Essays on Production Structure and Economic Integration

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Essays on Production Structure and Economic Integration by Lidia Smitkova, Dissertation Summary

In this dissertation, I present three chapters that study the linkages between the structural makeup of economies and the process of trade- and financial liberalization.

In the first chapter I examine the role of trade and external deficits in explaining the patterns of structural change in twenty developed and developing economies between 1965 and 2000. First, for each country, I break down the time series of manufacturing value added share into a secular trend and a trade-induced deviation from the trend. I show that national differences are in large part due to trade. Second, I investigate changes in sectoral productivity, trade costs and trade deficits as the driving forces behind the patterns in the data. To do this I build a multi-sector Eaton and Kortum (2002) model and simulate the effects of different shocks on the manufacturing value added shares in the sample. While calibrating the model, I develop a novel method of identifying trade cost- and productivity shocks, which makes use of symmetry restrictions on sectoral trade cost shocks. I calibrate the model at a two-digit level of disaggregation, which permits me to study not only the changes in the manufacturing share, but also its composition at a sub-sectoral level. I find that open economy forces are responsible for 32% of the observed change in the manufacturing shares in my sample, and for 39% if the composition of the manufacturing sector is taken into account. Focusing on individual shocks, I show that for the aggregate manufacturing share, trade cost- and aggregate trade deficit shocks played the biggest role, whereas the productivity shocks mattered more in driving the composition of manufacturing.

In the second chapter, I study financial liberalization between economies that differ in their overall competitiveness. I first show that if firms compete oligopolistically, then competitiveness — relatively low aggregate unit costs of production — is a feature of an economy with a fatter tailed productivity distribution and relatively more very large — 'superstar' — firms. Embedding this setup in a two-country model with heterogeneous agents and non-homothetic saving behaviour, I show that if the home is more competitive, then: (1) it enjoys a higher aggregate profit rate than foreign; (2) its autarkic interest rate is lower than that in foreign; (3) should the two economies undergo financial liberalization, the capital will be flowing from home to foreign; (4) if one of the sectors is non-tradable, the capital inflows push up the wages in foreign, leading to further losses of competitiveness and to current account overshooting.

In the third chapter, I calibrate the quantitative version of the model developed in Chapter 2 to eight European economies on the eve of the Global Financial Crisis. I show that the competitiveness gap can explain 27% of variation in the current account imbalances incurred in the period. I conclude by discussing policies for rebalancing.

To my mom, Galina.

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Contents

Chapter 1

Beyond the Hump: Structural Transformation in an Open Economy

In this chapter I examine the role of trade and external deficits in explaining the patterns of structural change in twenty developed and developing economies between 1965 and 2000. First, for each country, I break down the time series of the manufacturing value added share into a secular trend and a trade-induced deviation from the trend. I show that national differences are in large part due to trade. Second, I investigate changes in sectoral productivity, trade costs and trade deficits as the driving forces behind the patterns in the data. To do this I build a multi-sector Eaton and Kortum (2002) model and simulate the effects of different shocks on the manufacturing value added shares in the sample. While calibrating the model, I develop a novel method of identifying trade cost- and productivity shocks, which makes use of symmetry restrictions on sectoral trade cost shocks. I calibrate the model at a two-digit level of disaggregation, which permits me to study not only the changes in the manufacturing share, but also its composition at a sub-sectoral level. I find that open economy forces are responsible for 32% of the observed change in the manufacturing shares in my sample, and for 39% if the composition of the manufacturing sector is taken into account. Focusing on individual shocks, I show that for the aggregate manufacturing share, trade cost- and aggregate trade deficit shocks played the biggest role, whereas the productivity shocks mattered more in driving the composition of manufacturing.

1.1 Introduction

For the first economies to industrialize, structural transformation – the process of shifts in the relative sizes of major sectors of the economy – was characterized by a hump shaped pattern in the manufacturing share over time. A considerable literature has linked this pattern primarily to changing expenditure shares as economies mature: first, due to non-homotheticities in consumer preferences, referred to as the *income channel*; and second, due to a non-unitary elasticity of substitution across sectoral goods in the presence of shifting relative prices, referred to as the *price channel* (see Herrendorf, Rogerson, and Valentinyi (2014) for an overview). Importantly, previous studies have found little role for trade, unless operating through either the price- or income channels. In this chapter, I argue that open economy forces affect the process of structural transformation in a quantitatively important way and through channels other than the endogenous response in expenditure shares. In particular, I emphasize the role of trade-induced specialization, and of shifts in relative demand resulting from international borrowing and lending. Inasmuch as the structural makeup of the economy has implications for growth (McMillan and Rodrik 2011), inequality (Buera et al. 2022), and its resilience to macroeconomic shocks (Moro 2012), understanding how global forces shape structural transformation is a first-order consideration.

I begin by documenting a novel empirical puzzle: over the period between 1965 and 2000, the value added share of manufacturing in China, Finland, South Korea, and Sweden breaks with the classical hump shaped pattern, and increases after seemingly reaching its peak. I show that this pattern is not driven by changes in domestic expenditure shares, which parsimoniously capture both price- and income effects, and at the sub-sectoral level is driven by changes in the share of high-skilled manufacturing. This observation raises two questions. What mechanisms are responsible for deviations from the hump shaped pattern in manufacturing shares? Why do we observe heterogeneous behavior of sub-sectors within the broadly-defined manufacturing sector?

To address these questions, I set up a multi-sector model of international trade. I use the Eaton and Kortum (2002) setup as it lends itself naturally to studying trade-induced specialization. In the model, the sectoral varieties are produced using labor and intermediate inputs, and are subject to Pareto productivity draws. Varieties can be shipped after paying iceberg trade costs. Sectoral good producers source sectoral varieties from the origin with the lowest cost after transportation, and combine them into sectoral bundles. These are consumed by the households, and used as intermediate inputs in the production of varieties. Preferences and production functions are country-specific and are subject to exogenous shocks. Finally, as in Dekle, Eaton, and Kortum (2007), international borrowing is exogenous and constitutes transfers between the economies in the form of aggregate trade deficits.

Once the model is set up, I derive the partial equilibrium responses of the sales in the manufacturing sector with respect to exogenous shocks. These allow me to highlight the different mechanisms that affect the course of structural transformation in an open economy. First, the sales in the manufacturing sector of the home economy increase if the manufacturing productivity of the home economy grows by more than that of its average competitor, weighted by their trade shares, in the typical market where home trades. Likewise, the sales in the manufacturing sector of the home economy increase if the costs of exports of manufacturing for the home economy decline by more than that of its average competitor, weighted by their trade shares, in the typical market where home trades. These two mechanisms capture the notion of trade-induced specialization: inasmuch as sectoral productivity and bilateral trade costs evolve differentially across economies, the forces of specialization will alter their sectoral makeup. Second, the sectoral sales of the home economy decrease if home lends internationally and if its propensity to spend on domestically produced goods is greater than that of an average borrower economy. Intuitively, international lending transfers the purchasing power away from domestic consumers, and to these abroad. Typically, this will mean that demand for domestically produced goods contracts. However, the most export-oriented industries will experience the smallest contraction, and will expand, in relative terms, as a share of GDP. In other words, running an increasing aggregate trade surplus will tend to boost the key export industries in the economy due to the changes in relative demand. Finally, I show that the partial equilibrium responses are sufficient to derive the general equilibrium responses of sectoral value added shares to different subsets of shocks. I use this result to decompose changes in the manufacturing value added share into two components: the 'local' component that reflects changes in domestic final and intermediate expenditure shares, and the 'global' component, that captures all drivers of sectoral shares other than changes in domestic expenditure shares. The global component can be further decomposed into the contributions of (i) trade liberalization, (ii) evolution of comparative advantage, (iii) financial liberalization, (iv) changes in foreign intermediate expenditure shares, and (v) changes in foreign final expenditure shares, respectively. For small enough shocks, the decomposition is exact.

A key feature of the Eaton and Kortum (2002) setup is that a fully calibrated model reproduces the sectoral trade flow, consumption and production data precisely. I exploit this property of the model and use it to study the changes in manufacturing value added shares across twenty economies, covering around 80% of global GDP and containing both developed and developing economies, over the period between 1965 and 2000. I use the Groningen Growth and Development Centre Long-run World Input Output Database as my data source. The dataset features thirteen tradable sectors, eleven of which are sub-sectors of manufacturing. I retain this level of disaggregation throughout my analysis.

Much of the calibration of the model is standard, but solving for model-consistent trade cost- and productivity shock series requires further identifying restrictions. Here, I propose a novel methodology, which makes use of symmetry restrictions on sectoral trade cost shocks. I show that my method is better suited to estimating structural gravity shocks in models with a relatively large number of sectors. Compared to alternatives, it does not rely on estimating preferences over a large set of goods, and is more robust to near-zero trade share observations than methods that use sectoral deflators for identification. Once the model is calibrated, I use the Eaton et al. (2016) exact hat algebra version of the model to derive simulation-based counterparts to the theoretical decomposition of sectoral shares, and take it to the data.

First, I decompose changes in the manufacturing value added shares across the economies in the period between 1965 to 2000 into 'local' and 'global' components. I find that the former explains 68%, and the global forces are responsible for the remaining 32% in the whole sample. However, it is the global forces that are solely responsible for the post-peak growth of the manufacturing shares in South Korea, Finland, and Sweden. Next, I apply the decomposition to the eleven sub-sectors of manufacturing. I find that after allowing for the changes in the composition of the manufacturing sector, the relative importance of the global component increases to 39%. Looking at individual sectors, the relative importance of global forces in electrical and transport equipment sub-sectors is higher still, at 63% and 56% respectively.

Next, I turn to decomposing the global component into its five sub-components. For the manufacturing sector as a whole, changes in trade costs and aggregate trade deficits play the biggest role, and together explain two thirds of the global component of the change in the manufacturing shares in the period. Changes in sectoral productivities are relatively less important at this aggregate level, but become the second most important force once the changes in the composition of manufacturing are taken into consideration. At this more disaggregated level, I find that changes in global intermediate and final demand explain some of the movement out of textile production, and into the electrical equipment production in my sample. Financial liberalization plays the biggest role for the economies that saw the biggest growth in the aggregate trade surpluses in the period: South Korea, Finland, Sweden, and Denmark. However, which sub-sector of manufacturing expanded the most depends on the initial export structure of the economies. Finally, I find that the effects of changing costs of trade and sectoral productivity play an important role in explaining the dynamics in the high-skilled manufacturing sectors: machinery, electrical- and transport equipment. Across the three sectors, South Korea, Finland and Taiwan each have shown patterns of increased specialization. The decompositions show that Finland was able to expand into high skilled manufacturing by diverting resources from the pulp and paper, as well as food production industries. Both South Korea and Taiwan, on the other hand, have moved out of agricultural production and mining.

1.1.1 Related Literature

Much of the literature has studied structural transformation in a closed economy. Two mechanisms in particular have been recognized as key drivers of the hump shaped pattern in the manufacturing share: the price- and income effects.[1] The former has been studied in Ngai and Pissarides (2007) and Acemoglu and Guerrieri (2008), who show that if the relative price of manufacturing declines over time and if sectoral goods are complements, the final expenditure share of manufacturing, likewise, contracts. The latter, investigated in Kongsamut, Rebelo, and Xie (2001), Boppart (2014), and Comin, Lashkari, and Mestieri (2021), operates if preferences over sectoral goods are non-homothetic: as income grows, the household demand switches away from agricultural goods and towards services. Two recent contributions, Herrendorf, Rogerson, and A. Valentinyi (2021) and Garcia-Santana, Pijoan-Mas, and Villacorta (2021), point out that price- and income effects are also affecting the demand for investment goods and their composition. In this chapter, I treat changes in final- and intermediate expenditure shares (which in my model capture both the rate of investment and its composition) as determined exogenously, and remain agnostic as to the mechanism behind their evolution. The upshot of this approach is that I am able to replicate the evolution of sectoral shares of a wide range of countries over a long period of time and at a much more disaggregated level than is typical in the literature. Moreover, shutting down the endogenous price- and income effects allows me to highlight and quantify the specialization and borrowing channels of structural change, which are otherwise difficult to disentangle.

Structural transformation in an open economy received relatively less attention. A number of papers have focused on the operation of individual channels and on the

1. Both the value added share and employment share have been used as a measure of the relative size of the sectors. The two are highly correlated, but ultimately distinct and subject to different processes.

experiences of individual economies, such as Uy, Yi, and Zhang (2013), who study the contribution of falling trade costs and changing sectoral productivity to the industrialization of South Korea, or Kehoe, Ruhl, and Steinberg (2018), who study how international borrowing affected the manufacturing employment share in the United States. In contrast, Świecki (2017) and Cravino and Sotelo (2019) study how openness shapes the process of structural transformation in a large sample of economies and consider the operation of multiple channels simultaneously. However, both find that trade liberalization and changes in sectoral productivities affect the sectoral makeup of economies primarily through their effect on relative prices and incomes. In comparison, I focus on determinants of sectoral shares *other* than price- and income effects. Moreover, both papers restrict their attention to the movements in the sectoral shares of broad sectors of the economy: agriculture, manufacturing, and services in the former, and goods and services in the latter. Unsurprisingly, this limits the extent to which structural change can be shaped by the open economy forces: it is difficult to specialize in manufacturing broadly defined, but countries can and do specialize in sub-sectors of manufacturing. Studying structural change in three broad sectors thus overlooks the compositional changes *within* manufacturing that are concealed in the aggregate.

Finally, this chapter relies on the machinery pioneered by Eaton and Kortum (2002), and the large number of papers that build upon it. In particular, I follow Dekle, Eaton, and Kortum (2007) in modelling international borrowing as exogenous wedges between the aggregate household income and expenditure, and Eaton et al. (2016) in recasting the model in changes, which aids the calibration substantially. The calibrated version of Eaton and Kortum (2002) has been widely used in quantitative trade exercises. Relative to previous work, the contribution of this chapter is a novel method of identification of trade cost- and productivity shocks using a symmetry condition for the trade cost shocks.

The organization of this chapter is as follows. In Section 1.2, I document the patterns of structural transformation for twenty economies over years 1965 to 2000, and conduct a back of the envelope exercise to highlight the operation of forces beyond price- and income effects. In Section 1.3, I present a quantitative model of trade that can be used to interpret the patterns in the data as driven by structural shocks. Section 1.4 discusses the calibration of the model. Finally, in Section 1.5, I use the calibrated model to study the local and global drivers of structural transformation in the years between 1965 and 2000. I conclude the analysis in Section 1.6.

