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Factor Proportions and the Growth of World Trade

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Abstract

Most of the expansion of global trade during the last three decades has been of the North-South kind – between capital-abundant developed and labour-abundant developing countries. Based on this observation, I argue that the recent growth of world trade is best understood from a factor-proportions perspective. I present 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 upstream capital flows towards capital-abundant regions. I analyse their impact on specialisation and the volume of trade in a dynamic model which combines factor-proportions trade in goods with international trade in financial assets. Calibrating this model, I find that it can account for 60% of world trade growth between 1980 and 2007. It is also capable of predicting international investment patterns which are consistent with the data.

JEL Classification codes: F11, F14, F21, F32, F43

Keywords: Heckscher-Ohlin, international trade, China, financial globalisation

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 magnitude 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 export in industries which make use of their relatively abundant production factors, and that factor-endowment differences give 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 nearly 90% 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 −
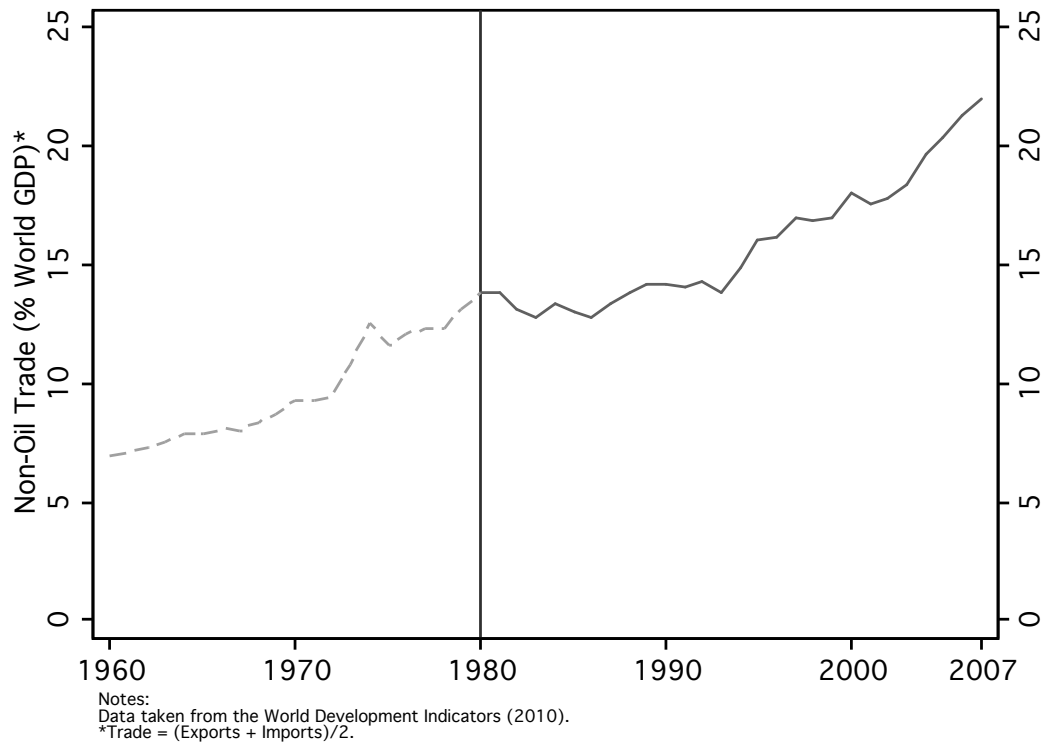
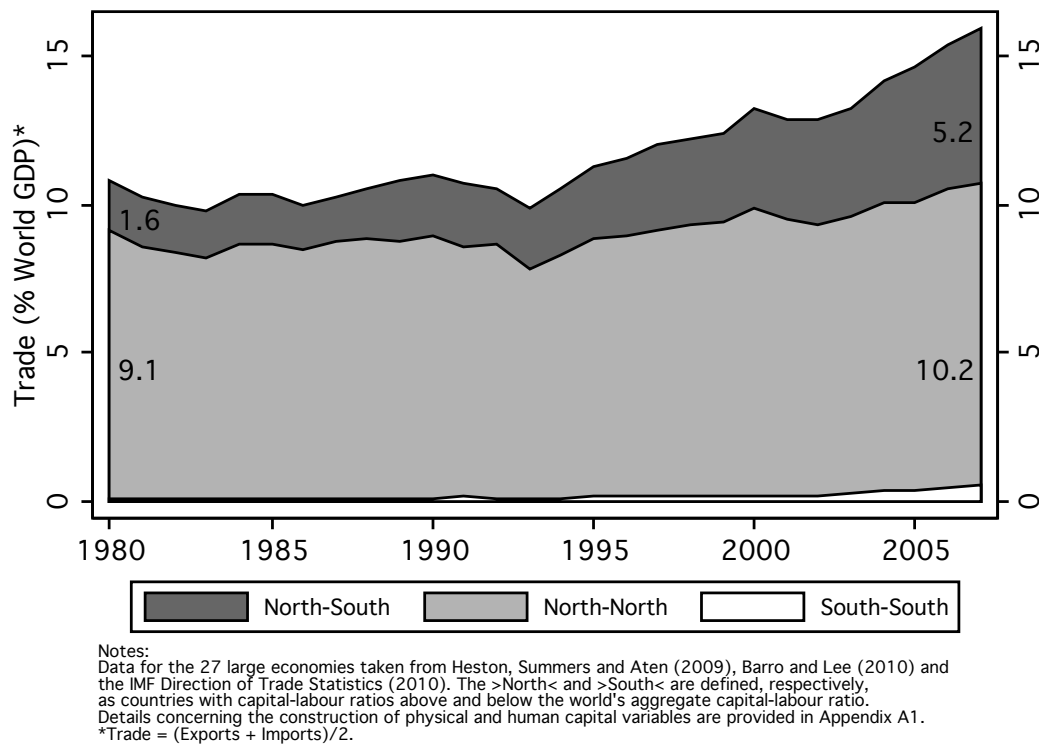---

Figure 1: The Growth of World Trade, 1960-2007

Figure 2: World Trade by Region, 1980-2007

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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 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 17% are due to financial globalisation and the resulting flow of capital to capital-abundant regions.

China's trade liberalisation − in accordance with the program of "reform and opening up" initiated by the Communist Party of China under Deng Xiaoping in 1978 − is generally viewed as an exogenous policy shock. It merits special consideration because its scale and global impact are unique in the period 1980-2007.[4] Its significance for any factor-proportions-based view of international goods trade derives from China's sheer size and labour-abundance. Although China's comparative advantage in labour-intensive industries is widely acknowledged,[5] 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 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 and sustained capital returns, while a large trade

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[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.

[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]Since 1990 China has slashed its average import tariff by 25 percentage points − more than any other large economy. The value of its imports relative to world GDP has risen from 0.2% in 1980 to 2.1% in 2007 and is now similar to Germany's.

