fewer than fifteen annual observations, and all countries with fewer than fifteen sectoral export series that satisfy this criterion. To minimise the number of sectoral export series lost, I use mirrored export data wherever the exporter-reported series is insufficiently complete or non-existent. However, the use of mirrored data has little impact on the overall sample size and none of the paper's main results are sensitive to using only exporter-reported trade flows. Finally, in order to address potential concerns about reverse causality, I exclude all exporting sectors whose average exports during the sample period exceeded 1% of domestic GDP. The cleaned export data comprises 28 industries for 95 countries, 35 of which experienced at least one sovereign default during the sample period.

As in Rajan and Zingales (1998), financial dependence of sector-i production is defined as the share of capital expenditure not financed from cash flows by the median US firm in that sector, according to Compustat. The measure is based on U.S. firm-level data for two reasons. Firstly, similarly detailed financial data at the firm level is not available for the majority of countries in the sample used here, most notably the set of developing economies. Secondly, even if such data were available, the observed use of finance would reflect an equilibrium market outcome which, to the extent that financial-market frictions are pervasive, may reflect domestic market distortions, rather than the true "technological" financial dependence of a sector. Seeing as U.S. financial markets can be viewed as the most frictionless in the world, U.S. data on the use of external financing is likely to provide the best indicator of the technological external financing requirement

	Median	
	Defaulter	Non-Defaulter
DC_{c2007}/GDP_{c2007}	0.30	0.85
Avg. Financial Dependence of Exp_{c2007}	0.22	0.26
Avg. CA_{ct}/GDP_{ct} *in 2 Years Prior to Default*	-0.07	-

Table 2.1: Economic Characteristics of Sample Defaulters

of different sectors.[6] Table B2 in the Appendix lists this measure of financial dependence for my 28 ISIC industries. The source is Braun (2003).

The default dummy is based on the initial year of any government default on private bank or bond debt, reconciling information from Standard & Poor's (2003), Moody's (2011) and the financial crisis database of Laeven and Valencia (2008). This yields 56 distinct episodes of sovereign debt repudiation across 35 countries. Table B1 in the Appendix provides a comprehensive list of all sample countries, and their sovereign debt crises as covered by my data.

The main additional control variables are country GDP and private-sector domestic credit. Both are taken from the World Development Indicators in current U.S. dollars, and converted into constant 2000 U.S. dollars.

a.3 Economic Characteristics of Sample Defaulters

If default by country c in year t leads to a temporary rise in the interest rate charged on foreign loans to c, the discussion in Section 2 suggests that we should observe a decline in the relative competitiveness of

[6]For a more detailed discussion, see Rajan and Zingales (1998).

c's exporters in international goods markets in accordance with their degree of dependence on external financing. A key identifying assumption, set out in equation (7), is that default-prone economies rely on the international capital market to finance some of their inputs and, hence, that the foreign interest rate directly affects exporters' production costs. Table 1 documents that this is an appropriate description of the median defaulter covered in my sample.

The table compares two characteristics of interest, the ratio of private-sector domestic credit to GDP and the average financial dependence of exports, for countries which did experience at least one default in my sample with those which did not. It highlights that in 2007 the median defaulter's ratio of domestic private credit to GDP − a widely used measure of financial development − was less than half that of the median non-defaulter. This reflects the fact that foreign-debt defaults have predominantly occurred in countries with less developed domestic financial markets, and may imply significant benefits for their exporters from borrowing internationally. In a similar vein, it is noteworthy that the most countries experienced net capital inflows on a large scale prior to debt crises, with the current account deficit in the two years prior to the median default episode amounting to 7% of the country's GDP.

The table also shows that the average financial dependence of exports is somewhat lower in defaulter economies. This is no surprise because, to the extent that sovereign default is correlated with weak financial and legal institutions, domestic producers would be expected to specialise in goods that are less reliant on both.[7]

[7]See Beck (2003) and Nunn (2007) for two papers which test this hypothesis formally, and find it to be supported by the data.

Dep. Variable: $\ln Exp_{cit}$	(1)	(2)	(3)	(4)
$Default_{ct}$			-0.063	
			(0.048)	
$Default_{ct-1}$			-0.133**	
			(0.055)	
$Default_{ct-2}$			0.007	
			(0.050)	
$FinDep_i \times Default_{ct}$				-0.313*
				(0.175)
$FinDep_i \times Default_{ct-1}$				-0.430**
				(0.186)
$FinDep_i \times Default_{ct-2}$				-0.361**
				(0.171)
$\ln GDP_{ct}$	0.803***	0.000	-0.021	
	(0.053)	(0.070)	(0.072)	
$\ln DC_{ct}$	0.473***	0.260***	0.265***	
	(0.041)	(0.038)	(0.039)	
$FinDep_i * \ln DC_{ct}$				0.075***
				(0.026)
Country F.E.	No	Yes	No	No
Industry F.E.	Yes	No	No	No
Year F.E.	Yes	No	Yes	No
Country-Year F.E.	No	No	No	Yes
Industry-Year F.E.	No	Yes	No	Yes
Country-Indust. F.E.	No	No	Yes	No
Observations	49,210	49,210	49,210	49,210
Adj. R^2	0.75	0.82	0.92	0.83

The dependent variable is the log of exports to the world by 3-digit ISIC industries, 1980-2007.
All regressions include a constant term and cluster errors at the country-industry level.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 2.2: Baseline Regression Results

b Empirical Results

b.1 Baseline Specification

The results of the baseline regression are reported in Table 2. Column 4 lists the results from the full specification as set out in equation (11), while columns 1 to 3 detail the outcome of three regressions with a reduced number of explanatory variables.

Column 1 shows that sectoral exports are strongly positively correlated with GDP and domestic credit, after controlling for cross-industry and -year variation using industry and year fixed effects. However, the importance of both variables is drastically diminished once country- and industry-year fixed effects are introduced (Column 2), with only domestic credit retaining a significant positive coefficient, indicating a 0.3% increase in exports for a 1% increase in domestic credit.

Column 3 introduces the default dummy with two lags, as well as country-industry fixed effects. Introducing country-industry dummies boosts the regression's adjusted R^2 to .92 as, predictably, the variation in sectoral exports across countries is substantially larger than the variation of countries' exports within industries over time. The new set of fixed effects alters the coefficient estimates of GDP and domestic credit little. Meanwhile, the coefficient estimates for the default dummies suggest that debt crises are associated with a negative but statistically insignificant contemporaneous decline in exports of about 6% and a decline of 13% in the subsequent year, which is statistically significant at the 5% level. There is little evidence of an impact on exports in the third year, but the hypothesis that the three coefficients are jointly insignificant can be rejected at the 15% level of statistical significance. Overall, this finding is suggestive of a decline in

Dep. Variable: $\ln Exp_{cit}$	(1)	(2)	(3)
$FinDep_i \times Default_{ct}$	-0.291*	-0.315*	-0.299*
	(0.174)	(0.174)	(0.174)
$FinDep_i \times Default_{ct-1}$	-0.405**	-0.437**	-0.416**
	(0.185)	(0.185)	(0.185)
$FinDep_i \times Default_{ct-2}$	-0.355**	-0.368**	-0.363**
	(0.172)	(0.172)	(0.173)
$FinDep_i \times Bank_{ct}$	-0.210		-0.211
	(0.134)		(0.132)
$FinDep_i \times Bank_{ct-1}$	-0.257*		-0.260*
	(0.136)		(0.136)
$FinDep_i \times Bank_{ct-2}$	-0.130		-0.148
	(0.132)		(0.130)
$FinDep_i \times Curr_{ct}$		-0.061	-0.013
		(0.120)	(0.120)
$FinDep_i \times Curr_{ct-1}$		0.058	0.090
		(0.129)	(0.130)
$FinDep_i \times Curr_{ct-2}$		0.053	0.067
		(0.127)	(0.125)
Controls:	Country-Year and Industry-Year F.E., $FinDep_i * \ln DC_{ct}$,		
Observations	49,210	49,210	49,210
Adj. R^2	0.83	0.83	0.83

The dependent variable is the log of exports to the world by 3-digit ISIC industries, 1980-2007. All regressions include a constant term as well as country-year and industry-year fixed effects, and control for the impact of domestic credit conditions on financially dependent sectors. Standard errors are clustered at the country-industry level.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 2.3: Baseline Regression Results, Controlling for Financial Crises

manufacturing exports as a result of default but, owing to the omitted variable problem discussed in Section 3.a.1 as well as the possibility of reverse causality from exports to the likelihood of debt crises, it is insufficient evidence to establish a causal link from default to declines in exports.

To address these concerns, and to test a specific causal mechanism by which a debt crisis may affect the defaulting economies' exports, I estimate equation (11) and report the results in Column 4. The estimated coefficients of the interaction between default and sectoral financial dependence are large and statistically significant at the 5 or 10% level. This confirms the hypothesis developed in the previous sections and represents the main finding of the paper: there is robust evidence that sovereign default reduces the exports of highly financially dependent sectors relative to those which are less financially vulnerable, consistent with a contraction in the supply of credit to exporters. In terms of magnitudes, the coefficient estimates imply that default should cause the exports in the "Textiles" industry − which is at the 75th percentile of industries ranked by their financial dependence − to contract 12 percentage points more (or the expand 12 percentage points less) than "Other non-metallic mineral products" − which is at the 25th percentile.

My regression also finds that higher volumes of domestic credit are associated with a relative expansion of the exports of financially dependent industries: the coefficient of the interaction between the log of domestic credit with financial dependence is positive and significant at the 1% level. Yet the effect is small with a 1% increase in domestic credit causing "Textiles" to expand by a mere .03 percentage points more than "Other non-metallic mineral products". This provides an intriguing contrast with Rajan and Zingales (1998). Their

paper shows that deep domestic financial markets benefit the overall growth of industries which are very financially dependent. Yet my findings indicate that domestic financial development, represented by the domestic supply of credit, has a minor impact on the exports of financially dependent sectors. This lends support to the view that domestic exporters are more reliant on international than on domestic capital markets, and is in line with the findings of Manova (2008) who shows that improved access to foreign credit strongly benefits financially dependent exporters.

A possible objection to the specification in Column 4 of Table 2 is that default may coincide with domestic bank or currency crises, and that the coefficients of interest may capture the impact of these financial crises, rather than a default-specific effect. Banking and currency crises are considerably more frequent in my sample than sovereign debt crises, with a total of 66 episodes of banking sector distress and 86 currency crises covered.[8] Yet only 10 out of 56 sample defaults coincide with a banking or currency crisis in the same year. This makes it implausible *a priori* that my key coefficients capture the omitted effect of the latter episodes.

In Table 3, I control for the effect of banking and currency distress directly. The size and statistical significance of the coefficients of interest is virtually unchanged. Meanwhile, domestic banking crises appear to have a similar effect on sectoral exports as sovereign default, albeit smaller and less statistically significant. This finding is consistent with Iacovone and Zavacka (2009) who show that banking crises have a stronger adverse impact on the exports of more financially

[8]The dates of banking and currency crises are based on Laeven and Valencia (2008) and reported in Table B2 of the Appendix.