1.2 Stylized facts

I begin by repeating the exercise in Herrendorf, Rogerson, and Valentinyi (2014): plotting the manufacturing value added share against the logarithm of per capita GDP. I use the Groningen Growth and Development Centre Long-run World Input Output Database for data on final consumption, intermediate inputs use, and sectoral output and value added. The dataset covers years 1965 to 2000. I focus on twenty of the economies reported, and split these into two groups by the per capita income in 1965. The result for the two groups can be seen in Figure 1.1.

Standard theory predicts that as economies mature, manufacturing grows at first, and then contracts, as a share of GDP. This pattern can be clearly seen in both panels. On the left, economies from the lower income half of the sample show clear hump shaped patterns. On the right, economies from the higher income half of the sample generally exhibit a post-peak decline in their manufacturing shares. However, a puzzling pattern emerges for China and South Korea in the first group, and for Sweden, Finland, and Canada in the second group: their manufacturing share first passes its peak and starts to wane, and then switches direction and resumes growth, most noticeably for Sweden and Finland. Is this pattern indicative of a surging domestic demand for manufacturing goods, or are there other forces behind it?

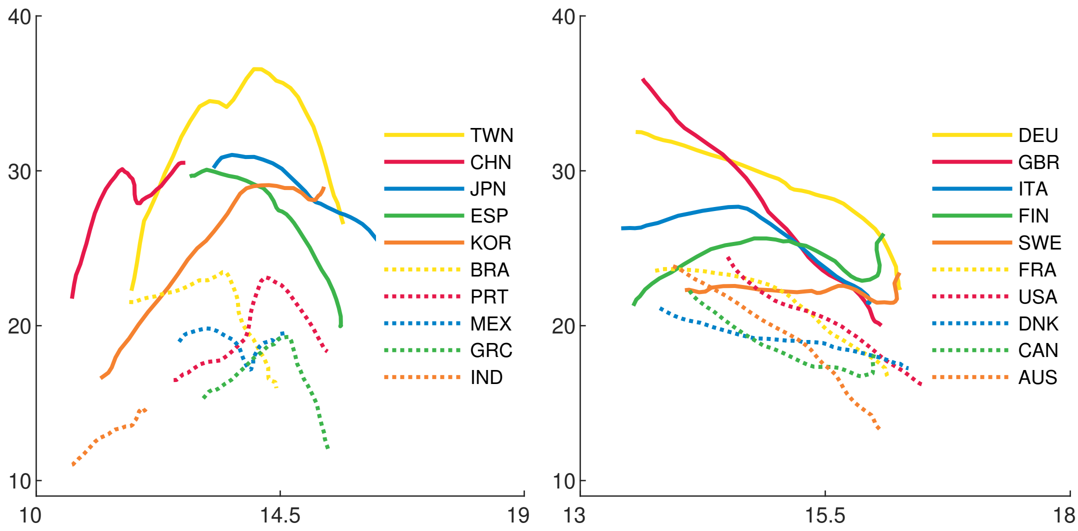

Figure 1.1: Manufacturing Value Added Share as Income Grows

Note: Value added shares in manufacturing as a share of GDP on the y-axis, logarithm of the GDP per capita in $ on the x-axis, both for the period 1965 to 2000.

To explore this behavior further I offer a simple counterfactual exercise. I begin with a toy example. Consider an economy where manufacturing and services are the only two sectors, and where both can be consumed as final goods. Manufacturing can also be used as an intermediate input. If the economy is closed to trade, then the sectoral output will have to satisfy the domestic final and intermediate demand:

$$Y_m = X_m^{FC} + \sum_{n=m,s} X_{nm}^{II},$$

where Y_m stands for manufacturing sales, X_m^{FC} for manufacturing final expenditure by the households, and X_{nm}^{II} for manufacturing intermediate inputs purchased by sector n. In this small economy it is easy to solve for manufacturing value added share in the economy va_m:

$$va_m = \alpha_m + \beta_{sm} - \alpha_m \beta_{sm},$$

where $\alpha_m = X_m^{FC}/Y$ is the share of income Y that the households spend on manufacturing, and $\beta_{sm} = X_{sm}^{II}/Y_s$ is the expenditure on manufacturing intermediate inputs as a share of the services sales.

Now, suppose that there are K sectoral goods, and all can be used as intermediate inputs. In Appendix A.1 I show that the sectoral value added can be solved for using linear algebra:

$$\mathbf{va} = diag(\mathbf{1}-\mathbf{B1})(\mathbf{I}-\mathbf{B})^{-1}\mathbf{A1}, \text{ where } \mathbf{A} = diag\left(\left[\frac{X_1^{FC}}{Y}, ..., \frac{X_K^{FC}}{Y}\right]\right), \ \mathbf{B} = \left[\frac{X_{kn}^{II}}{Y_k}\right]_{k,n}. \tag{1.1}$$

In both cases, the value added share of manufacturing is a function of the demand for manufacturing goods, directly for final consumption, but also indirectly as an input in the production.

I construct matrices **B** and **A** using the intermediate inputs use, sectoral sales, and final consumption from WIOD. The exercise is to obtain counterfactual value added shares had the economy been closed using the equation (1.1). I plot the resulting counterfactual manufacturing value added shares for the two groups of countries in the right panels of Figures 1.2 and 1.3. The left panels reproduce the manufacturing value added shares in the data for ease of comparison.

Several things are striking in this exercise. First, the closed economy counterfactual evolution of manufacturing shares is much more similar across economies: the dispersion in the location of the curve is much smaller in the counterfactual compared to the one in the data, both for the lower- and for the higher income sample. Thus, it is

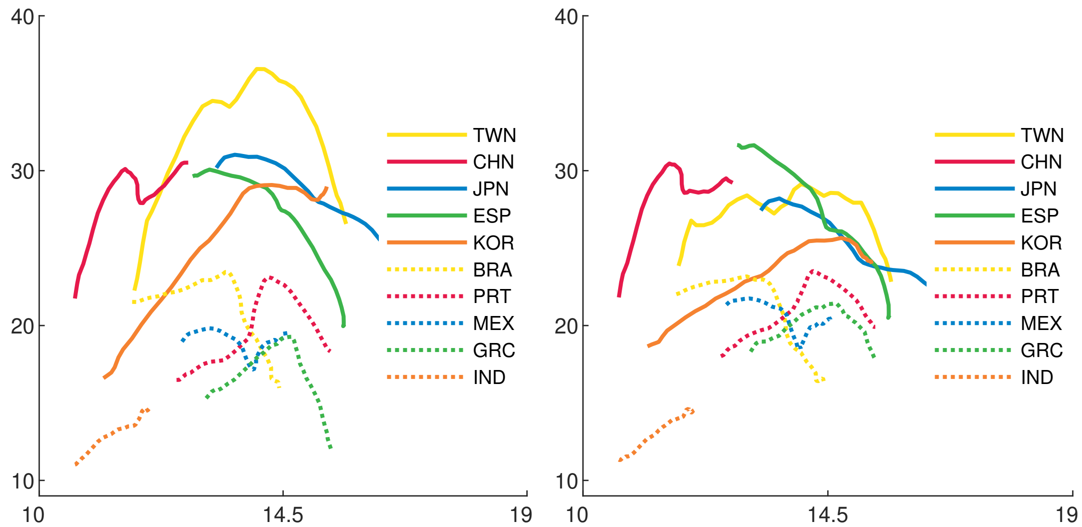

Figure 1.2: Manufacturing Value Added Share as Income Grows: Low Income Economies

Note: On the left panel, the value added shares in manufacturing as a share of GDP on the y-axis, logarithm of the GDP per capita in \$ on the x-axis. On the right panel, the counterfactual closed economy value added shares in manufacturing as a share of GDP, computed using equation (1.1) on the y-axis, logarithm of the GDP per capita in \$ on the x-axis. All for 1965 to 2000.

not the differences in the domestic expenditure patterns that are behind much of the variability in the experiences of industrialization across the economies. Second, the abnormal patterns, such as the post-peak growth in the manufacturing share in China, South Korea, and Finland are not visible in the counterfactual manufacturing shares series. Domestic demand for manufacturing declines in line with that of other economies.

Finally, I break down the series into the low-skilled and high-skilled manufacturing and repeat the exercise. I group food, textiles, pulp and paper, coke and petrol, chemicals, rubber and plastics, minerals, and metals into low-skilled manufacturing, and machinery, electrical and optical equipment, and transport equipment into high-skilled manufacturing. The results can be seen in Figures C.1.1 and C.1.2 in the Appendix C. For lower income economies, both low-skilled and high-skilled sub-sectors of manufacturing contribute to the divergence between the manufacturing shares in the data and in the closed economy counterfactual. For the higher income group, it is the high-skilled manufacturing that is behind most of the dispersion in the evolution of their manufacturing shares. Moreover, it is the dynamics in the high-skilled manufacturing that stands behind the post-peak growth in the manufacturing shares of Finland and Sweden.

In the next section, I propose a model in which forces of trade-induced specialization

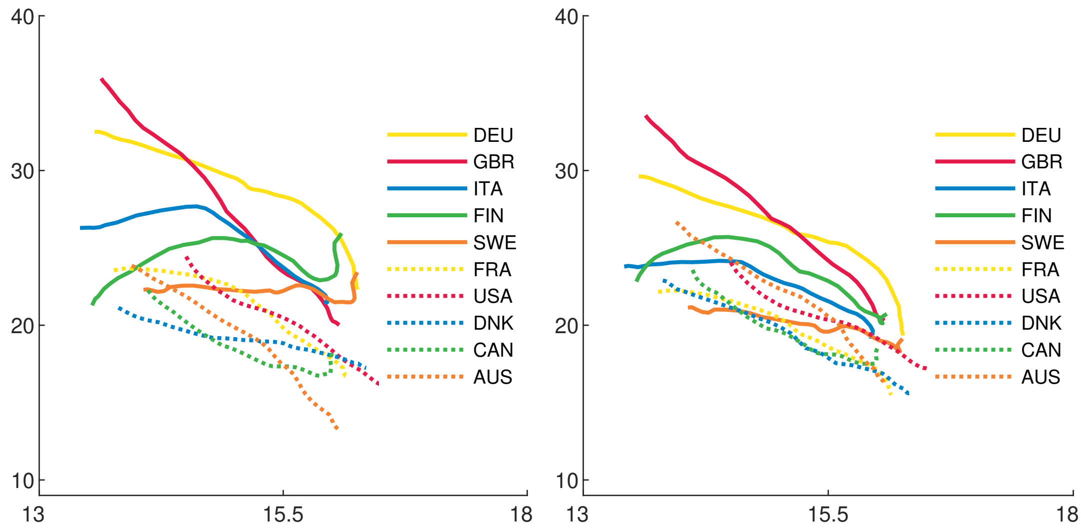

Figure 1.3: Manufacturing Value Added Share as Income Grows: High Income Economies

Note: On the left panel, the value added shares in manufacturing as a share of GDP on the y-axis, logarithm of the GDP per capita in \$ on the x-axis. On the right panel, the counterfactual closed economy value added shares in manufacturing as a share of GDP, computed using equation (1.1) on the y-axis, logarithm of the GDP per capita in \$ on the x-axis. All for 1965 to 2000.

and changing patterns in international borrowing can help explain the stylized facts documented in this section.

1.3 Model

In this section, I present the model that I will use to interpret structural transformation as observed in the data. I pick Eaton and Kortum (2002) setup to model sector-level markets, as it lends itself naturally to thinking about specialization subject to international competition. I model capital markets following Dekle, Eaton, and Kortum (2007), who represent capital flows as exogenous wedges between expenditure and income.

In the first subsection, I describe the model and define its equilibrium. In the following subsection I contrast sectoral value added shares in a closed and open economies, discuss how sectoral value added shares respond to various shocks, and offer a decomposition of changes in sectoral shares into local and global components, and further into sub-components reflecting the contributions of trade liberalization, evolution of comparative advantage, financial liberalization, and changing foreign household preferences and production functions, respectively. This sets stage for the calibration and the empirical decomposition in Section 3.

1.3.1 Model Setup

The model comprises of a series of static equilibria, time subscripts will be suppressed where possible for ease of exposition. There are I countries and K sectors in the model.

Producers. Each sector k in each country i can produce any of the continuum of varieties $z \in [0,1]$. Firms produce varieties using a Cobb-Douglas production function and are exogenously assigned a productivity level $a_{ik}(z)$. Firms produce using labor l_{ik} and intermediate inputs in form of sectoral aggregates m_{ikn}. Output of a firm producing z in country i and sector k is as follows:

$$y_{ik}(z) = a_{ik}(z) l_{ik}^{\beta_{ikL}}(z) \prod_n m_{ikn}^{\beta_{ikn}}(z),$$

where

$$\beta_{ikL} + \sum_n \beta_{ikn} = 1, \text{ and } \quad \beta_{ikL}, \beta_{ikn} \geq 0 \quad \forall k, n \in K.$$

The production functions vary across countries, sectors, and time.

The productivity level $a_{ik}(z)$ is drawn, independently for each country, from a Frechet distribution[2] with the cumulative distribution function as follows:

$$F_{ik}(a) = \exp\left[-\Big(\frac{a}{\gamma A_{ik}}\Big)^{-\theta} \right], \quad \gamma = \left[\Gamma\Big(\frac{\theta - \xi + 1}{\theta}\Big) \right]^{1/(1-\xi)}.$$

$A_{ik} > 0$ reflects the absolute advantage of country i in producing sector k goods: higher A_{ik} means that high productivity draws for varieties in i, k are more likely. $\theta > 1$ is inversely related to the productivity dispersion. If θ is high, productivity draws for any one country are more homogeneous.[3] γ is introduced to simplify the notation in the rest of the model[4].

Varieties can be shipped abroad with an iceberg cost τ_{ijk} (τ_{ijk} goods need to be

2. Kortum (1997) shows that if the sectoral productivities are an outcome of search for the new production techniques and the ideas are Pareto distributed, the distribution of the technological frontier (best ideas found so far) is Frechet.

3. The choice of the origin of a variety to be purchased will then be closely tied to the average productivity, costs of trade or costs of production in the exporter country. This means that changes in each of these will induce larger shifts in trade. In this sense, θ operates like trade elasticity in this model.