[5]See, for example, Rodrik (2006) and Amiti and Freund (2010).
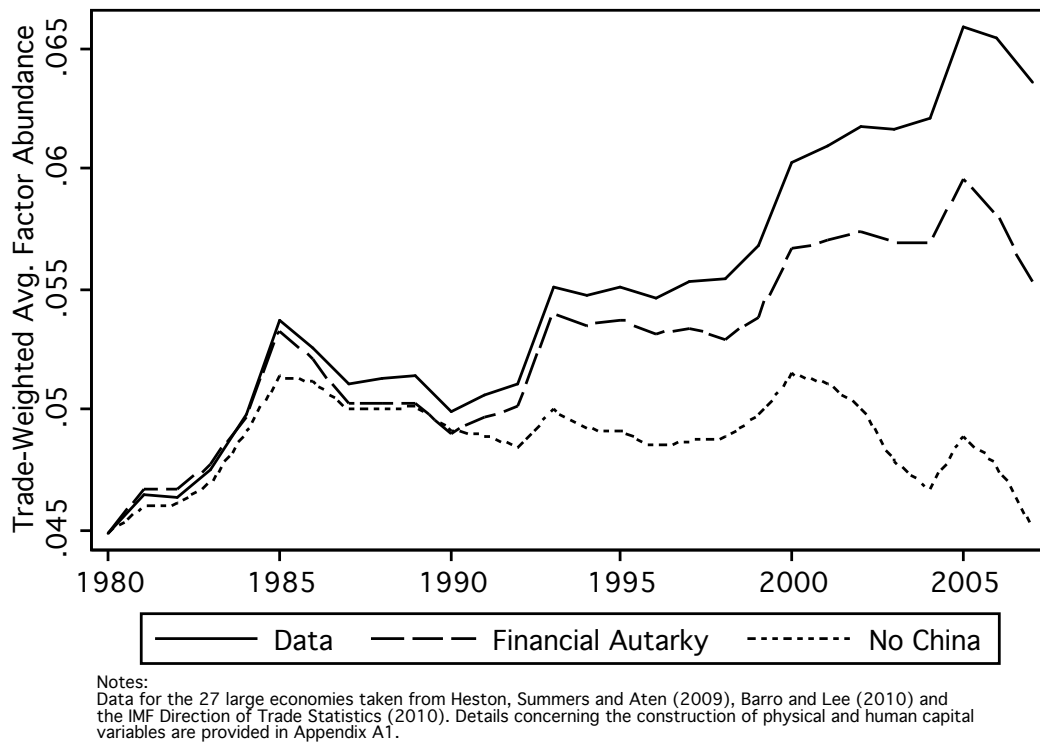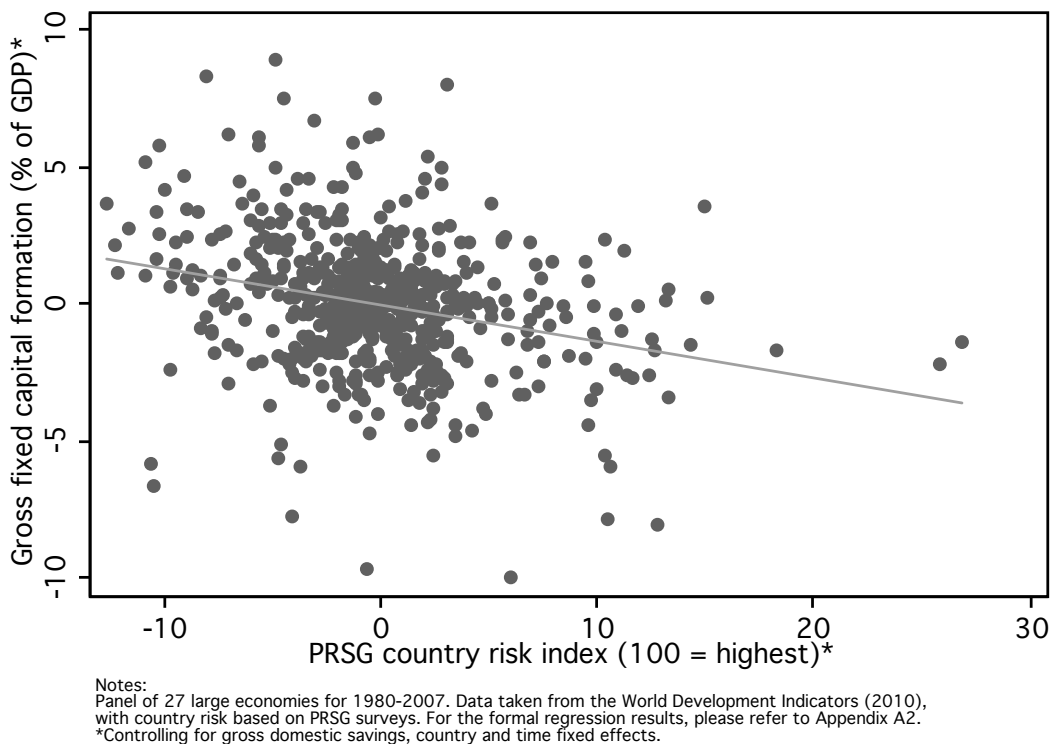
Figure 3: Dispersion of K/H-ratios Over Time

Figure 4: Investment and Country Risk, 1980-2007

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.[6] 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 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.[7]

My paper adds to a long literature on the quantitative implications of

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

[7]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.

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 (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 complimentary 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.[8]

The remainder of the paper is structured as follows. Section 2 describes

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[8]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).

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.

2 The Model

Below I outline a tractable general equilibrium model to illustrate the relationship between capital-labour ratios, the patterns of trade and the traded share of world output. 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 export the good which uses their abundant factor intensively. 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 2.2) and the impact of financial globalisation, modelled as the removal of all barriers to international asset trade (in Section 2.3).

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.

2.1 Basic Model

2.1.1 Endowments and Preferences

Consider a world consisting of large regions, $c = 1, ..., C$, and inhabited by two overlapping generations, the young and the old. Generations in region c have

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}. Young agents also receive profits Π_{ct} from the economy's firms. 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:

$$B_{ct} = S_c \left(w_{ct} H_c + \Pi_{ct} \right), \tag{1}$$

$$C_{ct} = (1 - S_c) \left(w_{ct} H_c + \Pi_{ct} \right) + r_{ct} B_{ct-1}, \tag{2}$$

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

2.1.2 Production

Each region c produces final goods which are used for consumption and investment:

$$C_{ct} + I_{ct} = Q_{ct}, \tag{3}$$

where I_{ct} denotes aggregate investment in c at t and Q_{ct} represents the total output of final goods. Final goods are Cobb-Douglas composites of two intermediate goods:

$$Q_{ct} = \theta Q_{cKt}^{\alpha} Q_{cHt}^{1-\alpha} \text{ with } \alpha \in (0, 1), \tag{4}$$

where Q_{cjt} is the input of intermediate good $j \in \{K, H\}$ used in final production, and θ is a productivity parameter. Intermediate goods are assembled using two factors of production — physical capital, K_{ct}, and human capital, H_c — according to

$$Q_{cKt} = K_{cKt}, \tag{5}$$

$$Q_{cHt} = H_{cHt}. \tag{6}$$

In words, production of the intermediate good of the K-type uses only physical capital, while production of the intermediate good of the H-type uses only human capital.