Dep. Variable: $\ln Exp_{cit}$	(1)	(2)	(3)
$FinDep_i \times Default_{ct+1}$	0.067		0.069
	(0.179)		(0.177)
$FinDep_i \times Default_{ct}$	-0.296*	-0.293*	-0.290*
	(0.179)	(0.165)	(0.171)
$FinDep_i \times Default_{ct-1}$	-0.418**	-0.410**	-0.412**
	(0.180)	(0.175)	(0.171)
$FinDep_i \times Default_{ct-2}$	-0.371**	-0.362**	-0.371**
	(0.161)	(0.172)	(0.160)
$FinDep_i \times Default_{ct-3}$		-0.054	-0.056
		(0.167)	(0.165)
$FinDep_i \times Default_{ct-4}$		-0.045	-0.045
		(0.150)	(0.150)
Controls:	Country-Year and Industry-Year F.E., $FinDep_i \times Bank_{ct}$, $FinDep_i \times Bank_{ct-1}$, $FinDep_i \times Bank_{ct-2}$, $FinDep_i \times Curr_{ct}$, $FinDep_i \times Curr_{ct-1}$, $FinDep_i \times Curr_{ct-2}$, $FinDep_i * \ln DC_{ct}$		
Observations	49,210	49,210	49,210
Adj. R^2	0.83	0.83	0.83

The dependent variable is the log of exports to the world by 3-digit ISIC industries, 1980-2007. All regressions include a constant term as well as country-year and industry-year fixed effects, and control for the impact of domestic credit conditions, banking crises and currency crises on financially dependent sectors. Standard errors are clustered at the country-industry level.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 2.4: Additional Lead and Lags of Default

dependent sectors. At the same time, the modest effect of banking crises compared to default underscores the potential importance of

foreign credit relative to domestic financial conditions for exporters in crisis-prone economies. Plausibly, I find little evidence that currency crises impact on domestic exports through a financial-dependence channel.

This section has documented that, for the period 1980-2007, the empirical specification derived in Sections 2 lends strong support to the hypothesis default hurt domestic exporters via a reduction in the supply of credit. Below, I explore the robustness of this finding. Unless otherwise indicated, each subsequent regression uses country-year and industry-year fixed effects and controls for the impact of banking and currency crises as well as domestic credit conditions.

b.2 Robustness Checks

So far, I have arbitrarily estimated a model with two lags of the default dummy, implying that the average effect of default on sectoral exports persists for a total of three years. In principle, however, there is no reason why the effect should not be more persistent. Table 4 presents the estimation results when two additional lags (as well as a lead) of the default dummy is included in the estimation.

Column 1 shows that a lead of default is positive and not statistically significant at any reasonable level. This is reassuring as it indicates that there is no robust change in sectoral export patterns prior to the default event, supporting the hypothesis of a causal relationship proposed here. Two additional lags of default return negative but statistically insignificant coefficients, irrespective of whether the lead is included or not (Columns 2 and 3). Throughout, the baseline coefficients and standard errors remain unaltered. This evidence seems to imply that the change in sectoral export patterns commences

in the year of default and fades three years after the event.

With no more than two relevant lags of default, my model seems to find a less persistent impact of default on trading patterns than previous studies. Rose's (2005) baseline specification contains 15 lags of default, and Martinez and Sandleris (2008) choose 5 lags in their most preferred specification. Both admit, however, that problems of multicolinearity make the appropriate lag structure difficult to determine.[9] Moreover, the finding that the average default episode affected export patterns for three years is broadly consistent with the observation by Gelos et al. (2003) that the average period of capital-market exclusion suffered by defaulters between 1980 and 1999 was 4.5 years. Once again, this suggests that capital-market access is crucial in explaining the link between sovereign default and trading patterns.

Table 5 explores the effect of several sample restrictions. The estimated impact of sovereign default on sectoral export patterns is, if anything, stronger and more significant if the estimation is restricted to the second half of the sample period (Column 1), thereby excluding the debt crises of the 1980s, and if countries which defaulted more than once between 1980 and 2007 are excluded (Column 2). Excluding the two most financially dependent industries – "Plastic products" and "Professional and scientific equipment" – and the two least financially dependent industries – "Tobacco" and "Pottery, china" – alters

[9]Note that Rose (2005) and Martinez and Sandleris (2008) use renegotiations of publicly held debt through the Paris Club to construct their default dummy, while I use records of defaults on private bank and bond debt. The Paris Club data is useful to the particular question these studies attempt to address, but Paris Club renegotiations are more frequent than the repudiation of privately held debt – giving rise to multicolinearity problems in lagged models – and arguably less representative of the non-cooperative nature of default commonly alleged in the theoretical literature.

Dep. Variable: $\ln Exp_{cit}$	(1) $t \geq 1994$	(2) Excluding serial defaulters	(3) Excluding 2 most and least financially dependent industries
$FinDep_i \times Default_{ct}$	-0.676**	-0.487*	-0.738***
	(0.293)	(0.272)	(0.282)
$FinDep_i \times Default_{ct-1}$	-0.809***	-0.566**	-0.183
	(0.289)	(0.254)	(0.307)
$FinDep_i \times Default_{ct-2}$	-0.592**	-0.680***	-0.279
	(0.240)	(0.251)	(0.291)
$FinDep_i \times Bank_{ct}$	-0.339**	-0.045	0.013
	(0.167)	(0.137)	(0.234)
$FinDep_i \times Bank_{ct-1}$	-0.436**	-0.097	-0.210
	(0.183)	(0.141)	(0.250)
$FinDep_i \times Bank_{ct-2}$	-0.350**	0.034	0.111
	(0.171)	(0.138)	(0.232)
$FinDep_i \times Curr_{ct}$	0.208	0.053	0.283
	(0.188)	(0.140)	(0.215)
$FinDep_i \times Curr_{ct-1}$	0.544***	0.150	0.217
	(0.198)	(0.154)	(0.222)
$FinDep_i \times Curr_{ct-2}$	0.302*	0.150	0.420**
	(0.162)	(0.142)	(0.212)
$FinDep_i * \ln DC_{ct}$	0.063**	0.096***	0.102**
	(0.027)	(0.029)	(0.050)
Controls:	Country-Year and Industry-Year F.E.		
Observations	28,647	40,611	41,688
Adj. R^2	0.83	0.84	0.83

The dependent variable is the log of exports to the world by 3-digit ISIC industries, 1980-2007. All regressions include a constant term as well as country-year and industry-year fixed effects, and control for the impact of domestic credit conditions, banking crises and currency crises on financially dependent sectors. Standard errors are clustered at the country-industry level.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 2.5: Sample Restrictions

the relative size of the coefficients of the three default dummies, but leaves their standard errors and the average effect unchanged, with the coefficients remaining jointly different from zero at the 10% level of statistical significance.

In Table 6, I allow for default to affect sectoral exports in accordance with two other industry characteristics, the industry's asset tangibility and its import penetration. Asset tangibility of industry i is defined as the share of net plant, property, and equipment in total assets for the median U.S. firm in i. This measure is used in the literature to capture an industry's ability to muster collateral and its source is Braun (2003), who shows it to be uncorrelated with the Rajan-Zingales measure of financial dependence. Import penetration is a country-industry-specific indicator based on a sector's average share in total imports. It is defined as $ImpPen_{ct} = \frac{1}{T}\sum_t (Imp_{cit}/\sum_i Imp_{cit})$, where Imp_{cit} is the nominal value of imports by country c in industry i and year t.

Columns 1 to 5 of Table 6 show that the additional interactions do not alter the baseline result but that default does affect sectoral export patterns along both new dimensions: there is significant evidence of a shift in exports towards sectors with a large share of collateralisable assets, and towards import-penetrated sectors. Both are consistent with a decline in the supply of foreign credit in the wake of default. A foreign credit shock should hurt industries with fewer collateralisable assets more. As foreign suppliers are often an important source of trade credit, it may also have a larger impact on exporters which purchase few inputs from foreign companies. The overall picture is striking: sovereign default leads to the largest contraction in the exports of sectors which are highly financially dependent, do not possess many tangible assets and do not import much from abroad.

Dep. Variable: $\ln Exp_{cit}$	(1)	(2)	(3)	(4)	(5)
$FinDep_i \times Default_{ct}$	-0.299*		-0.293*		-0.325*
	(0.174)		(0.173)		(0.176)
$FinDep_i \times Default_{ct-1}$	-0.416**		-0.466**		-0.497***
	(0.185)		(0.183)		(0.187)
$FinDep_i \times Default_{ct-2}$	-0.363**		-0.449***		-0.435**
	(0.173)		(0.171)		(0.176)
$Tang_i \times Default_{ct}$		1.073**	1.064**		
		(0.454)	(0.453)		
$Tang_i \times Default_{ct-1}$		1.602***	1.665***		
		(0.498)	(0.496)		
$Tang_i \times Default_{ct-2}$		1.599***	1.687***		
		(0.424)	(0.426)		
$ImPen_{ci} \times Default_{ct}$				0.910	1.158
				(0.874)	(0.878)
$ImPen_{ci} \times Default_{ct-1}$				1.870**	2.380**
				(0.940)	(0.944)
$ImPen_{ci} \times Default_{ct-2}$				1.395	1.873**
				(0.909)	(0.912)
$ImPen_{ci}$				2.048**	2.023**
				(0.966)	(0.964)
Controls:	Country-Year and Industry-Year F.E., $FinDep_i \times Bank_{ct}$, $FinDep_i \times Bank_{ct-1}$, $FinDep_i \times Bank_{ct-2}$, $FinDep_i \times Curr_{ct}$, $FinDep_i \times Curr_{ct-1}$, $FinDep_i \times Curr_{ct-2}$, $FinDep_i$* $\ln DC_{ct}$				
Observations	49,210	49,210	49,210	49,158	49,158
Adj. R^2	0.83	0.83	0.83	0.83	0.83

The dependent variable is the log of exports to the world by 3-digit ISIC industries, 1980-2007. All regressions include a constant term as well as country-year and industry-year fixed effects, and control for the impact of domestic credit conditions, banking crises and currency crises on financially dependent sectors. Standard errors are clustered at the country-industry level.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 2.6: Alternative Industry Characteristics

Dep. Variable: $\ln Exp_{cit}$	(1)	(2)	(3)
$FinDep_i \times Default_{ct}$	-0.542**		-0.554**
(*large CA reversal*)	(0.248)		(0.249)
$FinDep_i \times Default_{ct-1}$	-0.527**		-0.540**
(*large CA reversal*)	(0.259)		(0.259)
$FinDep_i \times Default_{ct-2}$	-0.484**		-0.495**
(*large CA reversal*)	(0.235)		(0.235)
$FinDep_i \times Default_{ct}$		-0.059	-0.071
(*small CA reversal*)		(0.230)	(0.230)
$FinDep_i \times Default_{ct-1}$		-0.262	-0.294
(*small CA reversal*)		(0.241)	(0.242)
$FinDep_i \times Default_{ct-2}$		-0.247	-0.276
(*small CA reversal*)		(0.229)	(0.231)
Controls:	Country-Year and Industry-Year F.E., $FinDep_i \times Bank_{ct}$, $FinDep_i \times Bank_{ct-1}$, $FinDep_i \times Bank_{ct-2}$, $FinDep_i \times Curr_{ct}$, $FinDep_i \times Curr_{ct-1}$, $FinDep_i \times Curr_{ct-2}$, $FinDep_i * \ln DC_{ct}$		
Observations	49,210	49,210	49,210
Adj. R^2	0.83	0.83	0.83

The dependent variable is the log of exports to the world by 3-digit ISIC industries, 1980-2007. All regressions include a constant term as well as country-year and industry-year fixed effects, and control for the impact of domestic credit conditions, banking crises and currency crises on financially dependent sectors. Standard errors are clustered at the country-industry level.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 2.7: Large and Small Current Account Reversals

Finally, I assess whether the differential impact of sovereign default across sectors coincides with a change in the defaulting country's pattern of foreign borrowing. If default is associated with a loss of access

to foreign credit markets which, in turn, hurts financially dependent exporters, the latter effect should be stronger the larger the reversal in foreign borrowing. Section 3.a.2 observes that most defaulters were net recipients of foreign capital flows in the two years prior to default. Comparing countries' average current account balance in the two years before and after default episodes, I find that the median defaulter experienced a reversal in its current account deficit by 2 percentage points of GDP. I group default episodes into two categories, depending on whether they coincided with a current account reversal in excess of 2 percentage points of GDP (a "large" reversal) or not (a "small" reversal). I then construct separate default dummies for each category.