4. Γ stands for the gamma function. Absent normalization, γ appears in the price equations as a shifter common across economies. The simplification is thus without loss of generality. I assume that $\theta > \xi - 1$. As long as this inequality is satisfied, the value of the parameter ξ does not matter for the analysis and need not be estimated.

shipped for one unit of good to arrive from i to j). These costs capture transportation, tariff and non-tariff barriers to trade. Trade within an economy is costless: $\tau_{iik} = 1$ for all i, k.

The final goods producer aggregates individual varieties into the sectoral good bundles in each economy using CES technology. Specifically,

$$Q_{ik} = \Big(\int_0^1 q_{ik}(z)^{(\xi-1)/\xi} dz \Big)^{\xi/(\xi-1)}.$$

The sectoral good bundles are non-tradeable.

Households. Country i houses a population of a mass L_i. Households are identical and are maximizing the aggregate consumption C_i, which is a Cobb-Douglas function over sectoral bundles:

$$C_i = \prod_K C_{ik}^{\alpha_{ik}}, \text{ where } \quad \sum_K \alpha_{ik} = 1, \text{ and } \quad \alpha_{ik} \geq 0 \quad \forall i, k.$$

Households spend a fraction α_{ik} of their total expenditure on the sector k bundle, such that

$$X_{ik}^{FC} = \alpha_{ik} E_i.$$

Each household is endowed with one unit of labor which it supplies inelastically, such that labor income in each economy is $w_i L_i$. Households have no other source of income.

Households can borrow and lend internationally. I follow Dekle, Eaton, and Kortum (2007) in treating these borrowing decisions as exogenous. I parameterize international borrowing such that the aggregate expenditure can differ from aggregate income by a factor D_i:

$$E_i = D_i w_i L_i.$$

$D > 1$ means that the country is borrowing and $D < 1$ means that it is lending internationally. Trade balances at a global level, so $\sum_i w_i L_i (D_i - 1) = 0$.

Market clearing. Markets for variety z in any sector are perfectly competitive. Thus, the price of a variety z shipped from j to i is its marginal cost corrected for the cost of shipping:

$$p_{ijk}(z) = \frac{\tau_{ijk} c_{jk}}{A_{jk}(z)},$$

where

$$c_{ik} = \Big(\frac{w_i}{\beta_{ikL}} \Big)^{\beta_{ikL}} \prod_n \Big(\frac{P_{in}}{\beta_{ikn}} \Big)^{\beta_{ikn}} \tag{1.2}$$

is the unit cost of production of a firm with a unit productivity.

Suppose that a variety z purchased from country i is a perfect substitute for the same variety purchased from any other country. In this case buyers choose to purchase variety z from a country with the lowest price, so that the price paid in i for variety z of sector k is $p_{ik}(z) = \min_j\{p_{ijk}(z)\}$. Eaton and Kortum (2002) show that if the firm level productivities follow a Frechet distribution, and the sectoral aggregator is CES, then the price index for a sector k bundle in i equals

$$P_{ik} = \left[\sum_l \left(\frac{c_{lk}\tau_{ilk}}{A_{lk}}\right)^{-\theta}\right]^{-\frac{1}{\theta}}. \tag{1.3}$$

Crucially, the assumptions of the model give rise to trade shares – the expenditures on imports from any given destination as a share of the total spending on the sectoral bundle – that can be solved for in closed form:

$$\Pi_{jik} = \frac{X_{jik}}{X_{jk}} = \frac{(c_{ik}\tau_{jik}/A_{ik})^{-\theta}}{\sum_l (c_{lk}\tau_{jlk}/A_{lk})^{-\theta}} = \left(\frac{c_{ik}\tau_{jik}}{A_{ik}P_{jk}}\right)^{-\theta}. \tag{1.4}$$

Intuitively, j's share in the i's expenditure on sector k goods increases in j's productivity distribution location parameter A_{jk} and suffers from higher productivity in competitor economies A_{lk}. On the other hand, j's trade share declines in own bilateral trade costs τ_{jik} and increase if the costs of shipping from the competitors, τ_{ilk}, increase.

Labor market clearing condition (combined with variety cost minimization) is as follows:

$$w_i L_i = \sum_{k\in K}\int_0^1 w_i l_{ik}(z)dz = \sum_{k\in K}\beta_{ikL}Y_{ik}. \tag{1.5}$$

Goods markets clear when the sectoral bundles output equals the sectoral bundles final and intermediate demand. The market clearing condition, making use of the variety cost minimization condition and household optimal expenditure, takes the following form:

$$X_{ik} = X_{ik}^{FC} + \sum_n X_{ink}^{II} = \alpha_{ik}D_i w_i L_i + \sum_{n\in K}\beta_{ink}Y_{in}. \tag{1.6}$$

Finally, the value of sector k output in country i is a sum of what is demanded by each trading partner:

$$Y_{ik} = \sum_{j\in I}\Pi_{jik}X_{jk}. \tag{1.7}$$

I normalize by setting the global GDP to 1:

$$\sum_i w_i L_i = 1. \tag{1.8}$$

Together, equations (1.2) - (1.8) constitute the equilibrium of the model for a given time period.

1.3.2 Structural Transformation in an Open Economy

Closed economy. To think about structural change in an open economy, it is helpful to consider a closed economy setting first. In a closed economy, the sales in sector k satisfy the final and intermediate demand for sector k goods:

$$Y_k = \alpha_k Y + \sum_n \beta_{nk} Y_n, \text{ where } \quad Y = \sum_n \beta_{nL} Y_n = \sum_n (1 - \sum_k \beta_{nk}) Y_n.$$

As discussed in Section 1.2, the sectoral value added shares can be solved for as s function of expenditure shares only. With Cobb-Douglas production and consumption, these are simply the Cobb-Douglas weights in the utility and the production functions:

$$\mathbf{va} = diag(\mathbf{1} - \mathbf{B1})(\mathbf{I} - \mathbf{B})^{-1}\mathbf{A1}, \text{ where } \quad \mathbf{A} = diag\left([\alpha_1, ..., \alpha_K]\right), \quad \mathbf{B} = [\beta_{kn}]_{k,n}.$$

In other words, the evolution of the domestic production structure is driven exclusively by the shocks to the domestic final and intermediate demand.

Open economy. In an open economy, domestic production is no longer pinned down by domestic demand: the two are decoupled due to the feasibility of exports. To see this, consider the sales in sector k in the model with international trade permitted:

$$Y_{ik} = \sum_j \Pi_{jik} \left(\alpha_{jk} D_j Y_j + \sum_n \beta_{jnk} Y_{jn} \right), \text{ where } \quad Y_j = \sum_n \beta_{jnL} Y_{jn} = \sum_n (1 - \sum_k \beta_{jnk}) Y_{jn}.$$

In Appendix A.2 I show that it is possible to express the value added shares in matrix notation, such that value added shares, stacked by country, are as follows:

$$\mathbf{va} = (\mathbf{I} - \mathbf{\Phi_{IK-1}})^{-1}\phi \oslash \left(\mathbf{\Sigma}(\mathbf{I} - \mathbf{\Phi_{IK-1}})^{-1}\phi\right), \text{ where } \quad \mathbf{\Phi} = diag(\mathbf{1} - \mathbf{B1})(\mathbf{I} - \mathbf{\Pi B})^{-1}\mathbf{\Pi A D \Sigma}.$$

$\mathbf{\Phi}_{IK-1}$ denotes the first $IK-1$ rows and columns of matrix $\mathbf{\Phi}$ and ϕ denotes the first $IK-1$ elements of the last column of matrix $\mathbf{\Phi}$. $\mathbf{\Pi}$ is a block matrix of dimensions IK

by IK, with blocks in position i, j represented by a diagonal matrix of sectoral trade shares Π_{jik}. $\mathbf{B}$ is a block diagonal matrix of country intermediate input weight parameter matrices. $\mathbf{I}$ is an IK by IK identity matrix, $\mathbf{1}$ is a vector of IK ones, and matrices $\mathbf{D}$ and $\mathbf{A}$ are diagonal matrices with parameters D_i and α_{ik} in positions $(i-1)K+k$. Finally, $\mathbf{\Sigma}$ is a block diagonal matrix of K by K matrices of one. $\oslash$ stands for element-wise division.

Note that now, in addition to domestic expenditure weights, three further forces shape the sectoral value added: the intermediate and final expenditure weights of the trading partners contained in matrices $\mathbf{B}$ and $\mathbf{A}$, the full set of trade shares contained in matrix $\mathbf{\Pi}$, and the international borrowing parameters contained in matrix $\mathbf{D}$. If countries engage in international trade, then, open economy forces will shape the structure of an economy alongside the domestic forces.

I next turn to the effect of exogenous shocks on domestic value added.

Comparative statics. The effect of exogenous shocks on value added shares is easier to understand in two steps. First, let $P(Y_{ik}|X)$ stand for the partial equilibrium effect of a set of shocks X on the sales of sector k of the home economy:

$$P(Y_{ik}|X) = \sum_{x \in X} \frac{\partial Y_{ik}}{\partial x}.$$

I consider six sets of shocks: A, τ, D, α, β, and L, which stand for a full set of changes in sectoral productivity parameters, trade costs, deficits, final expenditure and intermediate expenditure weights, and population sizes respectively. It can be shown that

$$P(Y_{ik}|A) = \theta \sum_j X_{jik} \left(\frac{dA_{ik}}{A_{ik}} - \sum_l \Pi_{jlk} \frac{dA_{lk}}{A_{lk}} \right), \tag{1.9}$$

$$P(Y_{ik}|\tau) = -\theta \sum_j X_{jik} \left(\frac{d\tau_{jik}}{\tau_{jik}} - \sum_l \Pi_{jlk} \frac{d\tau_{jlk}}{\tau_{jlk}} \right), \tag{1.10}$$

$$P(Y_{ik}|D) = \sum_j \Pi_{jik} X_{jk}^{FC} \left(\frac{\Pi_{jik}\alpha_{jk} - \overline{\Pi_{lik}\alpha_{lk}}}{\Pi_{jik}\alpha_{jk}} \right) \frac{dD_j}{D_j}, \quad \overline{\Pi_{jik}\alpha_{jk}} = \sum_j \zeta_j \Pi_{jik}\alpha_{jk}, \tag{1.11}$$

$$P(Y_{ik}|\alpha) = \sum_j \Pi_{jik} X_{jk}^{FC} \frac{d\alpha_{jk}}{\alpha_{jk}}, \tag{1.12}$$

$$P(Y_{ik}|\beta) = \sum_j \Pi_{jik} X_{jk}^{FC} \sum_n va_{jn} \frac{d\beta_{jnL}}{\beta_{jnL}} + \sum_j \Pi_{jik} X_{jk}^{II} \sum_n \frac{d\beta_{jnk}}{\beta_{jnk}}. \tag{1.13}$$

$$P(Y_{ik}|L) = 0. \tag{1.14}$$

Consider each of the partial equilibrium effects in turn.

Changes in sectoral productivities will tend to increase sales in sector k if it sees its productivity increase, as compared to the average change in productivity of its competitors in any given market, weighted by trade shares. The effects across markets contribute in proportion to sector k's exposure to it, X_{jik}. Intuitively, what matters is the change in performance in key markets against key competitors. Changes in trade costs affect sectoral sales analogously: sector k will increase sales if its trade costs decline by more than that of its competitors.

Changes in trade deficits affect sectoral sales by redistributing purchasing power across final consumers in different countries. Rising trade deficit at home will increase sector k sales as long as the domestic propensity to spend on sector k goods made at home, $\Pi_{iik}\alpha_{ik}$, is larger than that of an average lender[5]. Similarly, if trade deficits rise abroad, the sales in sector k will increase if the deficit country's propensity to spend on home goods is higher than that of an average financier economy.

Finally, changes in the relative sizes of the population have no partial equilibrium effects on the sectoral sales.

Changes in final expenditure weights will tend to increase sector k sales if the households increase their consumption of sector k goods, and, likewise, changes in intermediate inputs demand will increase sector k sales if it becomes more important as an input in production. Note that as long as i exports to j, changes in expenditure weights in j will affect production in i: in a globalized world, shocks to demand spill across borders.

So far I have ignored the endogenous response of trade shares. With slight abuse of notation, let $P(Y_{ik}|P(\mathbf{\Pi}|X))$ denote the partial equilibrium effect due to the changes in trade shares, as shocks to X move the relative costs of production:

$$P(Y_{ik}|P(\mathbf{\Pi}|X)) = \theta \sum_j X_{jik} \left(\frac{dc_{ik}}{c_{ik}} - \sum_l \Pi_{jlk} \frac{dc_{lk}}{c_{lk}} \right), \text{ where } \quad dc_{ik} = \sum_{x \in X} \frac{dc_{ik}}{dx} dx.$$

Finally, the partial equilibrium ignores the way changes to sectoral sales feed back

5. Deficit can not change unilaterally: it needs to be financed by surpluses elsewhere in the world. Here I assume that deficits in all countries adjust to ensure balanced trade at a global level. The extent of adjustment by each of the economies is governed by a factor ζ_j, s.t. $\sum_j \zeta_j = 1, \zeta_j \geq 0$. For example, $\zeta_j = 1$ would mean that i is the sole lender to l. Each country's deficit then needs to change by $D'_j = \zeta_j x$ such that

$$dD_j = -\frac{\zeta_j}{\sum_l \zeta_l w_l L_l} w_l L_l dD_l.$$

onto sectoral output through affecting the household income and the demand for intermediate inputs. In Appendix A.3, I show that the total derivative of the sectoral value added in levels with respect to a set of shocks X can be expressed using a vector of partial equilibrium effects $P(\mathbf{Y}|X)+P(\mathbf{Y}|P(\mathbf{\Pi}|X))$ (a vector of $P(Y_{ik}|X)+P(Y_{ik}|P(\mathbf{\Pi}|X))$ stacked), and a matrix $\mathbf{G}$ which summarizes the general equilibrium forces in the model:

$$G(\mathbf{VA}|X) = \mathbf{G}\left(P(\mathbf{Y}|X) + P(\mathbf{Y}|P(\mathbf{\Pi}|X))\right)$$

where

$$\mathbf{G} = diag(\mathbf{1} - \mathbf{B1})(\mathbf{I} - \mathbf{\Pi}(\mathbf{AD\Sigma}diag(\mathbf{1} - \mathbf{B1}) - \mathbf{B}))^{-1}.$$

Changes in sectoral value added shares is then just the relative movements of sectoral value added:

$$G(va_{ik}|X) = \frac{1}{VA_i}\left(G(VA_{ik}|X) - va_{ik}\sum_n G(VA_{in}|X)\right).$$

Drivers of structural transformation. Focusing on movements in sectoral value added shares in response to certain sets of shocks offers a way of decomposing changes in the sectoral makeup of economies into components explained by distinct processes.