Intermediate-good and factor markets are perfectly competitive everywhere. However, final goods in each c can be produced by two types of firms: a competitive fringe of firms with productivity $\theta = 1$, or a monopolist which is uniquely capable of operating the superior technology $\theta = \frac{1}{1-\tau}$, with $\tau \in (0, 1)$. In equilibrium, due to the unit elasticity of final demand, final goods in each region are supplied by the monopolist at a price equal to the marginal cost of firms

in the competitive fringe, and τ can be interpreted as the profit margin.[9]

2.1.3 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

$$K_{ct+1} = A_{ct+1}I_{ct}, \tag{7}$$

where A_{ct+1} is stochastic with

$$
\begin{aligned}
E_t\left(A_{ct+1}\right) &= 1 \\
Var\left(A_{ct+1}\right) &= \sigma_c^2 \\
Cov\left(A_{ct+1}, A_{c't+1}\right) &= 0 \ \forall \ c' \neq c
\end{aligned}
\tag{8}
$$

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.[10] I shall therefore refer to σ_c as a measure of c's country risk.

2.1.4 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 the production vector $\{Q_{cKt}, Q_{cHt}\}$ which suits their relative endowment of production factors. By the force of the Heckscher-Ohlin theorem, this leads K-abundant regions to export the K-intermediate and import the H-intermediate, while H-abundant regions do the reverse.

Since intermediate goods can be traded freely,

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

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[9]The parameter τ will be used in the calibrations in Section 3, where it will represent the share of income from non-traded production. However, for the remainder of this section there is nothing lost by letting τ equal zero and assuming that final-good firms are also perfectly competitive.

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

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

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

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, the assumed non-substitutability of capital and labour in the production of K- and H-intermediates ensures that commodity trade always equalises factor prices, irrespective of the given distribution of factor endowments.[11]

Since FPE applies,

$$Q_t = K_t^{\alpha} H^{1-\alpha}, \tag{9}$$

$$\Pi_t = \tau Q_t, \tag{10}$$

$$r_{ct} = r_t = (1-\tau) \alpha \frac{Q_t}{K_t} \ \forall \ c, \tag{11}$$

$$w_{ct} = w_t = (1-\tau)(1-\alpha) \frac{Q_t}{H} \ \forall \ c, \tag{12}$$

$$K_{t+1} = \sum_{c=1}^{C} A_{ct+1} I_{ct} = \sum_{c=1}^{C} A_{ct+1} s_c Q_{ct}, \tag{13}$$

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

$$Q_{ct} = \left[\alpha \frac{K_{ct}}{K_t} + (1-\alpha) \frac{H_c}{H} \right] Q_t. \tag{14}$$

---

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

2.1.5 The Patterns of Trade

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

$$M_{cHt} = (1 - \tau) \alpha (1 - \alpha) \left(\frac{K_{ct}}{K_t} - \frac{H_c}{H} \right) Q_t = -M_{cKt}. \tag{15}$$

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. 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, giving rise to larger net trade flows between such regions and the rest of the world. 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 imports and exports. I shall go one step further by highlighting the deeper roots of 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,

$$\left| \frac{K_{ct}}{K_t} - \frac{H_c}{H} \right| \approx \left| \frac{A_{ct}}{\sum_c A_{ct} \frac{H_c}{H}} - 1 \right| \frac{H_c}{H}. \tag{16}$$

Under this assumption, the pattern of trade is determined purely by luck. Regions which receive large positive investment shocks relative to the world average will be capital-abundant and export the capital-intensive good, while regions which receive small shocks will be capital-scarce and export the labour-intensive good. Moreover, as export patterns are essentially random, regions whose exports are capital-intensive in one generation may supply the world with labour-intensive products in the next. Clearly this view of the fundamental forces behind export patterns 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,

$$\left| \frac{K_{ct}}{K_t} - \frac{H_c}{H} \right| \approx \left| \frac{s_c}{s} - 1 \right| \frac{H_c}{H}. \tag{17}$$

Under this assumption, the pattern of exports is determined by savings behaviour. High-savings regions will accumulate large capital stocks relative to low-savings regions and export capital-intensive products. Low-savings regions will export labour-intensive products. This is the view of the fundamental causes of differences in capital-labour ratios implicit in most traditional mod-

els of factor-proportions trade. In Section 2.3, I will show that it crucially depends on the assumption of financial autarky. Once international asset trades are feasible, the determinants of trading patterns are fundamentally altered.

2.1.6   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 (15), the traded share of world output is

$$\frac{\sum_c \left(|M_{cKt}| + |M_{cHt}|\right)}{2Q_t} = (1 - \tau)\,\alpha\,(1 - \alpha) \sum_{c \in C} \left| \frac{K_{ct}}{K_t} - \frac{H_c}{H} \right|. \qquad (18)$$

Equation (18) will be crucial in the remainder of the paper. It shows that the larger the differences between regional shares in the world stocks of physical and human capital and, hence, the more varied the factor-content of regions' industrial production, the larger will be the overall volume of trade.

2.2   Opening Up of a New Country

2.2.1   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

$$Q_{China,t} = K_{China,t}^{\alpha} H_{China}^{1-\alpha}. \qquad (19)$$

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

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

$$(1 - \tau)\,\alpha\,(1 - \alpha) \sum_{c \in C} \left| \frac{K_{ct}}{K_t} - \frac{H_c}{H} \right| \left[1 + \left(\frac{K_{China,t}}{K_t} \right)^{\alpha} \left(\frac{H_{China}}{H} \right)^{1-\alpha} \right]^{-1}, \qquad (20)$$

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.

$$\frac{K_{China,t}}{K_t + K_{China,t}} < \frac{H_{China}}{H + H_{China}}. \tag{21}$$

In the remainder of this section, I will analyse the impact on the patterns of trade 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.

2.2.2 Impact on the Patterns of Trade

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 (15) and (21).

Consider now the impact on trade in another country called $Japan$, for which

$$\frac{K_{Japan,t}}{K_t} - \frac{H_{Japan}}{H} > 0, \tag{22}$$

i.e. $Japan$ is capital-abundant. For $Japan$,

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

which is a direct consequence of (21) and (22): the opening of $China$ makes $Japan$ more capital-abundant relative to the group of trading countries, causing it to import more of the H-intermediate.

By contrast, consider what happens to trade in a third country called $Indonesia$, for which

$$\frac{K_{Indonesia,t}}{K_t} - \frac{H_{Indonesia}}{H} < 0, \tag{23}$$

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

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

The opening up of $China$ makes $Indonesia$ less labour-abundant relative to all other trading countries, causing it 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 *K*-exporters' trade with the rest of the world, but has an ambiguous impact on countries which used to export the *H*-good before *China*'s arrival.