Table 7 presents the results of my estimations when default is grouped according to the size of the accompanying current account reversal. The table documents that both categories are associated with a decline in the exports of financially dependent sectors relative to less financially vulnerable counterparts, but the effect is only statistically significant − and considerably stronger − for default episodes associated with large current account reversals. Of course, this finding does not imply a causal link between default and current account reversals, but it provides further evidence that access to international capital markets plays a crucial role for explaining changes in the patterns of trade in the wake of sovereign debt crises.

c Financial Dependence and the Decline in Exports

c.1 Magnitude of the Financial-Dependence Channel

Following on from equation (10), the impact of sovereign default at t on exports in sector i is

$$\left.\frac{\triangle Exp_{cit}}{Exp_{cit}}\right|_{\triangle Default_{ct}=1} = \beta_1 FinDep_i + \beta_2, \tag{2.12}$$

where I drop the lag-related subscripts for expositional convenience. Equation (12) implies

$$\left.\frac{\triangle Exp_{ct}}{Exp_{ct}}\right|_{\triangle Default_{ct}=1} = \beta_1 \frac{\sum_i FinDep_i Exp_{cit}}{\sum_i Exp_{cit}} + \beta_2, \tag{2.13}$$

where $\sum_i FinDep_i Exp_{cit} / \sum_i Exp_{cit}$ is the average financial dependence of exports in country c and year t. Equation (13) describes the overall impact of sovereign default on a country's manufacturing exports, which consists of the financial-dependence-related impact (β_1) and a possible direct effect (β_2). My estimates from Section 3.b only allow me to identify the importance of the financial-dependence channel, which is conditional on a country's export composition at the time of default. Figure 2 plots the the impact from this channel for the 56 default episodes in my sample.[10]

The figure documents that, by itself, the financial-dependence channel emphasised in this paper implied a reduction in country's overall

[10] One way to think about Figure 2 is as a plot of the distribution of (13) for the 56 debt crises assuming $\beta_2 = 0$. To construct the figure, I use the average financial dependence of exports for each defaulter in the three years prior to the debt crisis, and let $\hat{\beta}_1 = \frac{1}{3}\left(\hat{\beta}_{10} + \hat{\beta}_{11} + \hat{\beta}_{12}\right) \approx -.359$ from my baseline regression.

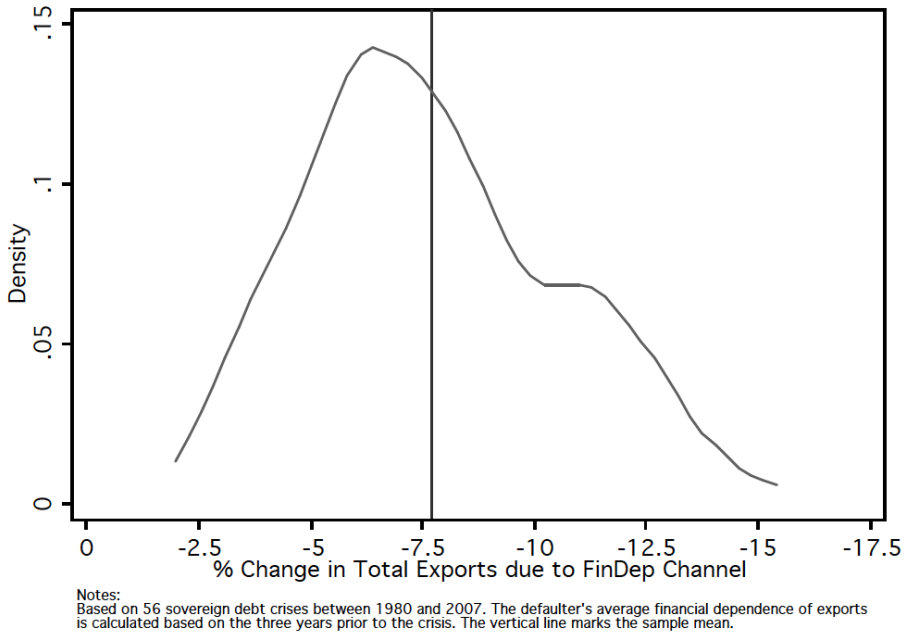


Figure 2.2: Distribution of $\beta_1 \times \sum_i FinDep_i Exp_{cit} / \sum_i Exp_{cit}$ for Sample Defaults

exports following each of the 56 defaults. The median and mean of the distribution are fairly close, at -7.3% and -7.7% respectively. This number is clearly economically significant. Nevertheless, it would be desirable to ascertain for how much of the overall change in manufacturing exports in the wake of the average default this channel can account. To answer this question, the next section considers alternative estimates of the overall impact of default on exports.

c.2 Overall Impact of Default on Exports

As discussed in Section 3.a.1, the overall impact of default on sectoral exports is difficult to estimate consistently. Column 1 of Table 8

Dep. Variable: $\ln Exp_{cit}$	(1) Full Panel	(2) PSM Diff.-in-Diff.
$Post_t$		0.530***
		(0.070)
$Default_{ct}$	-0.077*	-0.162*
	(0.046)	(0.096)
$Bank_{ct}$	-0.029	-0.155
	(0.026)	(0.122)
$Curr_{ct}$	-0.022	-0.235**
	(0.026)	(0.093)
$\ln GDP_{ct}$	-0.031	0.070
	(0.074)	(0.346)
$\ln DC_{ct}$	0.267***	0.049
	(0.039)	(0.195)
Year F.E.	Yes	No
Country-Indust. F.E.	Yes	Yes
Observations	49,210	2,469
Adj. R^2	0.92	0.88

The dependent variable in regression (1) is the log of exports to the world by 3-digit ISIC industries, 1980-2007. The crisis dummies in regression (1) take value 1 in the first three years after a default, bank or currency crisis. The dependent variable in regression (2) is the log of average industry exports in the three years before and after a default episode. Both regressions include a constant term as well as country-industry fixed effects, and control for GDP and domestic credit conditions. Standard errors are clustered at the country-industry level.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 2.8: Overall Impact of Default on Exports

provides the results from a panel regression, using my full sample and year and country-industry fixed effects, where the effect of crises – and specifically, default – is captured by dummies taking value 1 in the first year of the episode and the two subsequent years. This is akin

to the regression estimated in Column 3 of Table 2. The regression suggests that default is associated with an average decline in exports of 7% for three years. However, it is questionable whether default is indeed the cause of this decline: my regressions may miss a crucial country-time varying explanatory factor, or the true causality may be reversed with default triggered by the incipient decline in exports.

To tackle this issue, I derive an alternative estimate of the overall impact of default on sectoral exports using a propensity score matching (PSM) approach.[11] This approach is also used in Levchenko, Rancière and Thoenig (2009) to identify the impact of financial liberalisation on sectoral output growth. Its basic premise is the identification of an appropriate control group to estimate a classic difference-in-difference model: for each country c experiencing default in year t, a control country is identified which displayed a similar propensity to default at t but did not experience default. If the match between treatment and control countries is appropriate, the PSM methodology simulates a random experiment.[12]

To determine a country's propensity to default in year t, I estimate a logistic regression of the form

$$Default_{ct} = \alpha_0 + \alpha_1 DefaultExpectation_{ct} + \alpha_2 \triangle \ln GDP_{ct} + \varepsilon_{ct}, \tag{2.14}$$

where $Default_{ct}$ takes value 1 if default occurred in c at t and 0 otherwise, $DefaultExpectation_{ct}$ is a measure of a country's perceived de-

[11]The use of instruments in the present context faces the insurmountable challenge of identifying a variable which is highly correlated with a country's propensity to default on foreign debt, but uncorrelated with the volume of its exports.

[12]My PSM approach in this section closely follows Levchenko, Rancière ad Thoenig (2009). The interested reader is referred to their paper for a more detailed discussion of the PSM methodology.

fault probability, and $\triangle \ln GDP_{ct}$ captures contemporaneous deteriorations in economic conditions. $DefaultExpectation_{ct}$ is measured using historical "foreign debt risk" scores from the Political Risk Services Group, while $\triangle \ln GDP_{ct}$ is based on GDP data from the World Development Indicators.[13] The specification is designed to match countries based on expectations of debt distress ahead of the default date as well as short-term economic changes likely to trigger default. It passes the Dehejia and Wahba (2002) test of equality of means within strata – a key criterion for the PSM approach to be applicable in this context.

Using the propensity scores predicted by the logit model, I calculate the proximity between countries c and d based on their default propensity as

$$Proximity_{cd} = \frac{1}{3} \sum_{t=t_c-2}^{t_c} \left(ps_{ct} - ps_{dt}\right)^2,$$

where t_c is the year in which c defaulted and ps_{ct} is c's propensity score at t. I use the first neighbour matching method and define the appropriate control country for defaulter c as

$$CC_c = \arg \min_{d \in C, |t_c - t_d| \geq 3} Proximity_{cd},$$

where the restriction $|t_c - t_d| \geq 3$ is imposed to prevent countries which defaulted at nearby dates from being chosen as control. Table B3 in the Appendix lists the control countries for each default episode.

Having chosen control countries, I estimate the following difference-in-difference specification:

$$\ln Exp_{cit} = \theta_0 Post_t + \theta_1 Default_{ct} + \delta_{ci} + \gamma Z_{cit} + \varepsilon_{cit}, \qquad (2.15)$$

[13] As the "foreign debt risk" scores have only been calculated since 1985, I am forced to restrict my PSM analysis to default episodes which occurred after this date.

Source:	(1) Table 8	(2) Table 8	(3) Martinez and Sandleris (‘08)	(4) Rose (‘05)
$\frac{\Delta Exp_{ct}}{Exp_{ct}}$ *due to default*	-0.08	-0.16	-0.06	-0.11
Persistence	3 years	3 years	5 years	5 years
Identification	Annual panel of sector-level exports, with country-industry and year F.E.	Diff.-in-diff. on sector-level exports, with control countries based on propensity score.	Annual panel of bilateral trade flows, with country and year fixed effects. Default dummy captures the impact on trade will all partners.	Annual panel of bilateral trade flows, with country and year fixed effects. Default dummy captures the impact on trade with defaulted creditors.

Columns (3) and (4) report comparable regression results from the two respective papers. Persistence indicates the number of years default is assumed to affect trade flows in the given empirical specification, including the year in which default took place.

Table 2.9: Overall Impact of Default on Exports, Comparison

where $\ln Exp_{cit}$ represents the log of countries' average exports in the three years before and after the default episode, $Post_t$ is a dummy taking value 0 before the episode and 1 after, and $Default_{ct}$ is a binary indicator taking value 1 if a country experienced a debt crisis. As before Z_{cit} is a vector of control variables and δ_{ci} a set of country-industry fixed effects. The results from the OLS regression are reported in Column 2 of Table 8.

The PSM regression finds a 16% decline in manufacturing sector exports as a result of sovereign default − more than twice the magnitude of the decline estimated in the panel regression. The coefficient estimate is significant at the 10% level of statistical significance. It

indicates that, if anything, the panel regression may understate the decline in exports due to default.

Table 9 compares these findings with the impact of sovereign default on trade flows estimated in earlier studies. Rose (2005) and Martinez and Sandleris (2008) identify the impact of default on international trading patterns by analysing bilateral trade flows in the aftermath of sovereign debt renegotiations. The table displays results from their most comparable reported specifications, using a default dummy with four lags. It highlights that my estimates are in the same ball park as theirs, despite methodological differences, with the estimated decline in total exports due to default ranging from 6 to 16%. This implies that, if we accept the "true" decline in exports caused by sovereign default to lie in this range, the financial-dependence channel uncovered in this paper can explain at least half of the impact of sovereign default on trade. In that case, the "trade costs" of sovereign default identified by Rose (2005) may be a mere symptom of capital-market exclusion triggered by sovereign debt distress.

2.4 Summary and Conclusion

In this paper I demonstrate empirically that sovereign default leads to a decline of the defaulting country's exports in sectors with a high degree of financial dependence relative to sectors which are less financially vulnerable. I argue that this is due to a reduction in domestic exporters' access to foreign capital. Although the evidence for this claim is indirect, it is also compelling. The estimated impact of default on sectoral exports occurs independently of the depth of domestic credit markets or contemporaneous systemic crises among resident banks. It

is robust to changes in the sample composition, and to controlling for a possible impact of default on sectoral exports through alternative channels. It is also more pronounced for defaulters which experienced large current account reversals.