First, I break down changes in sectoral value added shares into the 'local' and 'global' components. The *local* component collects the response of domestic sectoral shares to shocks to domestic final and intermediate expenditure weights, α_{ik} andβ_{ikn} $\forall k, n \in K$:

$$dva_{ik}^{local} = G(va_{ik}|\boldsymbol{\alpha}_i, \mathbf{B}_i). \tag{1.15}$$

Likewise, let the *global* component be the change in sectoral shares driven by all shocks but changes in domestic final and intermediate expenditure shares:

$$dva_{ik}^{global} = G(va_{ik}|\mathbf{A}, \boldsymbol{\tau}, \mathbf{D}, \mathbf{L}, \boldsymbol{\alpha}_{-i}, \mathbf{B}_{-i}, \mathbf{L}). \tag{1.16}$$

Conveniently, for infinitesimal shocks, $dva_{ik}^{local} + dva_{ik}^{global} = dva$. Furthermore,

$$dva_{ik}^{global} = G(va_{ik}|\mathbf{A}) + G(va_{ik}|\boldsymbol{\tau}) + G(va_{ik}|\mathbf{D}) + G(va_{ik}|\boldsymbol{\alpha}_{-i}) + G(va_{ik}|\mathbf{B}_{-i}) + G(va_{ik}|\mathbf{L}). \tag{1.17}$$

I interpret these sub-components as changes in sectoral shares driven by (i) evolution of comparative advantage, (ii) trade liberalization, (iii) financial liberalization, (iv) changes in global preferences, (v) changes in global production methods, respectively.[6]

The sub-components reflecting the effects of changes in sectoral productivity and trade liberalization (i and ii respectively) are informative of the changing patterns of specialization: both across space, and across sectors within each economy. First, this measure controls for the changing relative sizes of the economies: a growing share of global sectoral output might be indicative of specialization, or of the growth of the economy relative to the rest of the world. Focusing on value added shares abstracts from the former. Second, it controls for changes in the relative sectoral shares that are due to forces other than specialization, such as changes in domestic preferences. In the decomposition, all such forces are switched off when computing $G(va_{ik}|\mathbf{A})$ and $G(va_{ik}|\boldsymbol{\tau})$. Finally, if trade cost- or productivity shocks increase the value added share in sector k of economy i, there must be a country j where k's share, all else constant, has declined. Thus, specialization registers vis-à-vis the economies that become less intensive in producing given sectoral goods.

Discussion. In an already globalized world, the distinction between local and global drivers is always a judgement call. No event can be considered truly local, unaffected by developments elsewhere. My suggestion for the decomposition derives from observing that in a closed version of the model the sectoral shares are pinned down by the domestic final and intermediate expenditure weights exclusively. Thus, $dva = dva^{local}$, and $dva^{global} = 0$. However, in an open economy, it is clear that domestic expenditure weights can respond to a range of global factors, such as changes in prices of imported goods, trade-induced changes in domestic prices, changes in income that originate from gains from trade, to name a few. However, I suggest that drawing the line at domestic expenditure weights as local drivers is a helpful demarcation, since it is both easy to understand, and relies on no further modelling of preferences.

In the next section I discuss how the model can be calibrated and simulated to obtain empirical counterparts to the decomposition terms in equations (1.15), (1.16), and (1.17).

6. The final term, the changes in sectoral shares driven by changes in the relative sizes of the population, is non-zero inasmuch as differential population growth affects the relative wages. This effect is standard in the Eaton and Kortum (2002) type models, and is present in Dornbusch, Fischer, and Samuelson (1977), its antecedent. Its quantitative contribution is minimal, and the effect itself disappears with only slight alteration of the model. I keep it for completeness.

1.4 Calibration

In this section, I first describe the dataset that I use. I then present the calibration of the model. Finally, I discuss the algorithm for the identification of shocks to trade costs and sectoral productivity.

1.4.1 Data Description

I use Groningen Growth and Development Centre Long-run World Input Output Database as a source of data on annual sector level bilateral trade flows, final consumption, intermediate inputs use, and sectoral output and value added. There are two key features of this dataset. First, it covers global consumption and production by including a Rest of World region which aggregates the trade flows to and from all countries not included in the dataset. Second, it is internally consistent, in the sense that at a sectoral level, total value of resources used in production equals the total value of its sales. Thus, it maps readily to the equilibrium conditions of the model.

The dataset covers twenty five economies and an aggregate rest of the world region over years 1965 to 2000. I restrict my analysis to twenty economies, and group the remaining five together with the rest of the world.[7] The sectoral coverage is at a two digit level and is subject to ISIC rev. 3.1 industrial classification. There are twenty three sectors in the data, thirteen of which are tradable: agriculture, mining, and eleven sectors that produce different manufacturing goods. I group the remaining ten sectors into one aggregate services sector, so that $K = 14$. The list of countries and sectors can be found in Appendix B.

To calibrate the model, I use the full contents of the world input-output tables. I use the data on sector level intermediate inputs use which varies by country and sector of both origin and destination, i.e. X^{II}_{jinkt}, as well as consumption series which vary by destination, sector and country of origin: X^{FC}_{jikt}. I construct all the variables of interest using these two time series, and supplement with the population series, which I take from the Socio Economic Accounts segment of Long-Run WIOD.

I do minimal cleaning of the dataset. First, as I am focusing on the long run

7. I exclude Austria, Belgium, Hong Kong, Ireland and Netherlands from the analysis as the time series for these countries feature abnormalities. Austria and Netherlands series feature structural breaks in years 1995 and 1969 respectively. Hong Kong series show zero final or intermediate consumption of textiles, but positive production throughout the period. Belgium and Ireland do not show a clear structural break, but feature self-shares that dip down to zero for consecutive years absent a corresponding drop in sectoral sales. Since domestic sales in the dataset are obtained as a residual between output and exports, I interpret these observations as reflective of a measurement error in either the sales or the exports series.

processes, I smooth the data somewhat, using a moving average of the series with a window length of 10 years. This removes the jumps in the data while keeping the long run trends intact. Second, I force no trade in the services sectors. Trade in services in the Long Run WIOD is obtained as a residual between total trade and trade in goods. Thus, the trade in services series might reflect measurement error in either of the two. To remove potential measurement error, I attribute all sales of service sectors to domestic absorption. Finally, the consumption reported in WIOD includes inventories and thus can take negative values. I subtract inventories from sectoral sales such that my measure of output is now akin to 'goods delivered'. This alteration leaves all other intermediate and final use categories intact and the dataset remains internally consistent.

1.4.2 Model in Changes

Dekle, Eaton, and Kortum (2007) and Eaton et al. (2016) show that the model can be rewritten in changes, such that all objects in the model are solved for using the base year values of endogenous variables and the changes in the values of exogenous variables: $\hat{\mathbf{A}}, \hat{\boldsymbol{\tau}}, \hat{\mathbf{L}}, \hat{\mathbf{D}}, \hat{\boldsymbol{\alpha}}, \hat{\boldsymbol{\beta}}$, where change is from the level of the previous period: $\hat{x} = (x_{t+1} - x_t)/x_t$. Note that under this notation, $\hat{x} = 1$ means no change, and, conversely, $\hat{x} \neq 1$ means that x has changed its value between $t+1$ and t. Thus, I will be referring to changes in exogenous variables as 'shocks'. The benefit of this approach is a much smaller set of data required to parameterize the model. The model in changes is presented in Appendix A.4.

The calibration of the model in changes requires the values of Y_{ik}, Π_{jik}, α_{ik}, β_{ikL}, β_{ikn} and D_i for the base year. I derive these using the final and intermediate consumption series from WIOD, X^{FC}_{jik} and X^{II}_{jikn}, as follows:

$$\Pi_{ijk} = \frac{X_{ijk}}{\sum_l X_{ilk}}, \quad Y_{ik} = \sum_j X_{jik}, \quad X_{ijk} = X^{FC}_{ijk} + \sum_n X^{II}_{ijnk},$$
$$\beta_{ikn} = \frac{\sum_j X^{II}_{ijkn}}{Y_{ik}}, \quad \beta_{ikL} = 1 - \sum_n \beta_{ikn}$$
$$VA_{ik} = \beta_{ikL} Y_{ik}, \quad VA_i = \sum_k VA_{ik},$$
$$\alpha_{ik} = \frac{\sum_j X^{FC}_{ijk}}{E_i}, \quad E_i = \sum_{j,k} X^{FC}_{ijk}, \quad D_i = \frac{E_i}{VA_i}.$$

I obtain $\hat{\mathbf{L}}, \hat{\mathbf{D}}, \hat{\boldsymbol{\alpha}}, \hat{\boldsymbol{\beta}}$ by computing annual percentage changes for each year in the sample. The two remaining shock series, $\hat{\mathbf{A}}, \hat{\boldsymbol{\tau}}$, are less straightforward to back out. I discuss their estimation in the next subsection.

The only parameter set externally is the productivity draw dispersion/trade elasticity parameter θ. I follow the literature by setting it to 4, as estimated in Simonovska and Waugh (2014) and Donaldson (2018).

1.4.3 Identification of Trade and Productivity Shocks

The trade shares in the changes formulation of the model behave as follows:

$$\hat{\Pi}_{jik} = \left(\frac{\hat{c}_{ik}\hat{\tau}_{jik}}{\hat{A}_{ik}\hat{P}_{jk}}\right)^{-\theta}, \text{ where } \quad \hat{P}_{ik} = \left[\sum_{l} \Pi_{ilk,t}\Big(\frac{\hat{c}_{lk}\hat{\tau}_{ilk}}{\hat{A}_{lk}}\Big)^{-\theta}\right]^{-\frac{1}{\theta}}, \quad \hat{c}_{ik} = \hat{w}_{ik}^{\beta_{ikL}} \prod_{n} \hat{P}_{in}^{\beta_{ikn}},$$

and $\hat{w} = \hat{Y}/\hat{L}$ comes directly from the data. A full set of trade cost and productivity shocks comprises $I \times I \times K$ unknowns. However, the trade share changes give only $I \times (I-1) \times K$ independent equations: one trade share per country and sector can always be solved for as 1 less the other trade shares. In other words, trade share series are insufficient to identify trade cost and productivity shock series uniquely. Several methods of identification have been proposed in the literature. I discuss each in turn, and propose an alternative identification.

Identification using data price series. One option is to use price series data in place of a missing set of equations, as done in Eaton et al. (2016). Then,

$$\hat{A}_{ik} = \frac{\hat{c}_{ik}}{\hat{P}_{ik}}\hat{\Pi}_{iik}^{\frac{1}{\theta}}, \quad \text{and} \quad \hat{\tau}_{jik} = \frac{\hat{A}_{ik}\hat{P}_{jk}}{\hat{c}_{ik}}\hat{\Pi}_{jik}^{\frac{1}{\theta}}.$$

However, if the price data is not consistent with the model, the mismeasurement will distort the two shock series. For example, if price series in the data dips for reasons other than the forces accounted for in the model, the shock to productivity will be underestimated. The trade cost shock solutions will then record large drops, in order to square the relatively smooth trade share series with a jump in sectoral productivity. While the full set of shocks will still match the data perfectly, the counterfactuals with one set of shocks operating at a time will feature large offsetting movements.

Identification using imputed price series. Lewis et al. (2022) and Świecki (2017) follow a similar procedure, but instead of using the price series from the data, they construct their own, model-consistent price series. In both papers, household preferences are non-homothetic. The movements of expenditure shares, then, contain information on the relative movements of the prices. The price series can be solved for by minimizing the distance between the expenditure shares in the model and in the data. The trade cost and productivity shocks are then obtained analogously to the previous method.

The resulting price series tend to be smoother than that in the data, but ultimately are subject to the same problem of compensating movements in productivity and trade cost shocks. Moreover, the method is sensitive to the misspecification of the preferences. As the number of sectors in my application is substantially larger than in Lewis et al. (2022) and Święcki (2017) (fourteen, as compared to two and three, respectively), I opt for an identification strategy that does not involve modelling of the preferences.

Identification using trade cost shock symmetry. I what follows, I dispense with identification through prices, and introduce restrictions on trade cost shocks instead. Specifically, I force the changes in trade costs to be symmetric at a sector-country-pair level.

To see the intuition behind this restriction, consider the following thought experiment. Suppose all of the change in trade shares is explained by movements in trade costs, i.e. $\hat{A}_{ik} = 1 \; \forall i, k$. Suppose further that the economy i saw both rising exports in sector k ($\hat{\Pi}_{jik} > 1$), and sold more of k to domestic consumers than before ($\hat{\Pi}_{iik} > 1$). Trade cost shocks that rationalize such movements are: a decline in the costs of export, $\hat{\tau}_{jik} < 1$, and an increase in the costs of import, $\hat{\tau}_{ijk} > 1$. An increase in productivity, $\hat{A}_{ik} > 1$, will ease these pressures, and will result in estimated trade cost shocks that are more symmetric. Thus, I search over sectoral productivity shocks that minimize the distance between outward and inward sector-country-pair trade cost shocks. The algorithm records productivity growth when exports move in the same direction as self-shares, and records trade cost declines where a rise in exports is associated with self-shares that are falling.

Formally, for a given series of $\hat{\boldsymbol{w}}, \hat{\boldsymbol{\Pi}}$, pick a matrix of productivity shocks $\hat{\mathbf{A}}$ such that:

$$\min_{\mathbf{A}} \sum_{i,j,k} (\hat{\tau}_{ijk} - \hat{\tau}_{jik})^2, \text{ where } \quad \hat{\tau}_{jik} = \frac{\hat{A}_{ik} \hat{P}_{jk}}{\hat{c}_{ik}} \hat{\Pi}_{jik}^{-\frac{1}{\theta}},$$

and $\hat{\boldsymbol{P}}$ and $\hat{\boldsymbol{c}}$ jointly satisfy

$$\hat{c}_{ik} = \hat{w}_{ik}^{\beta_{ikL}} \prod_{n} \hat{P}_{in}^{\beta_{ikn}}, \quad \text{and} \quad \hat{P}_{ik} = \frac{\hat{c}_{ik}}{\hat{A}_{ik}} \hat{\Pi}_{iik}^{\frac{1}{\theta}}.$$

It can be shown that the productivity shocks in each of the sectors are identified up to an additive constant. I normalize by setting the productivity shocks in the United States to 1 in all periods and sectors. The interpretation of the shocks I estimate, then, is that $\hat{A}_{ik}$ is the percentage point change in i's productivity in sector k over and above that in the United States.