2.2.3 Impact on World Trade

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

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

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

$$- \ln \frac{(K_t + K_{China,t})^\alpha (H + H_{China})^{1-\alpha}}{K_t^\alpha H^{1-\alpha} + K_{China,t}^\alpha H_{China}^{1-\alpha}}, \tag{24}$$

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 (24) 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 is a good characterisation of the context in which China's opening up did take place during the last three decades.

2.3 Financial Globalisation

2.3.1 International Asset Trade and Country Risk

Section 2.1.5 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 trade − 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,[12] maximising

$$E_t\left(C_{t+1}\right) - \frac{1}{2}\gamma Var\left(C_{t+1}\right) \text{ with } \gamma \geq 0, \tag{25}$$

where γ is the parameter of relative risk aversion.

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

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

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[12]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. See Hirshleifer and Riley (1992) for a discussion of the relationship between expected-utility maximization and mean-variance analysis.

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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:

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

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

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.

2.3.2 The Pattern of International Capital Flows

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

$$\frac{I_{ct}}{B_t} = \phi_c = \frac{1}{\sigma^2_c} \left(\sum_{c'} \frac{1}{\sigma^2_{c'}} \right)^{-1}. \tag{26}$$

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.[13]

Region c is a net recipient of international capital flows if

$$\frac{1}{\sigma_c^2} \left(\sum_{c'} \frac{1}{\sigma_{c'}^2} \right)^{-1} > \frac{s_c \frac{H_c}{H}}{s}. \tag{27}$$

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 3.3 I will assess whether my model can deliver predictions about international investment patterns which are consistent with the data.

2.3.3 Impact on the Patterns of Trade

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 2.1 and 2.2. 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

$$-NX_{ct} \equiv M_{cHt} + M_{cKt} \tag{28}$$

and noting that

$$r_t K_{ct} + w_t H_c + \Pi_{ct} = C_{ct} + I_{ct} + NX_{ct}, \tag{29}$$

---

[13]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.

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

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

$$+\frac{1}{2}\left|(1-\tau)\,\alpha\,(1-\alpha)\left(\frac{K_{ct}}{K_t} - \frac{H_c}{H}\right) - (1-\alpha)\frac{NX_{ct}}{Q_t}\right|. \tag{30}$$

Equation (30) 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 α 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 α be close to 1. While the region's production will be geared towards the K-intermediate, its net imports — due, for example, to net capital inflows — also 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 α 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 produce relatively more K-intermediates than H-intermediates, and labour-abundant regions will do the reverse. 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

$$\frac{K_{ct}}{K_t} - \frac{H_c}{H} \approx \frac{1}{\sigma_c^2}\left(\sum_{c'}\frac{1}{\sigma_{c'}^2}\right)^{-1} - \frac{H_c}{H}. \tag{31}$$

With factor-price equalising commodity trade and fully integrated international asset markets, savings rates are no longer the most relevant underlying determinant of the patterns of production and trade. 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 produce relatively more capital-intensive products.

2.3.4 Impact on World Trade

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

$$|NX_{ct}| < \frac{1-\tau}{2} \left| \frac{K_{ct}}{K_t} - \frac{H_c}{H} \right| Q_t \; \forall \; c, \tag{32}$$

equation (30) reduces to (18), 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 (32) is satisfied − a trade surplus with $\alpha = 1/2$ 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 $\alpha \neq 1/2$.

Assume $\alpha = 1/2$ and (32) holds. It is now straightforward to determine the conditions under which this sudden shift from financial autarky to financial globalisation causes countries to trade more overall, namely:

$$\sum_c \left| \left(\frac{H_c \sigma_c^2}{H} \sum_{c'} \frac{1}{\sigma_{c'}^2} \right)^{-1} - 1 \right| > \sum_c \left| \frac{s_c}{s} - 1 \right|. \tag{33}$$

Financial globalisation increases trade 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 ($Cov \left\{ \sigma_c, \frac{H_c}{H} \right\} > 0$).

Suppose now that $\alpha \neq 1/2$. The impact of financial globalisation on regions' production patterns will be as in the previous case. Yet even if (33) is true, whether and by how much financial globalisation increases world trade relative to financial autarky also depends on the value of α and the incidence of trade surpluses and deficits. Without loss of generality, consider the case in which $\alpha < 1/2$. 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 $\alpha = 1/2$. If deficit countries are labour-abundant on average and surplus countries are capital-abundant, financial globalisation increases global trade less.

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 match 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 predicted differential impact of China's opening on the trade of capital-abundant relative to labour-abundant countries also appears to be of an empirically plausible magnitude.

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' model-implied capital stocks under the assumption of financial globalisation are a poor match for their "true" capital stocks estimated from investment data. Introducing country-specific foreign investment frictions allows me to reconcile the model's predictions with the data, while the implied size of these 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 can capture 87% of the growth in North-South trade − and 60% of the overall growth in world trade.

3.1   Basic Data and Parameterisation

3.1.1   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". Section 3.2.4 and Appendix A3 discuss the possibility of incorporating North-North trade into my calibrations.

The empirical volume of North-South trade is measured as one half times the observed volume of exports and imports between capital and labour-abundant countries, where a country's factor abundance is 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.

3.1.2 Parameters

I assume that the world was in financial autarky in 1980,[14] and that China was completely closed off from international goods markets. Using (20), the traded share of world output in 1980 is given by

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

$$(1-\tau)\,\alpha(1-\alpha)\sum_c \left|\frac{K_{c1980}}{K_{1980}} - \frac{H_{c1980}}{H_{1980}}\right| \left[1 + \left(\frac{K_{China,1980}}{K_{1980}}\right)^\alpha \left(\frac{H_{China,1980}}{H_{1980}}\right)^{1-\alpha}\right]^{-1}.$$
(34)

I let the capital share $\alpha = 0.33$ as per convention and, to discipline the model, use τ to match the ratio of North-South trade to world GDP in 1980. In the model, τ represents the share of each country c's income going to producers of the non-traded final good, and we can think of it broadly as the share of the non-traded sector in GDP. The calibrated value of τ is 0.75, which is very close to the 1980 GDP-share of non-manufacturing value added for my average sample country (0.76) − a common empirical proxy for the size of the non-traded sector.

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[14]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.

Parameter/ Data	Baseline Value	Source
α	0.33	-
τ	0.75	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: Parameter Values and Data Sources

Table 1 summarises the key parameter values and data sources.