My findings suggest that there exists a link between the sovereign's ability to tap international capital markets in the aftermath of default and the observed effect of sovereign debt crises on trade, widely interpreted as "trade costs" of debt repudiation. Early proponents of such "trade costs" seem to have been sympathetic to the view that these were credit-related. Bulow and Rogoff (1989), for example, contend that if a country repudiates its foreign loans it will "also be blocked from normal access to trade credits". So far, however, the present paper constitutes the only formal, broad-based empirical investigation to provide evidence of a credit link between default and the patterns of international trade. According to my estimates, this link can explain most of the decline in trade triggered by sovereign debt crises.

From a theoretical vantage point, the observation that the "trade costs" of default may constitute part of the overall costs of capital-market exclusion has profound implications for our understanding of the factors which induce governments to service their foreign debt. Much of the recent literature on sovereign borrowing treats the threat of capital-market exclusion and the risk of "trade costs" as substitutable explanations for why countries choose to Honor their obligations to foreign creditors. Based on the empirical analysis carried out in this paper, this notion is is mistaken: if default does not reduce the defaulting country's access to international lending, the "trade costs" of default may also fail to materialise.

The question why countries repay their debts is alive and well.

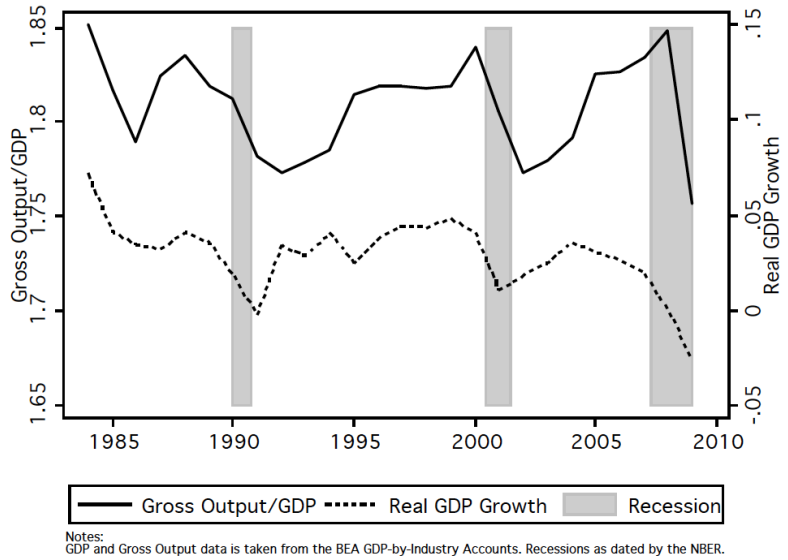
3 Input Trade Over the Cycle

3.1 Introduction

During the last 30 years trade in intermediate inputs has been strongly procyclical in the major economies. Figure 1 plots the ratio of gross output to GDP for the United States since the early 1980s and shows that the series has been closely correlated with real GDP growth in this period. Since economy-wide gross output amounts to total value added plus the value of firms' intermediate input purchases, the observed cyclical fluctuations are due to changes in the value of intermediate input purchases relative to GDP. The latter are remarkably large: during the most recent recession, for example, the value of input purchases relative to GDP fell by nearly 10 percentage points.

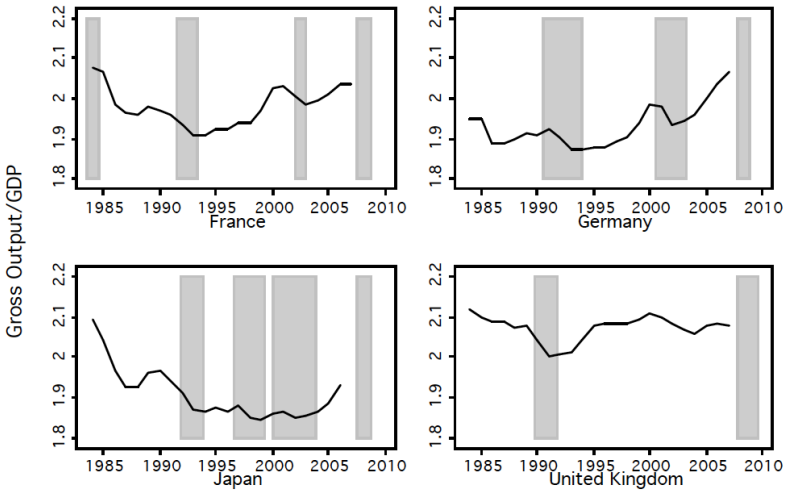
Figure 2 shows that this pattern is not solely confined to the United States. In the last three decades, recessions in France, Germany, Japan and the United Kingdom were generally accompanied by large declines in the value of input purchases relative to GDP.

This paper proposes an explanation for the observed procyclicality of input trade among domestic firms. I argue that periods of economic expansion create differences among ex-ante identical, vertically integrated producers in different sectors, providing an impetus for trade in inputs between fast-growing and slow-growing firms. A formal model of this mechanism is consistent with the broad stylised facts about input trade among U.S. firms. It also delivers a number of additional testable empirical implications which allows the theory to be evaluated against alternative explanations for fluctuations in input trade over the cycle.



Notes:
GDP and Gross Output data is taken from the BEA GDP-by-Industry Accounts. Recessions as dated by the NBER.

Figure 1: Gross Output/GDP in the United States



Notes:
GDP and Gross Output data is taken from the EU KLEMS database by O'Mahony et al. (2009). Recessions (shaded areas) based on OECD data and national statistical agencies, following NBER methodology.

Figure 2: Gross Output/GDP in Other Major Economies

While the procyclicality of U.S. input trade was initially documented by Basu (1995, 1996), my paper represents the first attempt to explain this business-cycle fact head-on. Standard real business cycle models assuming homothetic production technologies and a fixed division of production between firms would predict the ratio of input purchases to GDP to be constant. Yet, as Figures 1 and 2 make plain, this prediction is starkly at odds with empirical reality. This throws open the question why the value of firms' input purchases rises relative to the value of their output in booms, and why it declines in recessions.

A simple explanation for the cyclical pattern of input trade may be that economic contractions are accompanied by a compositional shift in aggregate spending away from input-intensive industries − such as manufacturing − and towards less input-intensive sectors − e.g. services. Figure 3 demonstrates that this is not the case: holding industry shares in GDP constant at their sample averages, the figure reveals that the procyclicality of the Output-to-GDP ratio is largely due to changes in the relation of gross output to value added at the level of individual industries.[1] Nor can the large fluctuations be plausibly be accounted for by the well-documented countercyclicality of inventory investment:[2] between the early 1984 and 2009 inventory investment accounted for less than half a percentage point of U.S. GDP, a small fraction of the observed changes in input trade over the cycle.

In the light of this, I illustrate a different channel through which

[1]The solid line in the figure represents the constant–shares ratio of gross output to GDP, defined as $\sum_i \overline{(VA/GDP)}_i (GO_{it}/VA_{it})$, where $\overline{(VA/GDP)}_i = \frac{1}{T}\sum_t (VA_{it}/GDP_t)$ and i is one of 62 industries defined in the BEA's GDP-by-industry accounts.

[2]See Ramey and West (1999) for an overview of this literature.

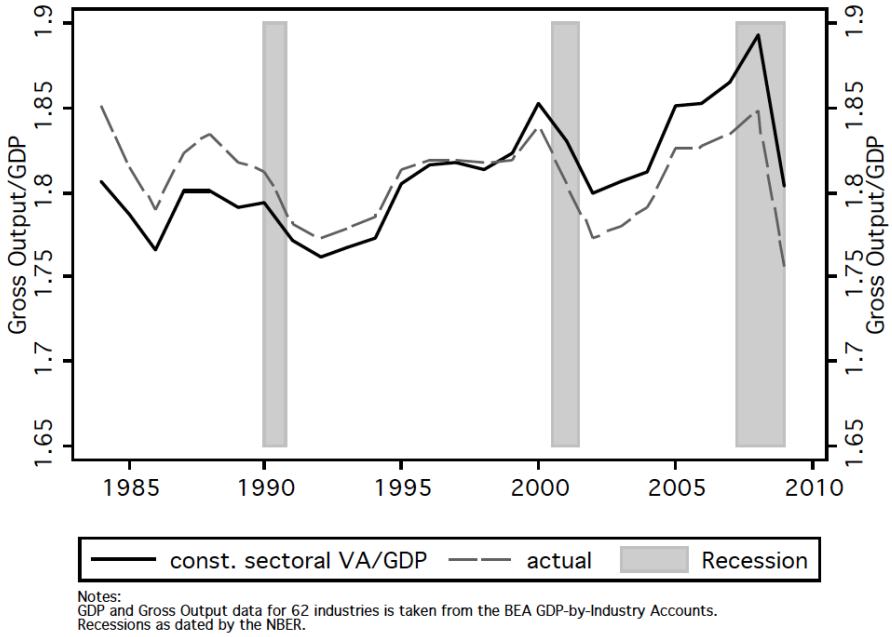


Figure 3: U.S. Gross Output/GDP, Constant Industry Shares in GDP

economic expansions may raise trade among firms in a simple, real model in which production proceeds in two stages. My model assumes that firms prefer to produce their own intermediates in the absence of uncertainty. However, probabilistic episodes of economic growth raise the productivity of a random subset of firms. If the resulting productivity differences are sufficiently large, such booms are accompanied by large volumes of input trade, with stagnating firms selling their intermediates to their fast-growing counterparts. This input trade collapses once the boom comes to an end. I show that this view is consistent with two further stylised facts about input trade among U.S. firms: the strongly procyclical pattern of trade between industries compared

to within-industry trade, and the absence of a long-run trend in the ratio of input purchases to aggregate output.

The behaviour of input trade over the business cycle has so far not received much formal attention in its own right. Basu (1995) is most closely related to the present paper. He studies the cyclical patterns of productivity in a model with imperfect competition, intermediate goods and menu costs. In this setting, intermediate-goods trade amplifies the price stickiness resulting from menu costs. With fixed prices, a rise in aggregate demand lowers mark-ups and raises input usage, causing an increase in labour productivity. Using U.S. sector-level data for the period 1959-1984, Basu (1995) finds evidence of the procyclicality of input usage implied by his model. Subsequently, Rotemberg and Woodford (1999) interpret this cyclical pattern of input trade as evidence of countercyclical mark-ups. My model is in principle complementary with the explanation for the procyclicality of input trade provided in these earlier papers. However, it highlights that an increase in input trade across firm boundaries during economic expansions can just as naturally arise in a model in which prices are perfectly flexible, mark-ups are fixed and firms earn zero profits in the long run.

More generally, the issue of the relative merit of intermediate goods trade compared with vertical integration − which lies at the heart of this paper − has been addressed in an extensive literature, starting with Coase's (1937) classic theory of the firm. This literature has sought to identify the conditions in which the organisation of production within a vertical hierarchy is superior to an arms-length exchange in a competitive market between producers at different stages of the

production process.[3] It is predominantly concerned with the equilibrium structure and boundaries of the firm. My paper notes that, at a macroeconomic level, the use of the market to facilitate firms' desired use of intermediate goods fluctuates with the growth rate of aggregate economic activity. In interpreting this observation, I take the boundaries of the individual firm as given and show that periods of high economic growth which increase the heterogeneity among final-goods producers may raise the opportunity cost of relying exclusively on in-house production.

The remainder of the paper is structured as follows. Section 2 outlines my theoretical model and discusses its properties. Section 3 describes its predictions concerning input trade in the short and long run, and compares them with U.S. sector-level data on the patterns of input purchases. Section 4 concludes.