The higher the level of disaggregation, the more likely it is that trade shares approach zero in any one period. In this case the recorded $\hat{\Pi}_{ijk}$ is either extremely large, or approaching zero. For a small change in trade flows, such observations carry disproportionate weight in the operation of the algorithm. Since my system is overidentified ($(I-1) \times (I-1) \times K/2$ extra restrictions in place of $I \times K$ missing), I drop such observations. Specifically, I exclude the residuals of sector-country-pairs where the trade share change is either above φ, or below $1/\varphi$, for some threshold parameter φ. I experiment with threshold values of 1.1, 1.05 and 1.01, corresponding to 10%, 5% and 1% changes per year. I use the value of 1.05 for my main specification, but report all my results using shock series obtained using the threshold values of 1.1 and 1.01 in Appendix C.

This completes the calibration of the model. I turn to the model simulation next.

1.5 Structural Transformation in an Open Economy

In this section, I use the calibrated version of the model to study the local and global drivers of structural transformation in the years between 1965 and 2000.

1.5.1 Model-Based Decomposition

In Section 1.3.2 I argued that in the model, changes in sectoral shares can be attributed to the changes in different sets of exogenous variables, and proposed a way of partitioning these variables to study how local versus global factors, as well as trade liberalization, evolution of comparative advantage, financial liberalization, and changes in global final and intermediate demand shape structural transformation in different economies. The calibrated version of the model can be used to derive a simulation-based counterpart of this theoretical exercise.

First, observe that the shocks estimated in Section 1.4 constitute the empirical counterparts to the changes in exogenous variables used to derive the comparative statics in Section 1.3.2:

$$\frac{dA_{ik}}{A_{ik}} \rightarrow \hat{A}_{ik} = \frac{A_{ik,t+1} - A_{ik,t}}{A_{ik,t}}, \quad \text{and likewise for} \quad \frac{d\tau_{jik}}{\tau_{jik}}, \frac{dD_i}{D_i}, \frac{dL_i}{L_i}, \frac{d\alpha_{ik}}{\alpha_{ik}} \text{ and } \frac{d\beta_{ik}}{\beta_{ik}}.$$

Second, simulating the model using the partitioning of the shocks proposed in Section

1.3.2 produces the empirical counterpart to the decompositions (1.15)-(1.17):

$$dva_{ik}^{local} = G(va_{ik}|\boldsymbol{\alpha}_i, \mathbf{B}_i) \quad \rightarrow \quad \Delta va_{ik}^{local} = \Delta va_{ik}(\boldsymbol{\alpha}_i, \mathbf{B}_i),$$

where $\Delta va_{ik}(X)$ stands for the difference between the value added share in i, k, simulated using the set of shocks X, and that in the previous year. The counterpart to va_{ik}^{global} is generated analogously:

$$dva_{ik}^{global} = G(va_{ik}|\mathbf{A}, \boldsymbol{\tau}, \mathbf{D}, \boldsymbol{\alpha}_{-i}, \mathbf{B}_{-i}, \mathbf{L}) \quad \rightarrow \quad \Delta va_{ik}^{global} = \Delta va_{ik}(\mathbf{A}, \boldsymbol{\tau}, \mathbf{D}, \boldsymbol{\alpha}_{-i}, \mathbf{B}_{-i}, \mathbf{L}).$$

Finally, since $\Delta va_{ik}^{local} + \Delta va_{ik}^{global} \approx \Delta va_{ik}^{data}$, the values of the components can be interpreted as relative contributions to the sectoral shares in the data.[8]

In the rest of this section, I study the changes in the total share of manufacturing across the economies, and then the changes in the composition of aggregate manufacturing in terms of the eleven manufacturing sub-sectors available in the data. To obtain decompositions at an aggregate manufacturing level, I sum the decompositions across the eleven sub-sectors:

$$\Delta va_{im}(X) = \Delta va_{im_1}(X) + ... + \Delta va_{im_N}(X),$$

where m stands for manufacturing and $1, ..., N$ are its sub-sectors.

To measure the contribution of each of the factors over a given period of time, I sum the simulated yearly differences across years.

1.5.2 Local Versus Global Drivers of Structural Transformation

Changes in the aggregate manufacturing share. Figure 1.4 below presents the decomposition of the changes in manufacturing value added shares into the contributions of (i) changes in domestic final and intermediate expenditure weights, referred to as the 'local' component; and of (ii) changes in trade costs, sectoral productivity levels, current account deficits, and foreign final and intermediate expenditure weights, referred to as the 'global' component. The black circles mark the change in the manufacturing value added shares in the data, and the white circles mark the sum of the two components.

First, note that most countries in the sample have undergone deindustrialization in the period between 1965 and 2000. Most notably, the United Kingdom has seen an

8. The model simulated with the full set of shocks reproduces the changes in the sectoral shares in the data exactly. The discrepancy between the data and the approximation based on the sum of results from simulations using subsets of shocks is accounted for entirely by the missing interactions.

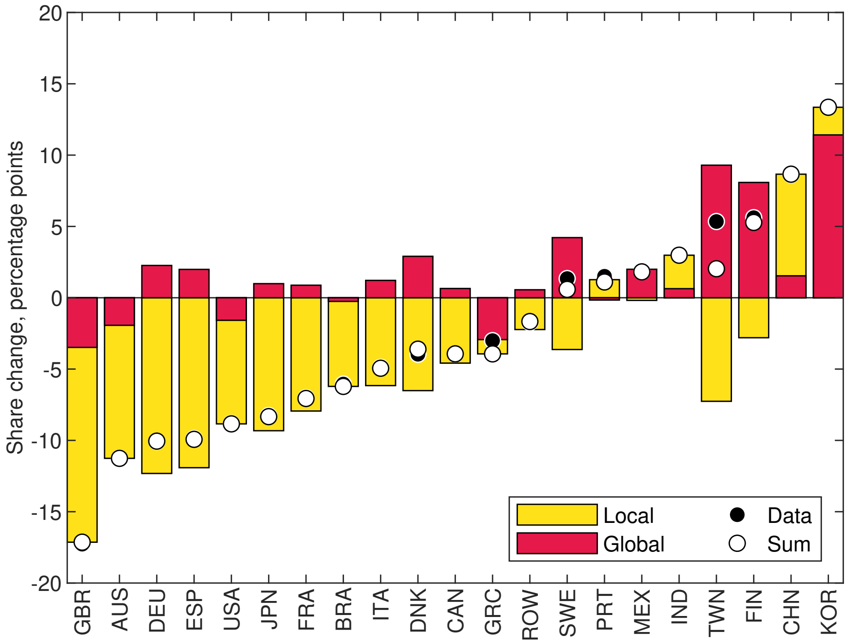

Figure 1.4: Local Versus Global Drivers of Manufacturing Value Added Shares

Note: The black circles mark the change in the manufacturing value added share between 1965 and 2000. The bars correspond to the simulated changes in manufacturing value added share using different subsets of shocks estimated in Section 1.4. 'Local' is computed using only the shocks to domestic preference- and production function parameters. 'Global' is computed using all the remaining shocks: changes in sectoral trade costs, productivity, aggregate trade imbalances, and foreign preference- and production function parameters. The white circles mark the sum of the 'local' and 'global' components.

almost 20 percentage points decline in its manufacturing share. Australia, Germany and Spain all saw their manufacturing sector shrink by around 10 percentage points. At the same time, some economies saw their manufacturing share expand. Notably, South Korea and China, who saw their manufacturing share increase by 13 and 9 percentage points respectively, but also Taiwan and Finland, whose manufacturing share rose by around 5 percentage points.

The decomposition into the local and global components helps shed light on these different experiences. As such, all the economies that underwent deindustrialization did so primarily due to changes in local demand, as indicated by the yellow bars. The forces such as switching out of manufacturing consumption due to the rising of income, or due to the falling relative price of manufacturing, were likely at play. However, the extent of deindustrialization was also partially shaped by the global forces. For example, manufacturing share in Denmark, Germany and Spain declined by less than would have been the case absent the global pressures.

The economies that saw their manufacturing expand can be divided into two groups. On one hand, China, India, Portugal and Korea saw their manufacturing grow due to increases in local demand. As before, this could be attributed to the operation of standard mechanisms of structural change. For example, demand for manufacturing tends to follow a hump shape as income grows. Indeed, economies in this group started off from a very low level, and saw some of the most rapid increases in the per capita income in the sample. On the other hand, Korea and Taiwan, but also Finland and Sweden all saw their manufacturing share increase due to the operation of global forces. Notably, both Finland and Sweden are high income economies that would have seen their manufacturing share decline if not for the open economy forces.

To quantify the contribution of each, I compute the absolute values of the components and divide through by the sum:

$$RC^{local} = \frac{\sum_i |\Delta va_{im}^{local}|}{\sum_i |\Delta va_{im}^{local}| + |\Delta va_{im}^{global}|}, \quad RC^{global} = \frac{\sum_i |\Delta va_{im}^{global}|}{\sum_i |\Delta va_{im}^{local}| + |\Delta va_{im}^{global}|}.$$

I repeat the exercise for each of the economies in my sample, such that

$$RC_i^{local} = \frac{|\Delta va_{im}^{local}|}{|\Delta va_{im}^{local}| + |\Delta va_{im}^{global}|}, \quad RC_i^{global} = \frac{|\Delta va_{im}^{global}|}{|\Delta va_{im}^{local}| + |\Delta va_{im}^{global}|}.$$

I find that the local factors explain 68% of the structural transformation in the whole sample. The global forces are responsible for the remaining 32%. At an individual country level, global forces played a relatively more important role in the industrialization experiences of Greece, Taiwan, Mexico, Finland, South Korea and Sweden. The full list of relative contributions for each of the economies can be found in the Table C.2.1 in the Appendix C.

Structural transformation within manufacturing. Figure 1.5 presents the decomposition into the local and global components for each of the eleven sectors within manufacturing.

First, observe that the global demand plays a greater role in structural transformation across the sub-sectors of manufacturing, than that for the manufacturing sector as a whole. Second, note the heterogeneity of responses to both local and global forces across the sub-sectors of manufacturing. Some, such as the production of food and textiles, as well as manufacture of metals, other mineral products, coke and petroleum, and pulp and paper, were shaped primarily by changing local demand. Other sectors, most notably the manufacture of electrical and optical equipment, transport equipment and

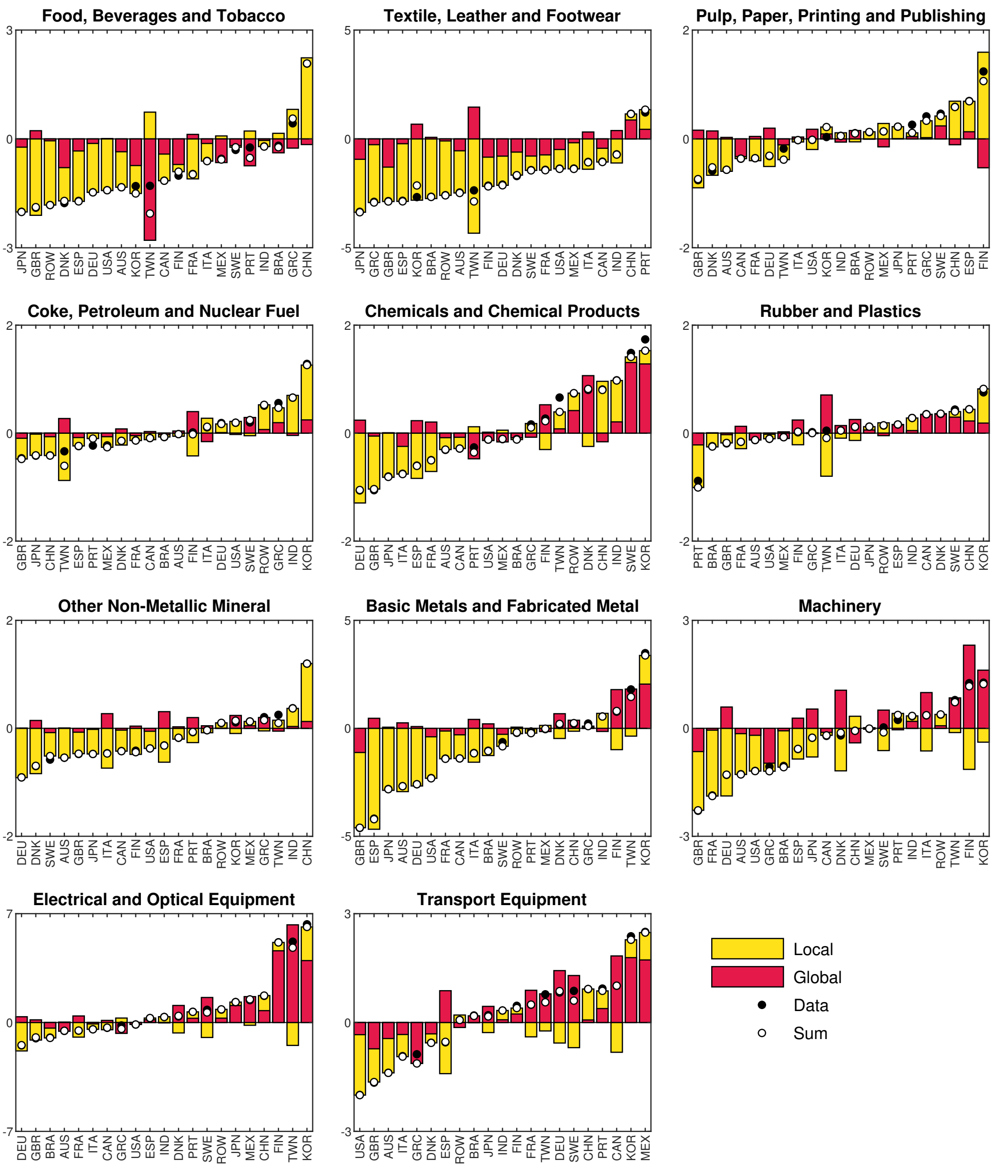

Figure 1.5: Local versus Global Drivers of Structural Transformation within Manufacturing

Note: The black circles mark the change in the manufacturing value added share between 1965 and 2000. The bars correspond to the simulated changes in manufacturing value added share using different subsets of shocks estimated in Section 1.4. 'Local' is computed using only the shocks to domestic preference- and production function parameters. 'Global' is computed using all the remaining shocks: changes in sectoral trade costs, productivity, aggregate trade imbalances, and foreign preference- and production function parameters. The white circles mark the sum of the 'local' and 'global' components.

other machinery, but also the production of rubber and chemicals, were to a much larger extent shaped by the global forces. Finally, observe that in the majority of cases when the sub-sectors of manufacturing experienced growth in their value added share, this had occurred due to the global forces rather than due to changes in demand at home.