3.2 Opening Up of China

3.2.1 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

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

$$(1 - \tau)\,\alpha(1-\alpha) \sum_c \left| \frac{K^{FA}_{c2007}}{K_{2007}} - \frac{H_{c2007}}{H_{2007}} \right| \left[1 + \left(\frac{K^{FA}_{China,2007}}{K_{2007}} \right)^{\alpha} \left(\frac{H_{China,2007}}{H_{2007}} \right)^{1-\alpha} \right]^{-1},$$
(35)

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
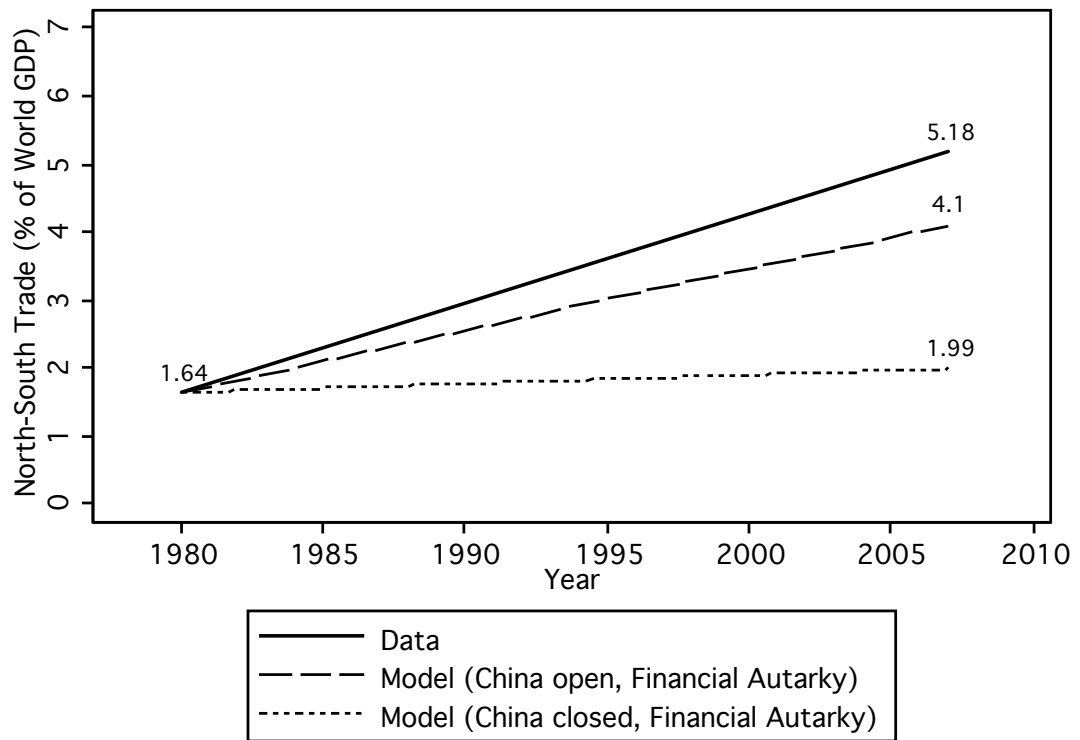
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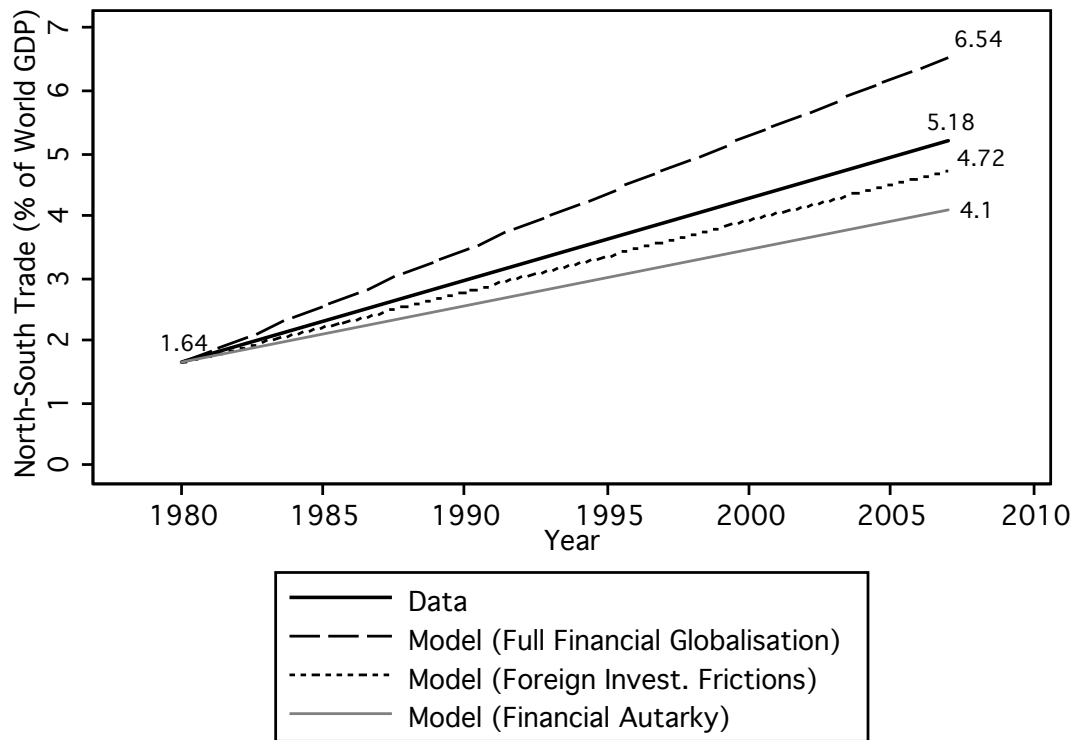Figure 5: Calibration Results - Opening Up of China

Figure 6: Calibration Results - Financial Globalisation

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:

$$\frac{\sum_c \left(|M_{cK2007}| + |M_{cH2007}|\right)}{2Q_{2007}} = (1-\tau)\,\alpha(1-\alpha) \sum_{c,China} \left| \frac{K_{c2007}^{FA}}{K_{2007}} - \frac{H_{c2007}}{H_{2007}} \right|. \quad (36)$$

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%), respectively.

3.2.2 Impact on Other Labour-Abundant Countries

As discussed in Section 2.2, my model of factor-proportions trade shows that the arrival of a labour-abundant country like China should increase the exports and imports of previously capital-abundant countries relative to world GDP, but reduce the exports and imports of countries which were previously very labour-abundant. In Table 2, I explore the empirical validity of this prediction with a difference-in-difference approach.

Using data for my set of large economies, Column 1 regresses the change in countries' exports and imports relative to world GDP between 1980 and 2007 on their average capital abundance for this period *in the absence of China*. The purpose is to test whether there is evidence that the growth of countries' trade relative to world GDP was contingent on their capital abundance among the group of initially open economies. The estimates presented in the first column suggest that this was indeed the case: the coefficient on the capital-abundance term is positive and statistically significant at the 5% level. Moreover, as the

	ΔTrade$_c$/WorldGDP	ΔTrade$_c$/WorldGDP	Trade$_{ct}$/WorldGDP
$K_c/K - H_c/H$	0.028**	0.024*	
	(0.013)	(0.013)	
$(K_c/K - H_c/H)\times$Tariff$_{CHNt}$			-0.092***
			(0.029)
Constant	0.001***	0.002***	0.006***
	(0.000)	(0.000)	(0.000)
Country F.E.			Yes
Year F.E.			Yes
Period	1980-2007	1992-2007	1992-2007
Adj. R^2	0.12	0.09	0.98
Observations	26	26	416

Robust standard errors in parentheses. * significant at 10%, ** significant at 5%; *** significant at 1%

$(K_c/K - H_c/H)$ represents country c's average capital abundance without China for the given period. Tariff$_{CHNt}$ is China's average tariff rate.