3.2 The Model

This section sets out a simple model which can account for the patterns of input trade among firms outlined in the Introduction. The model takes a technological view of the firm, identifying it with the production of a differentiated variety of a final consumption good. Final-good production requires intermediate inputs which need to be assembled one period ahead. I assume that contracting problems between final-good producers and suppliers of intermediates make it preferable for inputs and final goods to be produced in the same firm. Finally, I

[3]Recent theories have emphasised difficulties in writing complete contracts to govern arms-length transactions (see, for example, Klein, 1978; and Williamson, 1985) and the importance of the allocation of the residual rights of control for production outcomes (see, for example, Hart and Moore, 1990).

let booms − which arrive with a given probability − take the form of productivity growth in a random subset of the economy's final goods.

This set of assumptions imply that firms are identical ex ante, but may be different ex post in the event that a boom occurs. If a boom does materialise, productivity differences between firms encourage input trade despite the cost of sourcing intermediates from external suppliers. If no boom occurs, no input trade will take place. Thus, the model predicts cyclical fluctuations in input trade but no long-term trend as permanent increases in productivity for a subset of final goods will ultimately cause new, integrated producers of these varieties to enter the market.

a Basic Setup

a.1 Sequence of Events

Let there be two periods, $t = 0, 1$, and two types of final-good varieties, azure (A) and blue (B). I will think of these types as representing different sectors of the economy. In period 0, firms decide whether to enter the domestic market with a differentiated product variety of a given type. Having entered, they choose the level of their in-house production of intermediates so as to maximise their expected profits in period 1. At the time of making this choice there is uncertainty about total factor productivity in period 1. If no boom occurs in period 1, the final-good assembly of types A and B proceeds with an identical total factor productivity of 1. However, if a boom occurs, total factor productivity of one of the two types rises to $\gamma > 1$. Once the state of the world in period 1 is revealed, firms can trade inputs and hire labour to produce their final output which is purchased by consumers using their wage and asset earnings.

a.2 Endowments and Preferences

There is a unit mass of consumers endowed with L_0 units of labour in period 0 and L_1 units of labour in period 1. Consumers supply their labour inelastically in domestic labour markets. As production is sequential, with intermediates produced from labour in period 0 and final goods produced from intermediates and labour in period 1, workers only receive their wage earnings upon completion of final-good production. I normalise the wage rate to 1. At the end of period 1, consumers purchase differentiated final goods so as to maximise their utility. Utility is linear in consumption, and the consumption aggregator is given by

$$C = \left[\int_0^{N_A} y_A(i)^{\varepsilon} di + \int_0^{N_B} y_B(i)^{\varepsilon} di \right]^{\frac{1}{\varepsilon}}, \tag{3.1}$$

where $y_j(i)$ is consumption of product variety i of type j and N_j is a measure of differentiated final goods produced of this type.[4] These preferences imply a demand function

$$y_{js}(i) = A_s p_{js}(i)^{-\frac{1}{1-\varepsilon}}, \tag{3.2}$$

for final good i of type j, where s denotes the state in period 1, $p_{js}(i)$ is the good's price and

$$A_s = \frac{E_s}{\int_0^{N_A} p_{As}(i)^{-\frac{\varepsilon}{1-\varepsilon}} di + \int_0^{N_B} p_{Bs}(i)^{-\frac{\varepsilon}{1-\varepsilon}} di}. \tag{3.3}$$

E_s denotes aggregate spending in state s, equal to national income. The unique producer of variety i takes A_s as given.

[4] In the following, I suppress time subscripts wherever this is not confusing.

Firms are owned by consumers who use their profits to pay for consumption goods in period 1. This is relevant because, while firms' expected profits will be zero, their realised profits will generally be positive in some states of nature.

a.3 Production

In period 0, producers decide whether to enter the market or not. To set up shop, they need to pay a fixed cost of f. As is well-established in this setting, if producers do decide to enter the market, they will do so with a new variety of the final good, rather than as competitors in the market for an existing variety.

Having entered in period 0, producers hire labour to produce an intermediate input, $x(i)$. One unit of labour produces one unit of the intermediate input in period 1. The firm then combines intermediates with labour to produce the final good. In doing so, it may purchase additional inputs from other firms in a competitive market, or sell excess inputs from its own stock. Crucially, I assume that external inputs are imperfect substitutes for intermediates produced in-house. In particular, letting $x_s^m(i)$ denote the volume of intermediates bought or sold in the market by i in state s

$$y_{js}(i) = \begin{cases} a_{js} l_{js}(i)^{1-\alpha} \left[x_{js}(i) + \theta x_s^m(i)\right]^{\alpha} & \text{if } x_{js}^m(i) \geq 0 \\ a_{js} l_{js}(i)^{1-\alpha} \left[x_{js}(i) + x_s^m(i)\right]^{\alpha} & \text{if } x_{js}^m(i) < 0 \end{cases}, \tag{3.4}$$

where $\theta < 1$ and $\alpha \in (0, 1)$. The assumed imperfect substitutability between in-house inputs and inputs from suppliers of other varieties can be thought of as purely technological, or as a short cut to capturing the contracting difficulties between input suppliers and final-good

producers emphasised in modern theories of the firm:[5] successful use of the input produced by another firm may require the supplier to make a non-contractible investment, the returns to which are largely appropriated by the purchaser due to contractual incompleteness. In that case, the supplier will underinvest, reducing the value of the good to the purchaser. The assumption $\theta < 1$ can be interpreted as stating that such contracting problems are more severe between different firms than between different production stages within the same firm.

The parameter a_{js} represents the total factor productivity of firms producing a good of type j in state s. There are three possible states of nature in period 1: growth in the A-sector (AG), growth in the B-sector (BG) or zero growth (ZG). Total factor productivity in these three states is given by

$$\{a_{As}, a_{Bs}\} \begin{cases} \{\gamma, 1\} & \text{if } s = AG \\ \{1, \gamma\} & \text{if } s = BG \\ \{1, 1\} & \text{if } s = ZG \end{cases}, \tag{3.5}$$

where $\gamma > 1$. A boom $- s \in \{AG, BG\} -$ occurs with probability λ. If it does, both sectors are equally likely to receive the positive TFP-shock. Therefore, the two types of final-good varieties are perfectly identical ex ante.

b Equilibrium

b.1 Final-Good Revenues

The model is solved backwards, and I begin by considering the production choices and revenues of firms in period 1. Since variety types

[5] See Hart (1995) for an excellent overview.

A and B are indistinguishable ex ante, I conjecture that producers of both types behave symmetrically in the first period − i.e. $x_A(i) = x_B(i)$ − and then verify this conjecture.

To begin with, consider the case of an A-boom in period 1, without loss of generality. Firms hire labour and they may trade inputs in competitive markets at price p^m. Let us define R_j as the revenue of a firm of type j in period 1. Then,

$$R_{A,AG} = A_{AG}\left[\varepsilon\gamma\left(1-\alpha\right)^{1-\alpha}\left(\frac{\alpha\theta}{p^m}\right)^{\alpha}\right]^{\frac{\varepsilon}{1-\varepsilon}}, \tag{3.6}$$

$$R_{B,AG} = A_{AG}\left[\varepsilon\left(1-\alpha\right)^{1-\alpha}\left(\frac{\alpha}{p^m}\right)^{\alpha}\right]^{\frac{\varepsilon}{1-\varepsilon}}, \tag{3.7}$$

and

$$\frac{x_A(i)+\theta x^m_{A,AG}(i)}{x_B(i)+x^m_{B,AG}(i)} = \theta^{\frac{1}{1-\varepsilon}}\gamma^{\frac{\varepsilon}{1-\varepsilon}}, \tag{3.8}$$

which means that there is a positive volume of input trade if

$$\gamma > \theta^{-\frac{1}{\varepsilon}}. \tag{3.9}$$

I impose this condition from now on.

Suppose instead that there is no boom in period 1. Then, if $x_A(i) = x_B(i) \equiv x$, there are no incentives for input trade and

$$R_{A,ZG} = R_{B,ZG} = \left\{A_{ZG}^{1-\varepsilon}\left[\varepsilon\left(1-\alpha\right)\right]^{\varepsilon(1-\alpha)}x^{\varepsilon\alpha}\right\}^{\frac{1}{1-\varepsilon(1-\alpha)}}. \tag{3.10}$$

b.2 Intermediate Production

Given equations (6), (7) and (10), expected profits as of period 0 are

$$E\left[\pi\right] = \lambda\frac{1+\left(\gamma\theta^{\alpha}\right)^{\frac{\varepsilon}{1-\varepsilon}}}{2}\left[1-\varepsilon\left(1-\alpha\right)\right]A_{AG}\left[\varepsilon\left(1-\alpha\right)^{1-\alpha}\left(\frac{\alpha}{p^m}\right)^{\alpha}\right]^{\frac{\varepsilon}{1-\varepsilon}}$$

$$+(1-\lambda)\left\{A_{ZG}^{1-\varepsilon}\left[\varepsilon\left(1-\alpha\right)\right]^{\varepsilon(1-\alpha)}x^{\varepsilon\alpha}\right\}^{\frac{1}{1-\varepsilon(1-\alpha)}}-x-f. \tag{3.11}$$

Note that (11) does not depend on the type of variety, as A and B are identical ex ante. This implies that $x_A(i) = x_B(i)$ in line with the conjecture above, and also $N_A = N_B \equiv \frac{N}{2}$.

Maximising (11) with respect to x yields

$$x=\left\{\left[\varepsilon\alpha\left(1-\lambda\right)\right]^{1-\varepsilon(1-\alpha)}\left[\varepsilon\left(1-\alpha\right)\right]^{\varepsilon(1-\alpha)}\right\}^{\frac{1}{1-\varepsilon}}A_{ZG}, \tag{3.12}$$

and labour-market clearing in period 0 implies

$$\hat{x}=\frac{L_0}{N}-f. \tag{3.13}$$

b.3 Profits, Entry and Consumption

Given (13), it is easy to show that total profits if no boom occurs will be given by

$$\Pi_{ZG}=\frac{1-\varepsilon\alpha\left(1-\lambda\right)}{\varepsilon\alpha\left(1-\lambda\right)}L_0-L_1-Nf. \tag{3.14}$$

If an A-boom occurs, profits will be

$$\Pi_{A,AG}=\frac{1-\varepsilon}{\varepsilon\left(1-\alpha\right)}\frac{\left(\gamma\theta^{\alpha}\right)^{\frac{\varepsilon}{1-\varepsilon}}}{1+\left(\gamma\theta^{\alpha}\right)^{\frac{\varepsilon}{1-\varepsilon}}}L_1+\frac{\alpha}{\left(1-\alpha\right)\left(1+\theta\right)}L_1-\frac{L_0}{2}, \tag{3.15}$$

$$\Pi_{B,AG}=\frac{1-\varepsilon}{\varepsilon\left(1-\alpha\right)}\frac{1}{1+\left(\gamma\theta^{\alpha}\right)^{\frac{\varepsilon}{1-\varepsilon}}}L_1+\frac{\alpha\theta}{\left(1-\alpha\right)\left(1+\theta\right)}L_1-\frac{L_0}{2}. \tag{3.16}$$

Using equations (14), (15) and (16), we can re-write expected profits as a function of the number of firms which enter in period 0:

$$E\left[\pi\right]=\frac{L_1}{N}\frac{\lambda-\varepsilon\left(1-\alpha\right)}{\varepsilon\left(1-\alpha\right)}+\frac{L_0}{N}\frac{1-\varepsilon\alpha}{\varepsilon\alpha}-f\frac{1}{\varepsilon\alpha}. \tag{3.17}$$

I assume free entry. Then the number of firms which enter the market in period 0 reduces (17) to zero, so that

$$\hat{N} = (1 - \varepsilon\alpha)\frac{L_0}{f} + \varepsilon\alpha\frac{L_1}{f}\frac{\lambda - \varepsilon(1-\alpha)}{\varepsilon(1-\alpha)}. \tag{3.18}$$

To ensure that a positive number of firms enters the market, but that this number is not so large that intermediates cannot be produced,[6] I impose

$$\frac{L_0}{L_1} > \max\left\{-\frac{\varepsilon\alpha}{1-\varepsilon\alpha}, 1\right\}\frac{\lambda - \varepsilon(1-\alpha)}{\varepsilon(1-\alpha)}. \tag{3.19}$$

Finally, total consumption in period 1 is given by

$$C_s = \begin{cases} \hat{N}^{\frac{1}{\varepsilon}}\left(\frac{L_1}{\hat{N}}\right)^{1-\alpha}\left(\frac{L_0}{\hat{N}} - f\right)^{\alpha} & \text{if } s = ZG \\ \hat{N}^{\frac{1}{\varepsilon}}\left(\frac{L_1}{\hat{N}}\right)^{1-\alpha}\left(\frac{L_0}{\hat{N}} - f\right)^{\alpha}\left(\frac{1+\theta}{2\theta}\right)^{\alpha}\left[\frac{1+(\gamma\theta^{\alpha})^{\frac{\varepsilon}{1-\kappa}}}{2}\right]^{\frac{1-\varepsilon}{\varepsilon}} & \text{if } s = \{AG, BG\} \end{cases}. \tag{3.20}$$

Given $\theta < 1$ and (9), it is easy to verify that $C_{AG} = C_{BG} > C_{ZG}$: consumption is higher if a boom occurs than if there is no productivity growth.