I compute the relative contribution of the two components as before, but now take into account the movements across the sub-sectors of manufacturing:

$$RC^{local,d} = \frac{\sum_{i,n} |\Delta va^{local}_{im_n}|}{\sum_{i,n} |\Delta va^{local}_{im_n}| + |\Delta va^{global}_{im_n}|}, \quad RC^{global,d} = \frac{\sum_{i,n} |\Delta va^{global}_{im_n}|}{\sum_{i,n} |\Delta va^{local}_{im_n}| + |\Delta va^{global}_{im_n}|}. \tag{1.18}$$

I then repeat the exercise for each of the sub-sectors:

$$RC^{local}_{n} = \frac{\sum_{i} |\Delta va^{local}_{im_n}|}{\sum_{i} |\Delta va^{local}_{im_n}| + |\Delta va^{global}_{im_n}|}, \quad RC^{global}_{n} = \frac{\sum_{i} |\Delta va^{global}_{im_n}|}{\sum_{i} |\Delta va^{local}_{im_n}| + |\Delta va^{global}_{im_n}|}. \tag{1.19}$$

The relative importance of the global component measured this way increases to 42%. Thus, global factors are responsible for almost a half of the changes in the size and composition of the manufacturing sector in my sample. The global forces explain more than half of the changes in sectoral shares in electrical and transport equipment sectors, 63% and 56% respectively. I report the full list of the relative contributions of the two components to structural transformation across the sub-sectors in Table C.2.1 in the Appendix C.

Next, I turn to measuring the contribution of trade liberalization, evolution of comparative advantage, financial liberalization, and changes in global final and intermediate demand to the global component.

1.5.3 Unpacking the Global Drivers of Structural Transformation

Global drivers of the aggregate manufacturing share. Figure 1.6 presents the decomposition of the global component of the change in the manufacturing value added share into its sub-components. The decomposition adds further nuance to the understanding of different industrialization experiences in the last third of the twentieth century. For both the United Kingdom and Australia – the two economies that saw their manufacturing share contract the most – pressures posed by trade liberalization seem to have been the key factor. Interestingly, for Greece and Portugal, but also the Unites States, the declines in the manufacturing share brought about by the growing current account deficits are already visible in the 1965-2000 period, on the eve of the opening of the much more dramatic global imbalances of the twenty first century.

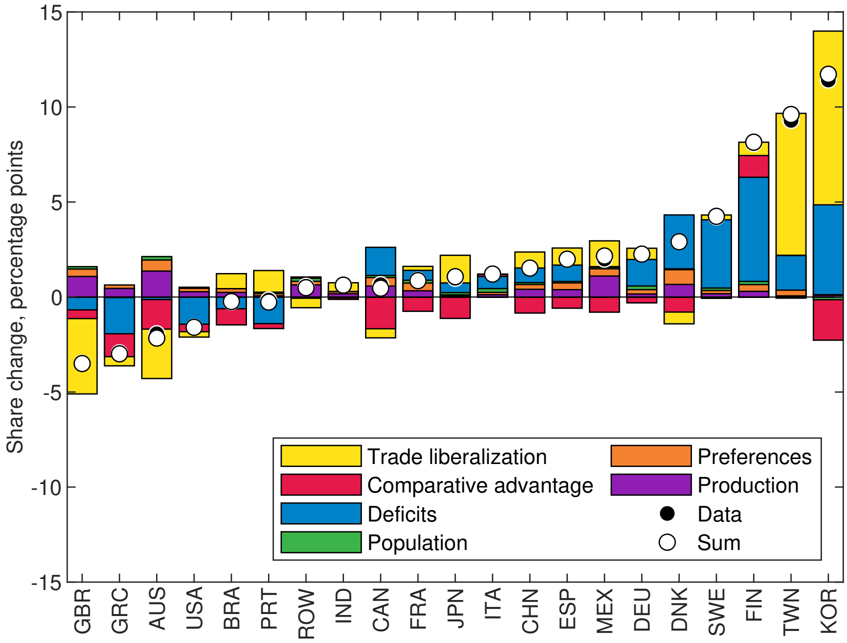

Figure 1.6: Global Drivers of Manufacturing Value Added Shares

Note: The black circles mark the 'global' component of the change in the manufacturing value added share between 1965 and 2000. The bars correspond to the simulated changes in manufacturing value added share using different subsets of shocks estimated in Section 1.4: trade cost, productivity, aggregate trade deficit, population size, foreign preference parameter, and production function parameter shocks, respectively. The white circles mark the sum of the 'local' and 'global' components.

The economies that saw the biggest gains in their manufacturing share can, again, be divided into two groups. The manufacturing sector in South Korea and Taiwan benefited enormously from the falling costs of trade. Sweden, Finland and Denmark, on the other hand, saw their manufacturing shares expand primarily by virtue of increasing their current account surpluses over the period.

I compute the relative contributions of each of the six sub-components as before. Trade- and financial liberalization play a key role in shaping the manufacturing shares across the world, accounting for 35% and 32% contribution of the global component each. The evolution of comparative advantage plays a secondary role, and is responsible for 16% of the global component in my baseline specification. The changes in the expenditure weights in final and intermediate global demand explain 9% and 6% respectively, and the changes in the relative population growth explain the remaining 2%.

In Figures C.3.1 and C.3.2 in Appendix C, I present the same decomposition, but done using shock series derived using different levels of the threshold φ: 1% and 10%. Intuitively, the lower the threshold – the more asymmetry in trade cost shocks I permit and the larger the role these take in explaining the movements in the data. The higher the threshold – the more symmetry in trade cost shocks I impose, leaving it to the productivity shocks to justify the observed trade flows. The result is a different relative roles played by the two forces: 42% and 6% of the global component driven by trade cost shocks and productivity shocks respectively for $\varphi = 0.01$, and 32% and 20% for $\varphi = 0.1$.

Global drivers of structural transformation within manufacturing. Finally, I break down the global component of changes in sectoral shares across the eleven sub-sectors of manufacturing. Figure 1.7 presents the results. Figures C.3.3 and C.3.4 in the Appendix C present the decompositions for $\varphi = 1.01$ and $\varphi = 1.1$. I discuss the contributions of the individual components in groups.

First, note that changes in global intermediate and final demand weights explain some of the movement in the value added shares of the sub-sectors. For example, global demand for textiles has been declining, squeezing production across the world, most notably for textile exporters: South Korea, Taiwan and Portugal. Expenditure weights on electrical equipment, on the other hand, have been going up, diverting the resources towards these sectors.

Macroeconomic imbalances played the biggest role for the economies that saw the biggest growth in the aggregate trade surpluses in the period: South Korea, Finland, Sweden and Denmark. However, which sub-sector of manufacturing expanded the most due to the operation of this channel depends on the export structure of the economies. For Finland, the largest category of export was 'pulp and paper', accounting for 36% of its exports in 1965. For South Korea, Denmark and Sweden, the largest export sectors were Textiles (59%), Food (57%) and Transport (30%), respectively. In each of these cases, as the increasing trade surpluses transferred the purchasing power to the rest of the world, sectors whose customer base was disproportionally foreign-based expanded.

The changing patterns of specialization across space are most noticeable in high skilled manufacturing sectors: machinery, electrical- and transport equipment. Across the three sectors, South Korea, Finland and Taiwan each has shown patterns of increased specialization. The opposite is the case for Italy, Denmark, Austria, the United Kingdom, and Greece. To see what these changing patterns of specialization entail within each economy, in Tables C.3.1 and C.3.2 in Appendix C I mark the three sectors that saw the highest gains in their sectoral share due to changes in trade costs and productivity, and three sectors that saw the largest losses. The table makes clear, for example, that Finland was able to expand into the high skilled manufacturing by diverting resources from the pulp and paper and food industries. Both South Korea and Taiwan, on the other hand, have moved out of both agricultural production and mining.

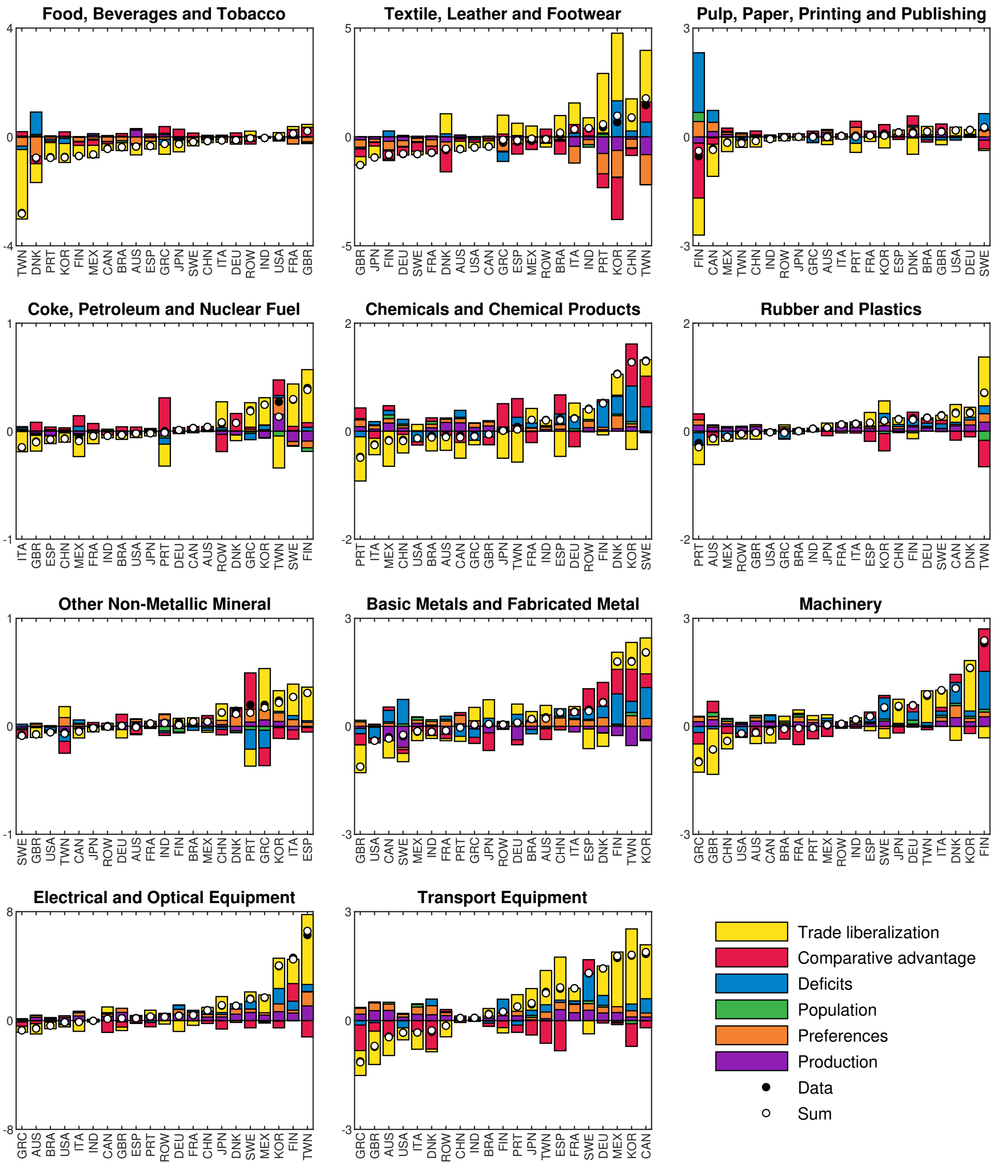

Figure 1.7: Global Drivers of Structural Transformation within Manufacturing

Note: The black circles mark the 'global' component of the change in the manufacturing value added share between 1965 and 2000. The bars correspond to the simulated changes in manufacturing value added share using different subsets of shocks estimated in Section 1.4: trade cost, productivity, aggregate trade deficit, population size, foreign preference parameter, and production function parameter shocks, respectively. The white circles mark the sum of the 'local' and 'global' components.

1.6 Conclusion

In this chapter I have examined the role of trade and external deficits in explaining the patterns of structural change in twenty developed and developing economies between 1965 and 2000. Using the data from Long Run World Input-Output Database, I have shown that manufacturing value added shares in the data deviate substantially from those in the closed economy counterfactual. To explain this discrepancy, I used a quantitative trade model: a multi-sector extension of Eaton and Kortum (2002) with aggregate trade deficits. I showed that in the model, changes in manufacturing shares can be attributed fully to the operation of shocks to preference- and production function parameters, as well as to shocks to trade costs, sectoral productivities, and aggregate trade deficits.

Eaton and Kortum (2002) model can be calibrated as to match the data exactly, and has been used to interpret the changes in the data as arising due to the operation of structural shocks. However, difficulties in separate identification of trade cost- and productivity shocks have constrained the use of the model to interpret the data at a relatively disaggregated level. In this chapter, I suggested a novel method of identifying trade cost- and productivity shocks in an environment with many near-zero trade share observations. For the case of structural transformation in particular, this flexibility was key to quantify the effect that has been known since Ricardo, namely that the sectoral makeup of economies will respond to the forces of specialization, and more so at a finer level of disaggregation. Moreover, I have shown that financial liberalization is an important, yet often overlooked contributor to the process of structural transformation.

Chapter 2

Competitiveness, 'Superstar' Firms and Capital Flows

In this chapter, I study financial liberalization between economies that differ in their overall competitiveness. I first show that if firms compete oligopolistically, then competitiveness — relatively low aggregate unit costs of production — is a feature of an economy with a fatter tailed productivity distribution and relatively more very large — 'superstar' — firms. Embedding this setup in a two-country model with heterogeneous agents and non-homothetic saving behaviour, I show that if the home is more competitive, then: (1) it enjoys a higher aggregate profit rate than foreign; (2) its autarkic interest rate is lower than that in foreign; (3) should the two economies undergo financial liberalization, the capital will be flowing from home to foreign; (4) if one of the sectors is non-tradable, the capital inflows push up the wages in foreign, leading to further losses of competitiveness and to current account overshooting.