Table 2: Impact of China on Labour Abundant Countries − Regressions

estimated constant term is small but positive, the regression suggests that marginally labour-abundant countries ($0 \geq K_c/K - H_c/H > -0.036$) also experienced an increase in trade while very labour-abundant countries ($-0.036 \geq K_c/K - H_c/H$) suffered a decline. This is consistent with the discussion in Section 2.2.

A shortcoming of the regression in Column 1 is that it fails to tie the differential change in trade directly to the opening up of China in this period. To address this, I estimate a difference-in-difference panel regression in the third column. The main variable of interest is an interaction term between countries' average capital abundance without China and the Chinese average tariff rate, as reported in the World Development Indicators. A negative coefficient would indicate that tariff reductions in China increased the ratio of trade to world GDP for capital-abundant countries relative to less capital-abundant regions. The panel structure of the data allows me to employ country and time fixed effects to control for all time-invariant heterogeneity across countries and for possible global trends. Unfortunately, tariff data for China is only available from the early 1990s, so the panel is restricted to the period 1992-2007.

Column 2 verifies that, just as in the period 1980-2007, the overall change in trade relative to world GDP between 1992 and 2007 was larger for more capital-abundant countries. Column 3 shows that the decline in China's average tariff in the latter period − by 25 percentage points overall − appears to have had the expected differential effect on countries' trade in accordance with their capital abundance. In terms of magnitudes, the estimated coefficients in Column 3 would suggest that the opening of China in this period increased the import-world GDP ratio for Japan − a very capital-abundant country − relative to Indonesia − a very labour-abundant country − by 0.35 percentage points.

In the calibrated model, China's opening raises the import-world GDP ratio for capital-abundant Japan relative to labour-abundant Indonesia by 0.25 percentage points. The model's predictions concerning the differential impact of China's trade liberalisation on the group of open economies thus appear to be both qualitatively and quantitatively plausible.

3.2.3 Evidence about Trading Patterns

A fundamental prediction of the model outlined in Section 2.1 is that differences in relative factor endowments can explain trading patterns in international goods markets: countries with a large stock of installed 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 proposition of factor-proportions models, with very mixed results.[15]

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.[16] 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.

3.2.4 North-North Trade

As noted above, my model only captures trade due to differences in factor proportions and, as a result, would predict the volume of trade between countries with similar factor endowments − such as the economies of the capital-abundant North − to be zero. In practice, North-North trade still represents the largest share of international trade overall. To account for this stylised fact, it would be necessary to incorporate additional motives for goods exchange into the theoretical framework developed in Section 2.

A natural way to do so would be to introduce trade in differentiated goods which are produced under monopolistic competition in the spirit of the "new" trade theory. This begs the question whether augmenting the model accordingly would alter the expression for the volume of North-South trade and, hence, invalidate the calibration results presented in this section. Appendix A3 shows that this need not be the case: it provides a set of plausible as-

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

[16]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.

sumptions under which there is a positive volume of North-North trade in differentiated varieties while the volume of North-South trade continues to be described by equation (18). We can thus think of the calibrations here as focusing on the North-South component of a more eclectic model of global trade.

3.3 Financial Globalisation

3.3.1 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. The model-predicted ratio of North-South trade to world GDP in 2007 under full financial globalisation is given by

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

$$\frac{1}{2} \sum_{c,China} \left| (1-\tau)\,\alpha\,(1-\alpha) \left[\frac{1}{\sigma_c^2} \left(\sum_{c',China} \frac{1}{\sigma_{c'}^2} \right)^{-1} - \frac{H_{c2007}}{H_{2007}} \right] + \alpha \frac{NX_{c2007}}{Q_{2007}} \right|$$

$$+ \frac{1}{2} \sum_{c,China} \left| (1-\tau)\,\alpha\,(1-\alpha) \left[\frac{1}{\sigma_c^2} \left(\sum_{c',China} \frac{1}{\sigma_{c'}^2} \right)^{-1} - \frac{H_{c2007}}{H_{2007}} \right] - (1-\alpha) \frac{NX_{c2007}}{Q_{2007}} \right|,$$