3.3 Model Predictions About Input Trade

a Short Run

The model outlined in the previous section delivers unambiguous predictions as to the cyclical patterns of input trade. If economic conditions remain unchanged, frictions in input markets − represented by

[6] Condition (19) is required because I have assumed an exogenous labour supply in both periods. However, it would be straightforward to endogenise L_0 and L_1, and to dispense with this condition.

the assumption $\theta < 1$ − cause firms to favour in-house production of intermediate goods, and no input trade takes place. However, if the economy experiences productivity growth which affects firms asymmetrically, leading to sufficiently large productivity differences − as specified by equation (9) −, firms will trade in intermediate inputs. In this latter case, the total value of input purchases relative to GDP will be given by

$$\frac{\frac{N}{2}p^m x^m}{E_{AG}} = \frac{\theta^{\frac{1}{1-\varepsilon}}\gamma^{\frac{\varepsilon}{1-\varepsilon}} - 1}{1 + (\theta\gamma)^{\frac{\varepsilon}{1-\varepsilon}}} \frac{\varepsilon\alpha}{1+\theta}. \tag{3.21}$$

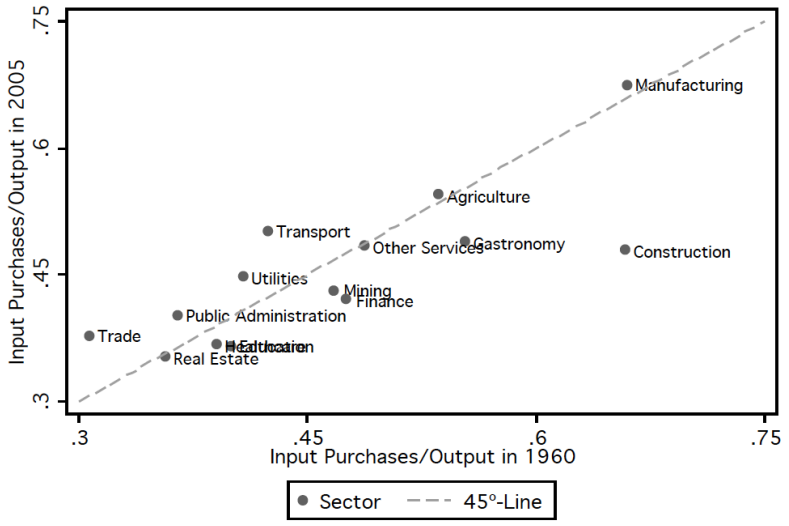
Equation (21) represents input trade between firms in the A-sector and firms in the B-sector, rather than within-sector trade. To verify if the cyclicality of input trade is indeed driven by trade between different sectors, rather than within-sector trade, I disaggregate U.S. sectoral input purchases by source in Figure 4. Using the annual BEA input-output accounts, I plot changes in the value of total input purchases relative to aggregate output for all within-sector and all across-sector input purchases.[7] The figure shows that virtually all the cyclical fluctuations in input trade relative to sectoral output since 1998 were driven by input purchases across sectors, consistent with my model.

Basu (1995) notes that procyclical input trade may be the result of countercyclical mark ups in the presence of sticky prices. My model shows that the same pattern may be observed even if mark ups are constant and prices are perfectly flexible. As would be expected, the

[7] As the BEA's annual input-output accounts date back to 1998, I can only construct these series for the last decade, covering the 2001 and the 2008-09 recessions.

Notes:
Data on the value of input purchases and output taken from the annual BEA Input-Output Accounts. Recessions as dated by the NBER. All the series have had means removed.

Figure 4: Change in Input Purchases/Output in the Short Run



Notes:
Data on the value of inputs and output for 13 sectors is taken from the US KLEMS database by Jorgenson et al. (2010).

Figure 5: Input Purchases/Output in the Long Run

model predicts larger volumes of input trade in booms, the larger the input-intensity of final-good production (α), the larger productivity differences resulting from the boom (γ) and the greater the substitutability between in-house and external inputs (θ). Given more comprehensive time-series and cross-sectional data on sectoral input purchases and output, the implied predictions for the cyclicality of input trade could easily be tested to evaluate the present model against rival explanations of cyclical input-trade fluctuations.

A potential criticism of deriving predictions about input trade over the cycle from equation (21) is that I have made the rather arbitrary assumption that the boundaries of the firm are defined by the production technology for distinct varieties of final goods. To see the implications of this, note that I could have just as arbitrarily assumed that production is organised within K large firms, each firm producing an equal share of final goods of the A- and B-type. In this case, there would never be any benefit from trade in intermediate goods across firms, and input trade would be zero in all states of nature. The example is illustrative but it is also pathological: except for the case in which all the economy's firms are perfectly symmetric, an equation akin to (21) could be derived in the conditions set out in Section 2. The crucial assumption, therefore, is not that firms are identified with individual product varieties but, less restrictively, that the boundaries of the firm are assumed to be fixed over the cycle.

b Long Run

Let us now revisit the model in Section 2 from the vantage point of an economy populated by overlapping generations of firms. Firms choose to enter the market and produce intermediates in the first period of

their lifetimes, then trade in goods and factor markets in the second period, produce the final good and pay out their profits before closing down. Suppose that intermediate goods are non-storable and that the productivity gains made in a boom are permanent, with $\gamma > 1$ now representing the gross growth rate of total factor productivity for the type of good benefiting from the boom.

Before the arrival of the first boom, the economy behaves as a repeated version of the model in Section 2. Suppose sector A is the first to experience a boom in period t. At t, the number of firms is fixed at $\hat{N}_{A,t-1} = \hat{N}_{B,t-1} = \frac{\hat{N}_{t-1}}{2}$. However, the new generation of entrants will take the permanent change in total factor productivity into account. Equation (11) will no longer be symmetric across A- and B-goods, and it is straightforward to demonstrate that

$$\hat{x}_{A,t} = \hat{x}_{B,t}, \tag{3.22}$$

$$\hat{N}_{A,t} > \hat{N}_{B,t}. \tag{3.23}$$

If there is no boom in period $t+1$, there will once again be no input trade. Moreover, as both sectors grow at the same rate in the long run, the long-run expected value of input purchases relative to GDP will be

$$E\left[\frac{\frac{N_t}{2} p_t^m x_t^m}{E_t}\right] = \lambda \frac{\theta^{\frac{1}{1-\varepsilon}} \gamma^{\frac{\varepsilon}{1-\varepsilon}} - 1}{1 + (\theta\gamma)^{\frac{\varepsilon}{1-\varepsilon}}} \frac{\varepsilon\alpha}{1+\theta}. \tag{3.24}$$

Equation (24) highlights that ratio of input trade to output is independent of the size of the economy. This distinguishes my model from alternative explanations of the volatility of input trade over the business cycle. For example, Grossman and Helpman (2002) show that there are conditions in which an increase in market size may lead to

an increase in the fragmentation of production processes across firms, causing more input trade. A model with this prediction could explain the cyclical behaviour of input trade but would also suggest that the ratio of input purchases relative to total output should increase over the long run. As Figure 5 shows, this is inconsistent with evidence from the U.S. economy.

The figure plots the ratio of input purchases relative to total output in 1960 against its counterpart in 2005 for 14 U.S. sectors. With the exception of the construction sector, which appears to have experienced a decline in input purchases, all observations are very close to the 45-degree line. Given that the size of the U.S. economy more than quadrupled in real terms between 1960 and 2005, there is very little evidence of a long-term increase in input trade relative to total output, which lends support to the view of input trade proposed in this paper.

3.4 Summary and Conclusion

This paper offers an explanation for the procyclicality on input trade in the major economies during the last 30 years. It is based on the notion that periods of economic expansion, if they generate sufficiently large differences between ex-ante similar sectors of the economy, raise the benefits from trade relative to whatever technological or contractual frictions impede exchanges in the market for intermediate goods. As a result, such booms may be accompanied by large, temporary increases in intermediate-goods purchases by firms. The broad predictions of this theory are consistent with two further aspects of the observed cyclical pattern of trade in intermediate goods: that it is mainly driven

by input trade across industries, rather than within-industry trade, and that there appears to be no long-run trend in the ratio of input purchases to total output.

The model developed here provides several new predictions which could be tested with cross-sectional and time-series data on sector- and firm-level input purchases. This remains an important task for future research. As a comparison between Basu (1995) and the present study highlights, a fuller understanding of the origins of cyclical fluctuations in input trade may allow us to distinguish between different theories of the business cycle with opposing implications for the role of public policy. In both Basu's (1995) and the present model, procyclical input trade is the result of imperfectly functioning intermediate-goods markets. However, the frictions present in his model − imperfect competition and sticky prices − leave room for improvements in allocative efficiency through monetary policy. By contrast, my theory implies no such role for monetary policy.

On a more general note, the patterns of domestic input trade deserve further study. The present paper has developed a theory of input trade across sectors, between ex-post heterogenous producers. However, as Jones (2011) shows using highly disaggregated input-output data, within-sector purchases of intermediates constitute the largest share of total input purchases for most sectors in the U.S. economy. I have provided some initial evidence that this type of trade is much more robust to changes in aggregate economic activity than between-sector trade. Taken together, these stylised facts provide an intriguing starting point for an analysis of the nature and causes of input trade between similar firms.

A Appendix to Chapter One

A.1 Factor Endowment Data

Factor endowment data is constructed in close correspondence with the methodology of the development accounting data, surveyed in Caselli (2005).

I generate estimates of capital stocks in 1980 using the perpetual inventory equation

$$K_{ct} = I_{ct} + (1 - \delta) K_{ct-1},$$

where I_t is gross investment in country c at t and δ is the constant depreciation rate. Investment data in constant, PPP-adjusted 2005 \$ is taken from Heston, Summers and Aten (2009) and, in line with convention, I set $\delta = .06$. I start in the year 1950 and, following standard practice, compute K_{c1950} as $\frac{I_{c1950}}{g_{I_c}+\delta}$ where g_{I_c} is the average geometric growth rate of the investment series. However, the choice of K_{c1950} is immaterial since it has little impact on the estimated capital stock in 1980 with a depreciation rate of 6%.