2.1 Introduction

Current account imbalances, and deficits in particular, are thought to have compounded the losses caused by the global financial crisis. Since then, both the IMF and the EU have set up surveillance mechanisms to monitor the evolution of imbalances in the EU and globally. However, the understanding of the origin of imbalances in the policy circles differs sharply from the views held in the macroeconomic literature. In policy reports, the issue of 'competitiveness' looms large, both in terms of diagnosis (inflows as driven by a loss of competitiveness) and policy recommendations (deficit economies are to 'restore competitiveness' by means of structural reforms).[1] Meanwhile, the notion of competitiveness is all but absent in macroeconomic models of capital flows.

This chapter bridges theory and practice by first defining a formal notion of competitiveness in a tractable heterogeneous firm oligopolistic equilibrium environment, and then by proposing a model linking competitiveness and capital flows. The contribution of this study is two-fold. First, it offers a novel mechanism that generates current account imbalances between economies undergoing an episode of financial liberalization. In the next chapter, I argue that my model is helpful for understanding the build-up of current account imbalances in Europe on the eve of Global Financial Crisis. Second, having the link between competitiveness and capital flows spelled explicitly permits formal analysis of policies for rebalancing offered by the international policy institutions. I argue that structural reforms typically recommended are unlikely to lead to rebalancing and discuss a set of policies that might do.

At the heart of my analysis are firms that engage in oligopolistic competition. Two properties of oligopolistic competition are key to link competitiveness and capital flows. First, oligopolistic competition means that firms generate non-zero profits. Non-zero profits, in turn, have non-trivial effects in asset markets. On one hand, a firm that acts oligopolistically demands less capital as a fraction of its sales. At an aggregate level, this means that capital used in production, and thus the asset supply, is lower as a share of GDP than that under perfect competition. On the other hand, inasmuch as profits accrue to a demographic with a higher propensity to save out of permanent income, high profit rates increase the demand for assets. By affecting asset markets from both the demand and supply sides, pure profits thus affect the autarkic interest rate. Second, under oligopolistic competition, the aggregate profit rate depends on the distribution of

1. In the context of current account imbalances build up in Europe on the eve of the Global Financial Crisis, see Dieppe et al. (2012), Bützer, Jordan, and Stracca (2013), Angelini, Ca'Zorzi, and Forster van Aerssen (2016), Rodriguez-Palenzuela and Dees (2016), and Zorell (2017), as well as speeches by Trichet (2011) and Draghi (2012)).

firm productivities. Specifically, I show that an economy with a fat tailed productivity distribution will feature many very large firms, which, following the literature, I refer to as 'superstar' firms. I show that an economy with many 'superstar' firms enjoys a high aggregate profit rate. To the extent that this produces a lower interest rate in autarky, an economy that features relatively more superstar firms will see capital outflows, should cross-border capital flows be permitted.

Under oligopolistic competition, the prevalence of superstar firms and country-level competitiveness are intimately linked. To see why, it is helpful to first consider what it means for an individual firm to be competitive. A firm is competitive if it performs better than other firms in its market. Fundamentally, this requires a cost advantage. Having lower unit costs of production affords the firm a price below that of its competitors, which in turn attracts a larger market share and results in a higher rate of profit. An economy with many superstar firms has similar features at an aggregate level: low aggregate unit costs of production, a high weighted average sales share and high aggregate profit rate. Each of these metrics, I suggest, offers a measure of country-level competitiveness. Algebraically, this is an outcome of the largest firms in the economy both charging higher markups and carrying a relatively large weight in the aggregation. However, far from being a simple aggregation result, this notion of competitiveness is underpinned by economic logic. An economy with many superstar firms that compete oligopolistically features low unit labour costs because, in their rent-seeking behaviour, the largest firms disproportionally contract their demand for labour. Noting that an economy is competitive if its costs of production are low given its level of productivity, it is this strategic behaviour of superstar firms that generates a downward pressure on wages.

This definition of competitiveness has several advantages. First, it can be traced back to individual firms that make an economy competitive. Its granular nature then permits an in-depth analysis of determinants of country competitiveness. Second, it is intuitive. As I will show, an economy is competitive if its firms are market leaders *across* industries. It suffices to bring to mind household brands such as 'Bosch', 'Nivea' and 'Volkswagen' to see that Germany is a competitive economy. Third, it provides a number of alternative and theoretically linked measures of competitiveness. To see the importance of such flexibility, consider a measure of competitiveness widely used: the unit labour costs. Due to the difficulties in measuring labour costs in levels, it is usually presented as an index. This precludes cross-country comparisons of competitiveness. In this chapter, I show that several measures of market concentration can be used instead. Unlike unit labour costs, these can be readily measured and thus are amenable to cross-country comparisons.

In order to highlight the mechanism, I set up a stylised model. In the model, two economies produce a non-overlapping set of varieties which are freely tradable. Firms compete oligopolistically à la Cournot following Atkeson and Burstein (2008). This is the simplest setup that generates variable markups and aggregate profits. Capital serves a dual purpose: as a factor of production and as an asset. There are two types of households: workers and capitalists. Both supply labour inelastically, but the latter also receive profits. Demand for assets is non-homothetic and is modelled in reduced form, as a higher preferred asset to income ratio for the richer capitalist households. This shortcut produces closed form solutions and is relaxed in the extended version of the model. Suppose that home is more competitive, i.e. it features a fatter tailed distribution of firm productivities and thus more 'superstar' firms. I show that: (1) home enjoys a higher aggregate profit rate than foreign; (2) the home autarkic interest rate is lower than that in foreign; (3) should the two economies undergo a period of liberalization of cross-border capital flows, the capital will be flowing from the more competitive home to the less competitive foreign economy; (4) if one of the sectors is non-tradable, the capital inflows push up the wages in foreign, leading to further losses of competitiveness and thus amplifying the mechanism. Current account imbalances overshoot on impact.

2.1.1 Related literature

This paper forms part of a literature on 'global imbalances': a pattern of large and persistent current account deficits in some countries, and current account surpluses in other. In much of the literature, the imbalances are understood as arising from asset market asymmetries in different parts of the world. For example, Caballero, Farhi, and Gourinchas (2008) focus on lower supply of assets in the surplus economies due to the lack of a developed financial system. Mendoza, Quadrini, and Rios-Rull (2009) and Ferrero (2010), instead, explain the imbalances as caused by differences in asset demand, e.g. due to the amount of idiosyncratic risk faced by households or demographic pressures. The majority of papers in the literature on global imbalances address the 'allocation puzzle': the observation that, globally, capital tends to flow from emerging economies to advanced countries. Therefore, the focus tends to be on the experience of Asia and the US – the economic regions responsible for the majority of the global capital flow. My paper differs from this existing literature by studying the experiences of countries within Europe, which can all be considered advanced. In order to generate capital flows in economies with similar levels of financial development and demographics, I introduce a new source of asset market asymmetry: the share of the economy that is constituted by pure profits.

A closely related strand of literature charts 'secular stagnation': a global decline in natural interest rates. Whereas the global imbalances literature focuses on differences between asset markets across countries, the secular stagnation literature focuses on how global asset markets change over time. A number of recent contributions have linked the declining interest rate with a trend of rising market power (De Loecker, Eeckhout, and Unger (2020), Liu, Mian, and Sufi (2019)). The mechanism in my paper, whereby higher profit rates suppress asset supply, functions similarly. Mian, Straub, and Sufi (2020), instead, link declining interest rates to growing inequality. The mechanism in their paper relies on heterogeneities in saving behaviour of different population groups. In my paper a similar mechanism links profit rates, through the higher propensity to save by the recipients, to higher asset demand. In my paper, the two mechanisms are brought into motion through trade in imperfectly competitive markets and are the driver of cross-border capital flows.

The central element of my model is heterogeneous profit rates which arise due to oligopolistic competition. Recently, there has been a resurgence in the use of oligopolistic competition models to study the behaviour of markups in both macroeconomics (Edmond, Midrigan, and Xu (2018), Burstein, Carvalho, and Grassi (2020)) and the trade literature (Bernard et al. (2003), Atkeson and Burstein (2008), Gaubert and Itskhoki (2018)). That the aggregate profit rate is shaped by the heterogeneous markups at a firm level is a standard result in this literature. However, the observation that it is the second moment of the firm productivity distribution that determines the level of aggregate profits is, to the best of my knowledge, novel. A closely related point is made in Gaubert, Itskhoki, and Vogler (2021), who argue that industrial policy targeted at the largest firms in the economy can boost the domestic economy at the expense of its trading partners. Inasmuch as such policy amounts to producing a more skewed distribution of firm sizes in the economy, it acts to make the home economy more competitive in the sense presented in this paper. Thus, this paper offers a connection between industrial policy as widely practiced, and a notion of competitiveness.

A number of papers have focused on the nexus of capital flows, trade and TFP. Gopinath et al. (2017), Benigno and Fornaro (2014) and Reis (2013) argue that capital inflows can lead to declines in TFP as they increase the misallocation of capital. Interestingly, two of the above papers make pre-crisis Europe their case study. Inasmuch as each of these papers takes capital flows as given, my paper can be viewed as taking one step back and asking what can explain the direction of these flows. The closest paper to mine is by Ferra (2021), which too focuses on North-South capital flows in pre-crisis

Europe. In it, capital flows are instigated by implicit subsidies to holdings of assets generated in Southern economies. The mechanism proposed in this paper is distinct and can be viewed as complementary.

The organization of this chapter is as follows. In Section 2.2, I discuss capital flows and firm performance in Europe on the eve of the Global Financial Crisis. Section 2.3 presents a two-country stylized model where oligopolistic competition between firms gives rise to capital flows.

2.2 Capital flows and firm performance in pre-GFC Europe

In this section, I discuss capital flows in Europe between years 1998 and 2007, alongside the evidence on the performance of Northern and Southern firms in the same period. The empirical regularities presented in this section are purely descriptive, and aim to set the stage for the modelling in Section 2.3 and quantitative exploration in the next chapter.

Financial integration in European Union. In the late 1990s Europe underwent a period of financial liberalization, involving wide ranging legal and regulatory harmonization in the financial markets and, ultimately, adoption of the Euro by twelve economies in 1999-2001 (see Kalemli-Ozcan, Papaioannou, and Peydró (2010) for a detailed discussion). The increased financial integration between the European states has led to a significant increase in intra-European cross-border financial linkages. At the same time, large current account imbalances opened up among the member states.

The current account dynamics followed a clear geographic pattern: over the period, Northern economies (Sweden, Netherlands, Germany, Austria, Finland, Belgium, Denmark and France) have accumulated current account surpluses, whereas Southern economies (Greece, Italy, Spain, Cyprus and Portugal) have instead been running increasingly large current account deficits.[2] Figure 2.1, below, presents the group average current account to GDP ratio for the two groups. At the pre-crisis peak, in 2006, the imbalances constituted 4.5% of the GDP, on average, in Northern economies, and -8% of GDP in the Southern economies. In addition to large magnitudes, the imbalances were also very persistent: out of the eight Northern economies, six – with the exception of Germany and Austria – were in surplus every year between 1999 and 2007. Germany and Austria ran surpluses from 2002 onward. Greece, Spain and Portugal have been

2. The capital flows into Ireland followed a very similar dynamic to that of the Southern economies. Thus, commentators often speak of 'periphery' – Southern economies plus Ireland – and 'core' economies. In the rest of the article I rely on firm-level data which is unavailable for Ireland. Thus, I use 'North' versus 'South' grouping.

running deficits from 1994 to 2007 inclusive, with Cyprus joining in 1999 and Italy in 2004.

This buildup of imbalances, and the associated accumulation of foreign liabilities by the Southern economies, is widely believed to have contributed to the European sovereign debt crises of 2012 (Giavazzi and Spaventa 2011; Lane 2012; Martin and Philippon 2017). In light of the risks that the debt crises posed to the existence of the monetary union, the ECB has since turned to study the drivers behind the imbalances. One statistic, in particular, has been guiding the discussion: during the pre-crisis period, Southern economies have seen a marked increase in the unit labour costs (see Panel (b) in Figure 1). An increase in the North was comparatively mild. Interpreted as a 'failure to remain competitive' on the part of the Southern economies, this formed one narrative as to the origin of imbalances (discussed, for example, in Dieppe et al. (2012) and Bützer, Jordan, and Stracca (2013)). The policy implication of this reading has been repeated calls for structural reforms in the South to 'restore competitiveness' in order to wind down the net foreign liabilities and fend off the return of the deficits (see, for example, Angelini, Ca'Zorzi, and Forster van Aerssen (2016), Rodriguez-Palenzuela and Dees (2016), and Zorell (2017), as well as speeches by Trichet (2011) and Draghi (2012)).

High unit labour costs are thought to affect 'competitiveness' inasmuch as they feed into the prices the firms charge, making the firm's output relatively less attractive. In the next segment, I show that on the eve of the GFC, Southern firms indeed underperformed when compared to their Northern counterparts.

Firm performance in pre-GFC Europe. To compare the performance of firms in different European economies I need a firm level dataset with widest possible coverage. For this I am using Orbis Historical by Bureau van Dijk Electronic Publishing: the best publicly available database for comparing firm panels across countries (Kalemli-Ozcan et al. (2015)). The dataset covers millions of firms in Europe and, crucially, covers both private and public firms. Despite this, the coverage still varies by country and year. To address the issue of representativeness, I work with the sample recommended by Bajgar et al. (2020), featuring Belgium, Germany, Finland, France, Italy, Portugal, Spain and Sweden, and focus on year 2007 – a year with the best coverage in the pre-GFC period. The firms are assigned to a 4-digit industry, which I further classify as either tradable or non-tradable following Mian and Sufi (2014). See Appendix D for description of the dataset.