$$\tag{37}$$

where country-level imbalances in North-South trade for the year 2007, $\{NX_{c2007}\}_c$, are taken from the IMF Direction of Trade Statistics. To proxy for idiosyncratic country risk, $\{\sigma_c^2\}_c$, I use the average PRSG composite country risk score for 1980-2007. 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 2.3, the finding of a rise in trade due to financial integration in part 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 "upstream" 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
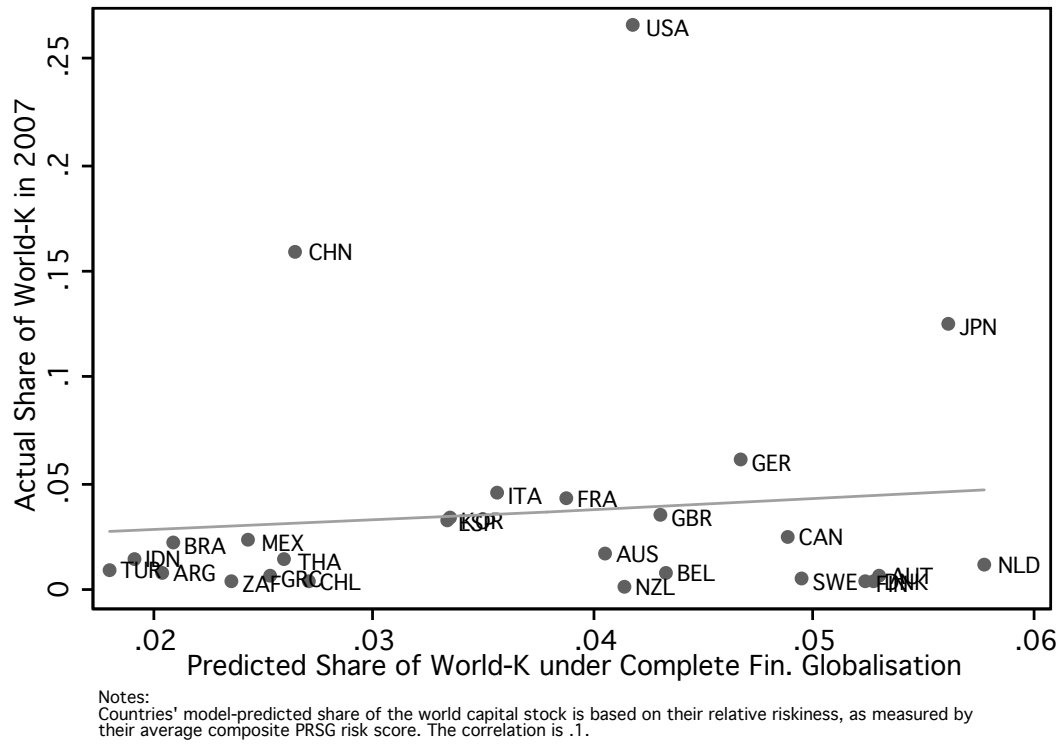
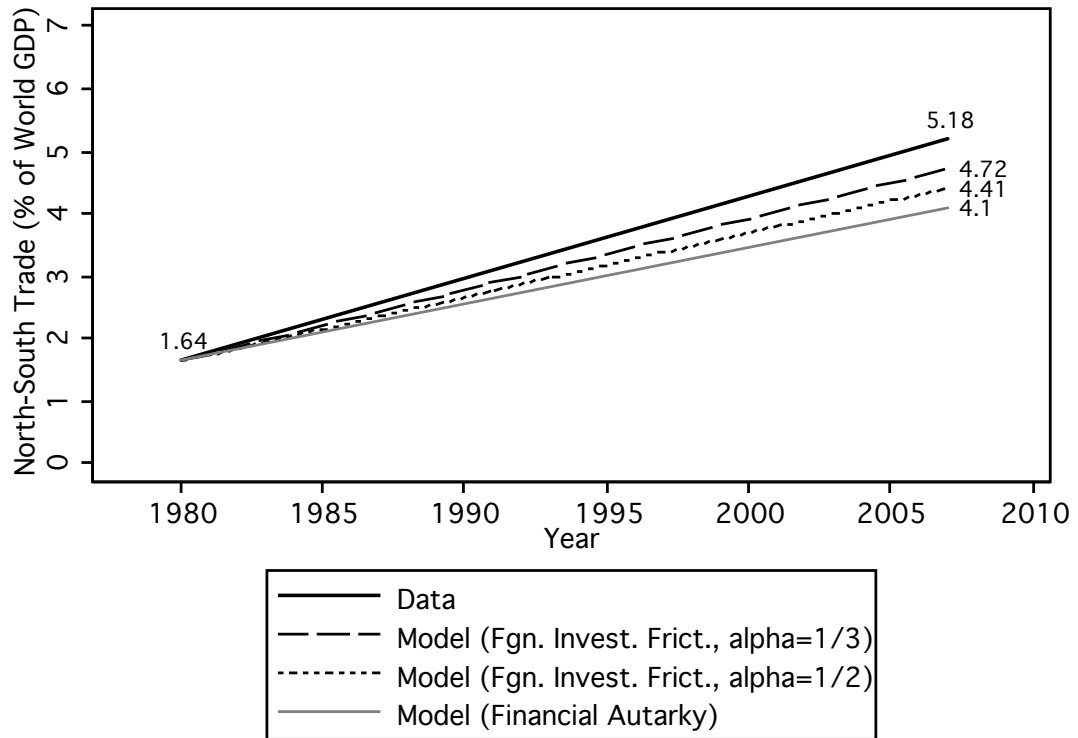Figure 7: Model-Implied and Actual Shares in the World Capital Stock

Figure 8: Calibration Results - Financial Globalisation ($\theta \neq 0.50$)

represents the standard estimate of a country's stock of physical capital.[17] Figure 7 plots the results. As is immediately evident, the fit is rather poor: the correlation between the 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 2.3 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

3.3.2 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.[18] This additional cost of foreign asset purchases reduces the expected returns from, and hence the relative 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

$$\phi_{c'}^c = \max\left\{\frac{1}{\sigma_{c'}^2}\left(\sum_{c'}\frac{1}{\sigma_{c'}^2}\right)^{-1}\left(1 - \frac{f_c}{\gamma\sigma_c^2}\right), 0\right\} \ \forall \ c' \neq c, \tag{38}$$

$$\phi_c^c = 1 - \sum_{c' \neq c}\phi_{c'}^c. \tag{39}$$

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[17]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.

[18]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.

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

Table 3: Model-Implied Foreign Investment Friction and Measures of Fin. Openness

If $f_c \geq \theta\sigma_c^2$, agents in c will choose not to purchase foreign assets at all. If $f_c \to 0$, (38) and (39) approach the optimal frictionless world portfolio described by equation (26). An immediate implication of (38) and (39) 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 17% of the expansion in North-South trade, and 87% 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 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.

3.3.3 The Role of Trade Imbalances

So far I have set $\alpha = 0.33$. As a result, there are two channels through which financial globalisation may impact on the global trade share in the model: i) by increasing factor endowment differences and ii) through the existence and incidence of trade imbalances. In this section I analyse how much of the model-predicted effect of financial globalisation on world trade is due to the latter.

I proceed by setting $\alpha = 0.5$. Since 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 alters the the ratio of North-South trade to world GDP in 2007. Specifically, as explained in Section 2.3.4, this ratio should now be unaffected by the presence of trade imbalances in 2007 as long as equation (30) is satisfied for my sample countries. It is easily verified that this is the case given the country-level imbalances in North-South trade, $\{NX_{c2007}\}_c$, from the IMF Direction of Trade Statistics.

As can be seen from Figure 8 (dotted line), setting $\alpha = 0.5$ reduces the share of North-South trade growth due to financial globalisation in the model approximately by one half. Overall, the model now captures 80% of the expansion of North-South trade, amounting to 54% of the total growth in world trade. According to the model, therefore, the presence of trade imbalances has had a significant impact on the overall volume of trade.

The reason for this impact is as follows. With $\alpha < 0.50$, 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 due to trade imbalances is thus largely the result of 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, $\alpha > 0.50$ 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.

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 interindustry trade. 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.[19] 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

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

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.[20] 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.

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 importance for the patterns of specialisation and global trade flows. Both will continue to shape the international economy for some time to come.

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[20]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,

Appendix A1 - 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_{c2007}^{FA}, I start from the estimated capital stock in 1980 and use an augmented version of the perpetual inventory equation for subsequent years,

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

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.[21] 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.

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[21]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).

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 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).[22] 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.

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[22]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

Appendix A2 - Empirical Appendix

A2.1 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 the model in Section 2.

Dep. Variable: Investment$_{ct}$/GDP$_{ct}$ (%)	(1)	(2)	(3)	(4)
Savings$_{ct}$/GDP$_{ct}$ (%)		0.487***		0.433***
		(0.037)		(0.046)
Risk index$_{ct}$ (0-100)			-0.195***	-0.177***
			(0.026)	(0.027)
Country F.E.	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes
Adj. R^2	0.67	0.76	0.75	0.79
Observations	743	743	608	608

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

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.[23] 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.

A2.1 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.[24] 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 2.1.