To construct capital stocks in 2007 in the counterfactual scenario of financial autarky, K^{FA}_{c2007}, I start from the estimated capital stock in 1980 and use an augmented version of the perpetual inventory equation for subsequent years,

$$K^{FA}_{ct} = S_{ct} + (1 - \delta) K^{FA}_{ct-1},$$

where S_{ct} are gross domestic savings in country c at t. The reasoning behind this new equation is as follows: from the national accounting identities,

$$S_{ct} = I_{ct} + CA_{ct},$$

where CA_{ct} is country c's current account at t, so $I_{ct} = S_{ct}$ in financially closed economies. Assuming constant savings rates, the set of counterfactual capital stocks thus provides a benchmark against which the impact of net international financial flows on the observed pattern of capital accumulation can be judged.[1] S_{ct} is constructed using the aforementioned investment series as well as data on the current account (as a percentage of GDP) from the IMF International Financial Statistics (2010). The "true" capital stocks in 2007, K_{c2007}, which incorporate the impact of the observed pattern of international capital flows, are constructed as those for the year 1980, i.e. using investment instead of savings flows.

Finally, I estimate the stock of human capital based on the size of the working-age population, using total population figures from Heston, Summers and Aten (2009) and multiplying with the population share of individuals between 15 and 65 from the World Development Indicators (2010). The "quality adjustment" follows Hall and Jones (1999):

$$H_{ct} = e^{f(d_{ct})} L_{ct},$$

where L_{ct} is the working-age population and d_{ct} is its average number of years of schooling in country c at t. The function $f()$ is piecewise

[1]The assumption that countries' observed savings rates would have been the same in counterfactual financial autarky may seem contentious because, in practice, the occurrence of financial globalisation is likely to have affected countries' interest rates. However, there is a large number of studies suggesting that the interest elasticity of savings is close to zero, both in advanced economies – see, for example, Blinder (1975, 1981), Mankiw (1981), Campbell and Mankiw (1989, 1991) – and in developing countries – see Giovannini (1983).

linear with

$$f(d_{ct}) = \begin{cases} 0.134 \cdot d_{ct} & \text{if } d_{ct} \leq 4 \\ 0.101 \cdot (d_{ct} - 4) + 0.134 \cdot 4 & \text{if } 4 < d_{ct} \leq 8 \\ 0.068 \cdot (d_{ct} - 8) + 0.101 \cdot 4 + 0.134 \cdot 4 & \text{if } 8 < d_{ct} \end{cases},$$

and d_{ct} is based on the average years of schooling in the population above the age of 15 from Barro and Lee (2010).[2] Average years of schooling are observed quinquennially, most recently in 2010. Since d_{ct} moves slowly over time, a quinquennial observation can plausibly be employed for nearby dates as well.

Throughout the paper I assume that the accumulation of physical capital is affected by international financial flows, but the accumulation of human capital is not.

[2]The paper's key empirical findings are, if anything, strengthened if population or the size of the workforce are used instead of the "quality adjusted" workforce to measure human capital endowments.

Country	Data					
	$(H_c/H)_{1980}$	$(K_c/K)_{1980}$	$(H_c/H)_{2007}$	$(K_c/K)_{2007}$	$(K^{FA}{}_c/K)_{2007}$	Avg. PRSG Score
Argentina	.014	.016	.013	.009	.009	37.63
Australia	.010	.017	.009	.018	.015	18.97
Austria	.004	.001	.003	.007	.007	14.50
Belgium	.006	.012	.004	.009	.010	17.75
Brazil	.035	.032	.056	.022	.021	36.71
Canada	.016	.026	.013	.025	.026	15.74
Chile	.005	.004	.006	.005	.005	28.34
China	.366	.035	.426	.159	.185	28.99
Denmark	.003	.006	.002	.005	.005	14.56
Finland	.003	.006	.002	.004	.005	14.68
France	.025	.064	.022	.044	.045	19.81
Germany	.035	.111	.033	.062	.067	16.47
Greece	.005	.011	.004	.007	.005	30.31
Indonesia	.049	.008	.057	.015	.016	40.04
Italy	.027	.063	.019	.046	.045	21.59
Japan	.074	.150	.049	.125	.136	13.70
Korea, Rep.	.021	.010	.021	.034	.035	22.96
Mexico	.022	.027	.034	.023	.022	31.53
Netherlands	.009	.018	.006	.012	.015	13.29
New Zealand	.002	.003	.002	.002	.002	18.54
South Africa	.011	.006	.015	.004	.004	32.61
Spain	.017	.035	.015	.033	.029	23.02
Sweden	.005	.009	.004	.006	.006	15.53
Thailand	.016	.008	.019	.014	.015	19.55
Turkey	.014	.007	.020	.010	.009	42.55
U.K.	.031	.044	.021	.035	.033	17.86
U.S.	.174	.262	.125	.265	.231	18.37

Table A1: Shares of World Factor Endowments, 1980 and 2007

A.2 Empirical Appendix

a Investment and Country Risk

Differences in country-specific investment risk play a crucial role in the view of international asset trade proposed in this paper. In order to provide a preliminary assessment of the significance of country risk as a determinant of investment patterns among financially open economies, I estimate a regression of the form

$$Investmt._{ct}/GDP_{ct} = \beta_0 + \beta_1 Savings_{ct}/GDP_{ct} + \beta_2 Risk_{ct} + \delta_c + \delta_t + \varepsilon_{ct},$$

where $Investmt._{ct}$, $Savings_{ct}$ and GDP_{ct} are, respectively, investment, savings and GDP in country c and year t, $Risk_{ct}$ is a measure of country risk, and δ_c and δ_t represent country and time fixed effects. Note that, as a matter of national accounting, we should obtain $\beta_1 = 1$, $\beta_2 = 0$ if all sample countries are completely closed to international financial flows.

To construct the panel, I take the three macroeconomic series for 27 largest economies between 1980 and 2007 from the World Development Indicators (2010). As a measure of country-specific investment risk, I use the composite country risk index compiled by the Political Risk Services Group (PRSG). This index ranks countries by their economic, financial and political risk based on PRSG's own macroeconomic analysis as well as surveys among international investment professionals. There are two main advantages to using the PRSG ranking in this context. First, it is compiled monthly, so an annual risk score can easily be constructed by taking the average over the corresponding 12-month period. Second, it largely captures countries' *idiosyncratic* investment risk, as emphasised by my model.

Dep. Variable: $Investmt._{c,t}/\ GDP_{c,t}$ (%)	(1)	(2)	(3)	(4)
$Savings_{c,t}/\ GDP_{c,t}$ (%)		0.487***		0.433***
		(0.037)		(0.046)
$Risk\ index_{c,t}$ (0-100)			-0.195***	-0.177***
			(0.026)	(0.027)
Country dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Observations	743	743	608	608
Adj. R^2	0.67	0.76	0.75	0.79

Robust standard errors in parentheses. Period: 1980-2007.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table A2: Investment and Country Risk

Table A2 reports the regression results. The first noteworthy finding appears in column 2. The estimated coefficient on $Savings_{ct}/GDP_{ct}$ – sometimes referred to as the "savings retention" coefficient – is around .5. This relatively low value suggests a high degree of financial globalisation.[3] The estimated value of this coefficient is almost unchanged when country risk is added to the regression in column (3). The country risk score itself is shown to be associated with significantly lower investment shares of GDP. Moreover, the economic impact of changes in country risk is substantial: an improvement in the average risk score from the 75th percentile of the country distribution (30) to the 25th percentile (16) would raise the average investment share by 2.6 percentage points. By way of comparison, an increase in the average savings rate from the 25th percentile of the country distribution (21%) to the 75th percentile (26%) would only raise the investment share by 2.2 percentage points.

[3]Obstfeld and Taylor (2004), using a similar sample of countries, report a coefficient of .83 for 1946-1972, and .75 for 1973-2000.

b Specialisation

Are factor-proportions an important determinant of the type of goods imported by the United States from its main trading partners? This question has generated a large empirical literature, which is surveyed in Helpman (1999). A basic test on U.S. bilateral trade flows, which can be motivated by augmenting the model in Section 2, does suggest this to be the case in recent decades.

As is, the model in Section 2 does not deliver predictions for countries' bilateral trading patterns. To derive a testable prediction, let us make an additional assumption about the nature of international trade.[4] Suppose a fraction $\mu \in (0,1)$ of trade transactions proceeds as follows. Producers in each industry put their outputs into a world pool for their industry, and consumers choose randomly their desired levels of consumption from these pools. By the law of large numbers, the expected share of goods of a given type produced by country c and used in consumption and investment of another country − call it $UnitedStates$ − will be equal to share of $c's$ production in global production of the good. For the remaining share $1-\mu$ of goods produced and consumed international trade proceeds as describe in Section 2.a.

Define the average capital intensity of $c's$ exports to the United States at t as

$$AKX_{ct}^{UnitedStates} = \sum_j \alpha_j \frac{M_{cjt}^{UnitedStates}}{M_{ct}^{UnitedStates}}, \tag{A.1}$$

where $M_{cjt}^{UnitedStates}$ are U.S. imports from country c in industry j at time t, and $M_{ct}^{UnitedStates}$ are total U.S. imports from c at t. Then,

[4] This assumption was first suggested by Deardorff (1998).

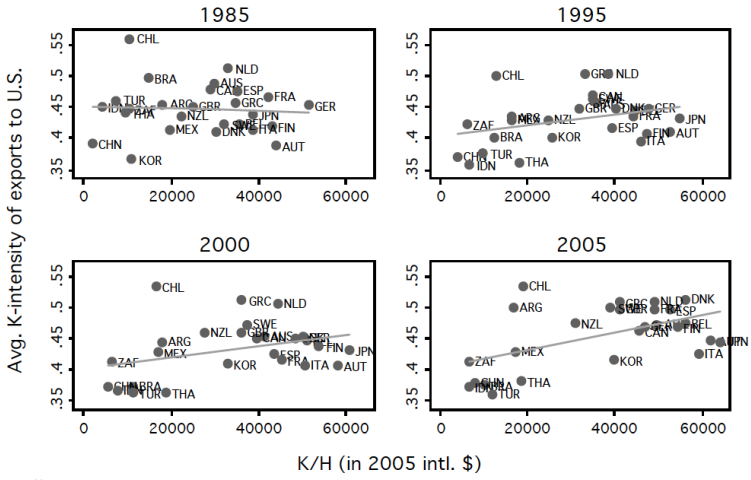


Figure A1: Capital-Labour Ratios and Specialisation

according to the model,

$$AKX_{ct}^{UnitedStates} = \frac{\alpha_K \frac{Q_{cKt}}{Q_{Kt}}\theta + \alpha_H \frac{Q_{cHt}}{Q_{Ht}}(1-\theta)}{\frac{Q_{cKt}}{Q_{Kt}}\theta + \frac{Q_{cHt}}{Q_{Ht}}(1-\theta)} = \frac{\alpha \frac{K_{ct}}{H_{ct}}}{\alpha \frac{K_{ct}}{H_{ct}} + (1-\alpha)\frac{K_t}{H_t}}. \tag{A.2}$$

Equation (40) shows that, at a given time t, we should expect a positive correlation between a country's capital-labour ratio and the capital-intensity of its exports to the United States.[5] Below, I verify that this prediction is borne out by U.S. sector-level trading patterns in recent years.

To calculate U.S. sectoral import shares, I use sector-level data on imports from the U.S. Census, assembled and converted to the 4-digit

[5]Romalis (2004) derives a similar expression under different assumptions and successfully tests it for a cross-section of countries.

level of SIC by Feenstra (2009). The data I employ covers U.S. imports from 26 large economies in more than 400 distinct sectors.

I construct an index of capital intensity at the 4-digit level of SIC from data provided in the NBER-CES Manufacturing Industry Database. In line with previous papers, I rank industries by the average non-wage share of U.S. manufacturing value added in the period 1958 to 2005. This ranking, normalised between 0 and 1, is taken as a measure of capital intensity. Note that this amounts to assuming that the technological capital intensity measured for the United States in a given sector i is a good description of the properties of this sector's production function for *any* country. This standard assumption is made partly for reasons of empirical convenience − as detailed sector-level manufacturing data would not be available for all countries in the given sample −, and partly because U.S. product and factor markets are considered to be among the world's most competitive and frictionless, so that the relative usage of capital and labour in U.S. manufacturing is most likely to reflect the true technological properties of different industries, rather than allocative distortions.