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

$$AKX_{ct}^{UnitedStates} = \sum_j \alpha_j \frac{M_{cjt}^{UnitedStates}}{M_{ct}^{UnitedStates}}, \qquad (40)$$

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[23]Obstfeld and Taylor (2004) estimate savings retention coefficients as one of several possible measures of financial globalisation for different time periods. Using a similar sample of countries, they report a coefficient of .83 for 1946-1972, and .75 for 1973-2000

[24]This assumption was first suggested by Deardorff (1998).
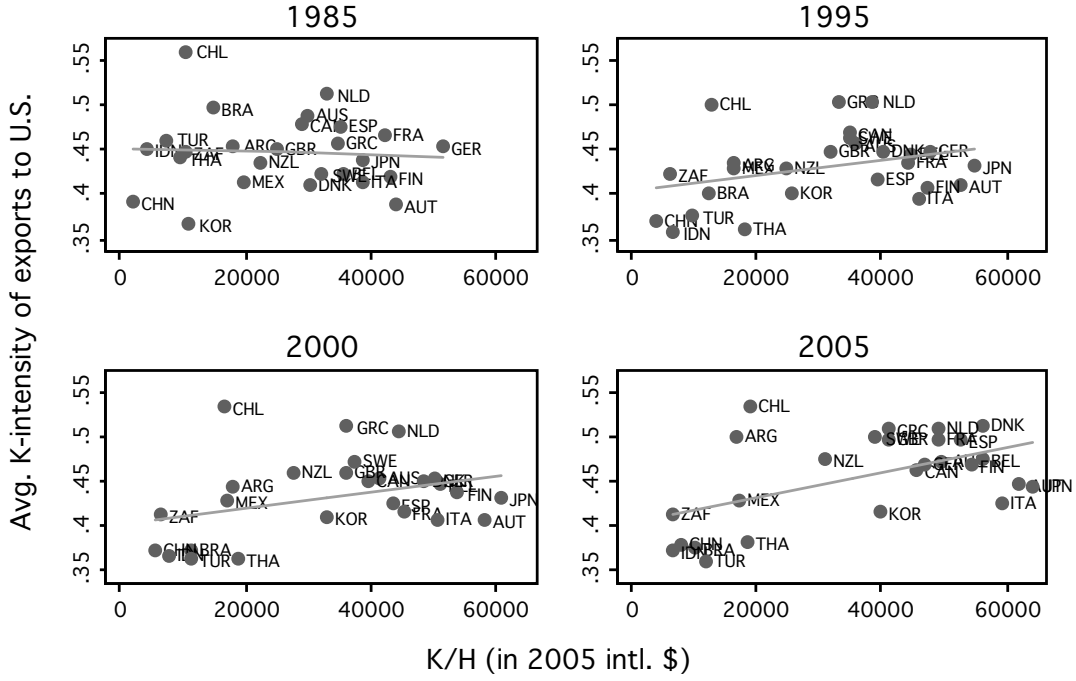
Notes:
Data on U.S. sector-level trade with 26 large economies taken from Feenstra (2009). Sectoral capital intensities based on the NBER-CES Manufacturing Industry Database. For data description and regression results, see text.

Figure A1: Capital-Labour Ratios and Specialisation

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, according to the model,

$$AKX_{ct}^{UnitedStates} = \frac{\alpha_K \frac{Q_{cKt}}{Q_{Kt}}\theta + \alpha_H \frac{Q_{cHt}}{Q_{Ht}}(1-\theta)}{\frac{Q_{cKt}}{Q_{Kt}}\theta + \frac{Q_{cHt}}{Q_{Ht}}(1-\theta)} = \frac{\alpha \frac{K_{ct}}{H_{ct}}}{\alpha \frac{K_{ct}}{H_{ct}} + (1-\alpha)\frac{K_t}{H_t}}. \quad (41)$$

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.[25] 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 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.

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

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.

Appendix A3 - Theoretical Appendix

Suppose the model is as described in Section 2.1, but replace equation (4) with

$$Q_{ct} = \theta \left\{ \left[\int_0^{J_t} q_{cKt}(j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right]^{\beta \frac{\varepsilon}{\varepsilon-1}} Q_{cKt}^{1-\beta} \right\}^\alpha Q_{cHt}^{1-\alpha} \text{ with } \alpha, \beta \in (0,1). \quad (42)$$

The production of final goods now also requires a set of differentiated varieties of K-intermediates, with $\varepsilon > 1$ representing the substitution elasticity between varieties and J_t denoting the (endogenous) mass of such inputs available at time t. Differentiated inputs are produced under monopolistic competition according to the production function

$$q_{ct}(j) = \max \{ k_{ct}(j) - f, 0 \}. \quad (43)$$

As in Section 2, the assumptions about tradability and production technologies ensure that goods trade equalises the price of the final good as well as factor returns. Producers of differentiated intermediates enter the global market with a unique variety and optimally charge a price equal to a fixed mark-up over their marginal cost,

$$p_{ct}(j) = \frac{\varepsilon}{\varepsilon-1} r_t \equiv p_t, \quad (44)$$

while free entry reduces the profits of monopolistic intermediate producers to zero, yielding

$$q_{ct}(j) = (\varepsilon - 1) f \equiv q. \quad (45)$$

Market clearing then requires that

$$J_t = \frac{\beta}{\varepsilon f} K_t. \quad (46)$$

Let us divide regions into two sets:

$$N_t = \left\{ c \in C \,\middle|\, \frac{K_{ct}}{K_t} \geq \frac{H_c}{H} \right\}$$

$$S_t = \left\{ c \in C \,\middle|\, \frac{K_{ct}}{K_t} < \frac{H_c}{H} \right\},$$

where $N_t \cup S_t = C$ and $N_t \cap S_t = \emptyset$. I now introduce two additional assumptions. First, all $c \in N_t$ have an infinitessimal productivity advantage in

differentiated K-intermediates. Second,

$$\beta \leq \sum_{c \in N_t} \frac{K_{ct}}{K_t}. \tag{47}$$

Defining J_{ct} has the mass of differentiated varieties produced in c at t, the assumption about productivities ensures that

$$J_{ct} = 0 \quad \forall\, c \in S_t.$$

Meanwhile, J_{ct} is indeterminate $\forall\, c \in N_t$, with $\sum_{c \in N_t} J_{ct} = J_t$.

We can now derive a new expression for the traded share of world output, assuming balanced trade for simplicity:

$$\frac{\sum_{c \in C} (M_{ct} + X_{ct})}{2Q_t} = (1 - \tau) \left[\beta \sum_{c \in N_t} \frac{Q_{ct}}{Q_t} \left(1 - \frac{J_{ct}}{J_t} \right) + \alpha (1 - \alpha) \sum_{c \in C} \left| \frac{K_{ct}}{K_t} - \frac{H_c}{H} \right| \right]. \tag{48}$$

The first term represents North-North trade in differentiated K-intermediates. Its size depends on Northern regions' respective shares in global output, and their shares in the total production of the differentiated goods. The second term represents North-South trade. As in Section 2, North-South trade arises purely due to factor-proportions differences. Equation (48) demonstrates that it is straightforward to account for the large observed volume of North-North in my model while keeping my main expression for the volume of North-South trade unchanged.

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