Finally, country shares in world physical and human capital are calculated on the basis of the physical-capital and human-capital estimates discussed in Appendix A1.

Figure A1 plots the correlation between the average capital intensity of countries' exports to the United States and their K/H-ratio for the years 1985, 1995, 2000 and 2005. The graphs document that capital-labour ratios do appear to have been positively correlated with the average capital intensity of exports to the United States. Indeed, in 2005 factor-proportions differences accounted for approximately 30% of the differences in the average capital intensity of U.S. imports from its major trading partners.

A.3 Theoretical Appendix

To allow me to better match my theoretical model with the data on North-South trade in Section 3, I introduce a nonhomotheticity in the consumption demand for the H-good. This assumption was first used by Markusen (1986) to explain the relatively low volume of North-South trade. Below, I outline my assumptions and provide the relevant derivations.

The change to the model requires a small re-interpretation of consumption and investment. Assume, as before, that the construction of one unit of physical capital requires an investment good which is produced from the tradable K- and H-goods using the Cobb-Douglas technology given by equation (3). By contrast, let consumers derive utility directly from consuming the K- and H-goods, with the utility from consumption at t for an individual i in country c given by

$$U(i) = \left[C_{cKt}(i)\right]^{\theta} \left[C_{cHt}(i) - \tau h_c\right]^{1-\theta}, \tag{A.3}$$

where τh_c can be interpreted as a minimum consumption requirement for the H-good. Equation (41) implies that a consumer's share of spending on the K-good will rise as her income increases, as long as her country's average labour-productivity is constant. The fact that the minimum consumption requirement depends on average local labour productivity is non-essential theoretically but, as will become apparent below, it ensures that a country's exports and imports only depend on its stocks of human and physical capital, in keeping with Section 2.

Since c has population L_c, we obtain the aggregate consumption expenditures

$$P_{Kt} C_{cKt} = \theta \left[C_{ct} - \tau P_{Ht} H_c\right], \tag{A.4}$$

$$P_{Ht}C_{cHt} = (1-\theta)\left[C_{ct} - \tau P_{Ht}H_c\right] + \tau P_{Ht}H_c, \tag{A.5}$$

Globally,

$$P_{Kt}Q_{Kt} = \theta\left[Q_t - \tau P_{Ht}H\right], \tag{A.6}$$

$$P_{Ht}Q_{Ht} = (1-\theta)\left[Q_t - \tau P_{Ht}H\right] + \tau P_{Ht}H, \tag{A.7}$$

where the normalisation $\left(\frac{P_{cKt}}{\theta}\right)^{\theta}\left(\frac{P_{cHt}}{1-\theta}\right)^{1-\theta} = 1$ is imposed, as in Section 2. Equations (44) and (45) imply

$$r_tK_t = \left[\alpha_K\theta + \alpha_H(1-\theta)\right]Q_t - \tau\theta\left(\alpha_K - \alpha_H\right)P_{Ht}H, \tag{A.8}$$

$$w_tH = \left[1 - \alpha_K\theta - \alpha_H(1-\theta)\right]Q_t + \tau\theta\left(\alpha_K - \alpha_H\right)P_{Ht}H. \tag{A.9}$$

To obtain a closed-form solution for P_{Ht} and, hence, for r_t and w_t we need to set $\alpha_H = 0$. Since α_H constitutes a free parameter in the calibration, I impose this parametrisation in the interest of analytical convenience. It then follows that

$$r_tK_t = \alpha\frac{1-\tau}{1-\tau\alpha}Q_t, \tag{A.10}$$

$$w_tH = \left(1 - \alpha\frac{1-\tau}{1-\tau\alpha}\right)Q_t, \tag{A.11}$$

where, as before, $\alpha \equiv \alpha_K\theta + \alpha_H(1-\theta) = \alpha_K\theta$. Using (48) and (49), one obtains

$$|M_{cKt}| = |M_{cHt}| = \frac{1-\tau}{1-\alpha\tau}\theta(1-\alpha)\left|\frac{K_{ct}}{K_t} - \frac{H_c}{H}\right|Q_t \tag{A.12}$$

for a financially closed economy.

In a financially open economy ($NX_{ct} \lessgtr 0$),

$$M_{cHt} = \frac{1-\tau}{1-\alpha\tau}\theta(1-\alpha)\left(\frac{K_{ct}}{K_t} - \frac{H_c}{H}\right)Q_t - (1-\theta)NX_{ct},$$

$$M_{cKt} = \frac{1-\tau}{1-\alpha\tau}\theta\left(1-\alpha\right)\left(\frac{H_c}{H} - \frac{K_{ct}}{K_t}\right)Q_t - \theta NX_{ct},$$

so that

$$\frac{|M_{cKt}| + |M_{cHt}|}{2Q_t} = \frac{1}{2}\left|\frac{1-\tau}{1-\alpha\tau}\theta\left(1-\alpha\right)\left(\frac{K_{ct}}{K_t} - \frac{H_c}{H}\right) + \theta\frac{NX_{ct}}{Q_t}\right|$$

$$+\frac{1}{2}\left|\frac{1-\tau}{1-\alpha\tau}\theta\left(1-\alpha\right)\left(\frac{K_{ct}}{K_t} - \frac{H_c}{H}\right) - \left(1-\theta\right)\frac{NX_{ct}}{Q_t}\right|. \qquad \text{(A.13)}$$

The negative impact of a rise in τ on the volume of trade can be explained as follows. For higher values of τ, countries spend a larger share of their income on the H-good and, in addition, earn a larger share of their income from producing the H-good, reducing the incentives for international goods exchange. As a side effect, the FPE condition becomes easier to satisfy: equation (7) reduces to

$$\frac{K_{ct}}{H_c} \leq \frac{\alpha_K}{1-\alpha_K}\frac{1-\alpha}{\alpha\left(1-\tau\right)}\frac{K_t}{H_t} \;\forall\; c \text{ and } \tau \leq 1. \qquad \text{(A.14)}$$

B Appendix to Chapter Two

B.1 Sample Countries and Financial Crises

Country	Debt Crisis	First Year of Bank Crisis	Currency Crisis
Albania	1991	1994	1997
Argentina	1982, 1989, 2001	1980, 1989, 1995, 2001	1981, 1987, 2002
Australia			
Austria			
Azerbaijan		1995	1994
Bangladesh		1987	
Barbados			
Belarus		1995	1994, 1999
Bolivia	1980, 1989	1994	1981
Brazil	1983	1990, 1994	1987, 1992, 1999
Cameroon		1987, 1995	
Chad			1994
Chile	1983	1992	
China		1998	
Colombia		1982, 1998	1985
Congo, Dem. Rep.		1983, 1991, 1994	1983, 1989, 1994, 1999
Congo, Rep.	1983	1992	1994
Costa Rica		1987, 1994	1991
Côte d'Ivoire	1983, 2000		
Croatia	1992	1998	
Denmark			
Djibouti		1991	
Dominica	2003		
Egypt, Arab Rep.	1984		1990
El Salvador		1989	1986
Fiji			
Finland		1991	1993
France			
Gabon	1999, 2002		1994
Georgia			1992, 1999
Germany			
Ghana	1987	1982	1983, 1993, 2000
Greece			1983
Grenada	2004		
Guatemala	1986, 1989		1986
Guinea	1986, 1991	1993	2005
Haiti		1994	1992, 2003
Honduras			1990
Hong Kong, China			
Hungary			
Iceland			1981, 1989
India		1993	
Indonesia	1998, 2000, 2002	1997	1998
Ireland			
Israel			1985
Italy			1981
Jamaica	1981, 1987	1996	1983, 1991
Japan		1997	
Jordan	1989	1989	1989
Kenya	1994	1985, 1992	1993
Korea, Rep.		1997	1998
Lebanon		1990	1990
Madagascar	1981, 1986		1994, 2004
Malawi	1982, 1988		1994
Malaysia		1997	1998
Mali		1987	
Mauritania	1992	1984	1993
Mauritius			
Mexico		1994	1995
Mongolia			1990, 1997
Morocco	1983, 1986	1980	1981
Nepal		1998	1984, 1992
Netherlands			
New Zealand			
Nicaragua	2003	1990, 2000	1990
Pakistan	1999		
Panama	1987	1988	
Papua New Guinea			

Paraguay	2003	1995	2002
Peru	1980, 1983	1983	1981, 1988
Philippines	1983	1983, 1997	1993, 1998
Poland			
Portugal			1983
Romania		1990	1996
Rwanda			1991
Senegal	1981, 1990, 1992		1994
Sierra Leone	1983, 1986	1990	1983, 1989, 1998
South Africa	1993		1984
Spain			1983
Sri Lanka		1989	
Suriname			1990, 1995, 2001
Sweden		1991	1993
Switzerland			
Syrian Arab Republic			
Thailand		1983, 1997	1998
Togo	1988, 1991		1994
Trinidad and Tobago	1988		1986
Tunisia		1991	
Turkey		2000	1991, 1996, 2001
United Kingdom		2007	
United States		1988, 2007	
Uruguay	1983, 1987, 1990, 2003	2002	1983, 1990, 2002
Vietnam		1997	

Table B1: Sample Countries and Financial Crises

B.2 Sample Industries and Industry Characteristics

ISIC	Industry Description	$FinDep_i$	$Tang_i$
311	Food products	.1368	.3777
313	Beverages	.0722	.2974
314	Tobacco	-.4512	.2208
321	Textiles	.4005	.3730
322	Wearing apparel, except footwear	.0286	.1317
323	Leather products	-.1400	.0960
324	Footwear, except rubber or plastic	-.0799	.1167
331	Wood products, except furniture	.2840	.3796
332	Furniture, except metal	.2357	.2630
341	Paper and products	.1756	.5579
342	Printing and publishing	.2038	.3007
351	Industrial chemicals	.2050	.4116
352	Other chemicals	.2178	.1973
353	Petroleum refineries	.0420	.6708
354	Miscellaneous petroleum and coal products	.3341	.3038
355	Rubber products	.2265	.3790
356	Plastic products	1.1401	.3448
361	Pottery, china	-.1459	.0745
362	Glass and products	.5285	.3313
369	Other non-metallic mineral products	.0620	.4200
371	Iron and steel	.0871	.4581
372	Non-ferrous metals	.0055	.3832
381	Fabricated metal products	.2371	.2812
382	Machinery, except electrical	.4453	.1825
383	Machinery, electric	.7675	.2133
384	Transport equipment	.3069	.2548
385	Professional and scientific equipment	.9610	.1511
390	Other manufactured products	.4702	.1882

Table B2: Sample Industries and Industry Characteristics

B.3 Defaulters and PSM Control Countries

Default Episode		Control Country
Albania	1991	Mali
Argentina	1989	Kenya
Argentina	2001	Philippines
Bolivia	1989	El Salvador
Côte d'Ivoire	2000	Sierra Leone
Gabon	1999	Zimbabwe
Gabon	2002	Zimbabwe
Ghana	1987	Guinea
Guatemala	1986	Mexico
Guatemala	1989	El Salvador
Guinea	1991	Cameroon
Indonesia	1998	Syrian Arab Republic
Indonesia	2000	Syrian Arab Republic
Indonesia	2002	Turkey
Jamaica	1987	Paraguay
Jordan	1989	Paraguay
Kenya	1994	Syrian Arab Republic
Madagascar	1986	Costa Rica
Malawi	1988	Mali
Morocco	1986	Israel
Nicaragua	2003	Congo, Dem. Rep.
Pakistan	1999	Senegal
Panama	1987	Tunisia
Paraguay	2003	Syrian Arab Republic
Senegal	1990	Madagascar
Senegal	1992	Greece
Sierra Leone	1986	Côte d'Ivoire
South Africa	1993	Vietnam
Togo	1988	Kenya
Togo	1991	Mali
Trinidad and Tobago	1998	Mali
Uruguay	1987	Thailand
Uruguay	1990	Paraguay
Uruguay	2003	Zimbabwe

Table B3: Default Episodes and PS-Matched Control Countries

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