First, I argue that Northern economies produced disproportionately more 'market leaders' in the tradable industries. Let the market comprise of all firms in the same

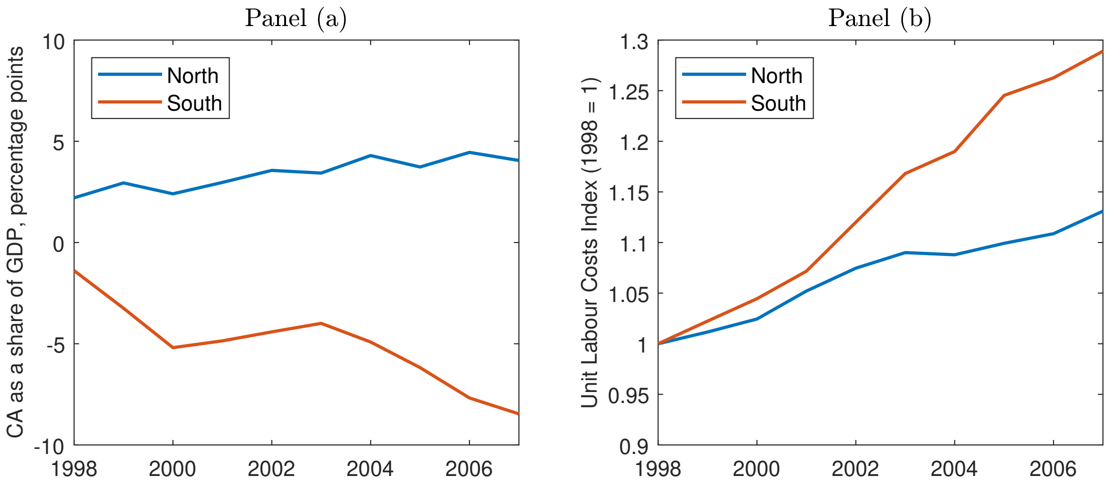

Figure 2.1: Current Account Imbalances and Unit Labour Costs in Europe

Notes: Panel (a): group average current account balances as a share of GDP. North includes Germany, Netherlands, Sweden, Denmark, Belgium, Finland, Austria, France. South includes Italy, Spain, Portugal, Greece. Panel (b): group average nominal unit labour cost index (1998 = 100). Sources: Eurostat and WEO.

4-digit industry across the eight economies in the sample.[3] One would expect that the share of sales by the firms from any one economy in this market would be proportional to the economy's GDP. The first two columns of Table 2.1 report the relative GDP (Column 1), and the share of sales in my Orbis sample that is represented by firms from each of the economies (Column 2). With the exception of Germany, which is somewhat underrepresented, and Belgium which is overrepresented, the numbers in the first two columns are indeed close. Now, consider a sample of 'market leader' firms – defined as the Top-x largest firms in the market.[4] Columns (3) to (7) report the share of

3. This definition of the market is stylised: if trade is costly, markets become segmented geographically. Without the data covering firm-level sales by destination, I am restricted to considering one common market. Additionally, focusing on eight economies only leaves out the firms from any other origin from my market definition. However, their presence leaves the relative size of sales shares represented by firms from economies in my sample intact.

4. One concern when studying the relationship between the prevalence of market leader firms in an economy and current account imbalances is that many large firms are multinationals. This introduces two potential problems for the analysis. First, multinational firms are known to engage in profit shifting: a practice of moving of the profits made elsewhere into a tax haven. This typically involves misreporting of intra-firm cross-border trade and financial flows. However, Hebous, Klemm, and Wu (2021) show that due to the double entry nature of the current account, profit shifting distorts the components of the current account, but not its overall balance. Thus, current account imbalance statistics are invariant to the profit shifting activity of multinational firms. Second, multinational firms generate both sales and profits in different countries of operation. Should these be recorded in the country of the headquarters (consolidated-) or of the subsidiary (unconsolidated accounts)? For the model presented in Section 2.3, the right measure are the consolidated accounts if the subsidiaries are always a shell for

sales among market leaders represented by firms from each of the eight economies. The shares of German, Belgian, French and Swedish firms increase as we consider narrower and narrower definition of market leaders. The opposite is true for Italian, Spanish and Portuguese firms. To see this more clearly, in Figure 2.2 I plot the results from the table, normalizing each country's share to 1 in the full sample. What emerges from the exercise is that German, Belgian and French firms are about quarter as likely to be amongst the top ten firms in any one industry than what the size of the country would suggest. Meanwhile, the prevalence of firms from Italy, Spain and Portugal amongst the market leaders is 60% of what their size would suggest. In other words, Northern economies disproportionally produce market leaders across industries, while as Southern firms are noticeably underrepresented.

	GDP	Sample	Top-100	Top-50	Top-25	Top-10
Finland	2.2	2.0	2.0	2.0	2.0	2.2
Sweden	4.3	5.1	5.2	5.5	5.4	5.5
Belgium	4.3	7.2	8.2	8.5	8.5	9.1
Germany	30.4	24.5	26.7	29.1	27.7	31.8
France	23.4	23.2	24.7	26.0	25.3	27.8
Italy	19.9	22.3	19.3	16.7	18.2	13.7
Spain	13.4	13.3	11.9	10.6	11.2	8.6
Portugal	2.1	2.4	1.9	1.6	1.8	1.4

Table 2.1: Market Leader Firms by Country of Origin

Notes: Entries in each column are shares of the (column) total, in percentage points. Column (1) contains shares of the total GDP. Columns (2) to (7) contain the share of sales in the given slice of the sample (where 'Sample' stands for the Orbis sample of all the firms in tradable industries, and 'Top-x' is the sub-sample with only top x largest firms in any one 4-digit industry retained) by firms that are domiciled in a given country.

Second, Northern firms also enjoyed higher profit rates, compared with their Southern counterparts. I obtain profit rates at a firm level by dividing the 'Profit (Loss) for Period' variable by the 'Operating Revenue / Turnover' and multiplying through by 100. I obtain aggregate profit rates as revenue weighted average firm profit rates. Panel (a) of Figure 2.3 below shows that Northern economies saw higher aggregate profit rates than

tax evasion and do not engage in production. On the other extreme, if subsidiaries generate value and retain their profits in the country of the operation, the right measure are the consolidated accounts. If firms engage in both, neither captures the model-consistent profit rates. In what follows, I focus on the unconsolidated accounts. Inasmuch as economies that generate disproportionately more superstar firms tend to generate more multinational firms, the unconsolidated accounts produce a more conservative estimate of the differences in the aggregate profit rates across the economies.

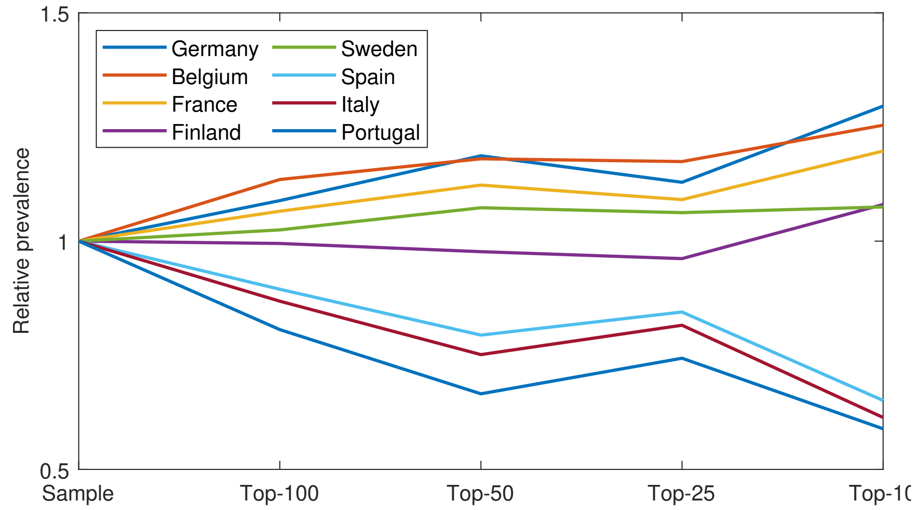

Figure 2.2: Market Leader Firms by Country of Origin

Notes: On the y-axis is the share of sales in the given slice of the sample (where 'Sample' stands for my full sample and 'Top-x' is the sub-sample with only top x largest firms in any one 4-digit industry retained) by firms that are domiciled in a given country, normalized by the share of the sales represented by firms from that country in the full sample.

their Southern counterparts. The pattern is also present, and is much more pronounced if we focus on the tradable sectors only (Panel (b)), with Northern firms enjoying profit rates twice as high as those in the South.

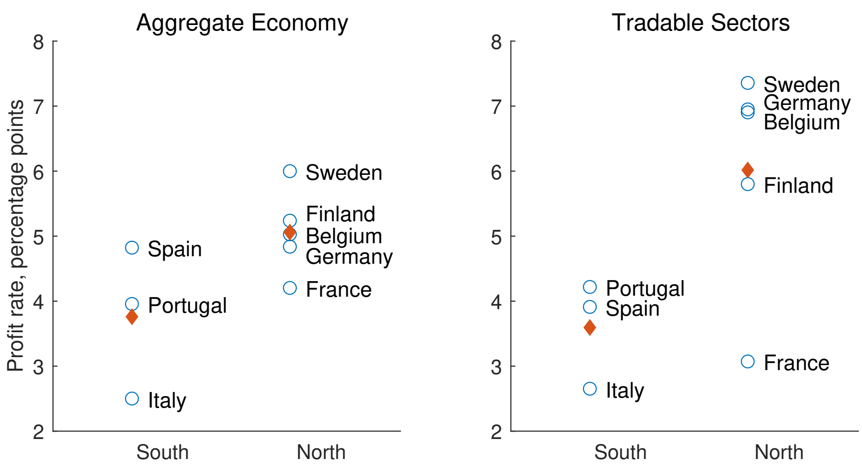

Figure 2.3: Aggregate Profit Rate and the Profit Rate in the Tradable Sectors

Notes: Aggregate profit rates in the whole economy and tradable sectors only, computed using the Orbis firm-level profit rates and aggregated using revenue weights. Red diamonds mark the group average profit rate.

Finally, Figure 2.4 shows that the current account imbalances that countries in Europe have seen in the pre-crisis period are associated with the relative performance of their firms on the eve of the GFC. In the first two panels I plot: (a) the prevalence among the Top-10 firms in an average industry and (b) the average profit rates in the tradable sector, against the average current account imbalances between years 1998 and 2007. Each of the measures of relative firm performance correlates with the current account in the pre-crisis period. Panel (c) shows that the unit labour cost increases between 1998 and 2007, likewise, correspond in magnitude to the current account imbalances incurred in the period. Note that the plots reveal no more than a correlation. I now turn to a model that can generate these patterns qualitatively in a tractable general equilibrium model with oligopolistic competition and non-homothetic asset demand.

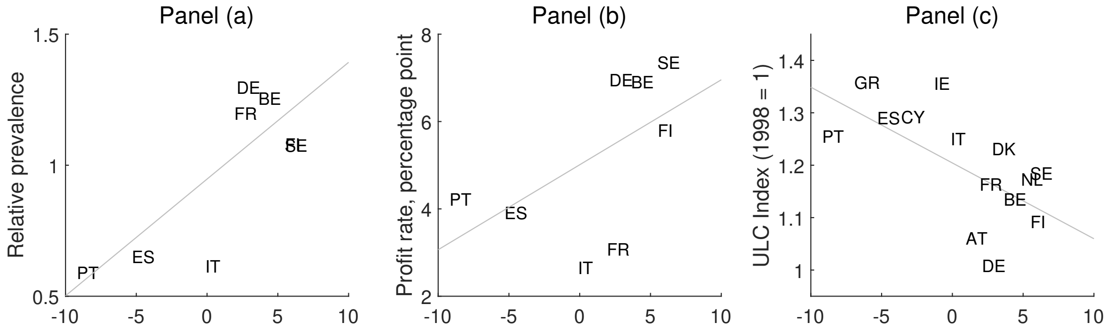

Figure 2.4: Competitiveness Gap and Current Account Imbalances

Notes: The x-axis plots the average current account balance between years 1998-2007 in each of the panels. On the y-axis, Panel (a): the share of sales in the Top-10 sample (sub-sample with only largest ten firms in each 4-digit industry retained) by firms that are domiciled in a given country, normalized by the share of the sales represented by firms from that country in the full sample; Panel (b): aggregate profit rate in the tradable sector; Panel (c): the value of the unit labour costs index (1998 = 1) in 2007.

2.3 Stylized model

In this section, I first outline the setup of the two-country model where firms compete oligopolistically. I then define a notion of country-level competitiveness. I then proceed by characterizing the steady state of the model under financial autarky and financial integration, and discuss the transition between the two following an episode of financial liberalization.

2.3.1 Model setup

The model features two countries, home and foreign. Foreign variables are marked by asterisks. There are N firms in each economy producing heterogeneous varieties, and a final good producer that combines the varieties into a final good. There are two types of households in each economy: workers and capitalists. Home and foreign are symmetric, with the exception of firm productivities and the population L, L^*. I derive the optimality conditions for the domestic firms and households, suppressing the corresponding conditions for the foreign for ease of exposition. I then characterize the equilibrium of the model. The model is kept intentionally simple to aid tractability, several extensions are added in the next chapter.

Firms in the common market. Domestic firms are indexed by $n \in N$. They are heterogeneous in their productivity z_n and produce using a Cobb-Douglas production function, taking capital and labor as inputs:

$$q_n = z_n k_n^{\alpha} l_n^{1-\alpha}, \quad \alpha \in [0, 1).$$

Intermediate goods can be traded costlessly across states. The intermediate goods are combined into a final good by a final good producer, using a CES technology with an elasticity of substitution $\sigma > 1$:

$$Q = \left[\sum_{n \in M} q_n^{\frac{\sigma-1}{\sigma}} + \sum_{n^* \in M^*} q_{n^*}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}},$$

where M, M^* are the subsets of firms that operate in equilibrium. The final good market is perfectly competitive. The final good is non-tradable.

The finite number of firms results in oligopolistic competition structure in the intermediate goods market. I assume that firms compete on quantity, à la Cournot. Atkeson and Burstein (2008) show that in this case, firm prices and sales shares are jointly determined by the firm profit maximization conditions and the final good producer demand for intermediate goods, such that firm n's price P_n is

$$P_n = \frac{\sigma}{\sigma - 1} \frac{c_n}{1 - s_n}, \quad \text{where} \quad c_n = \left(\frac{w}{1-\alpha} \right)^{1-\alpha} \left(\frac{r}{\alpha} \right)^{\alpha} \frac{1}{z_n}, \tag{2.1}$$

w is the wage, r is the rental cost of capital, c_n is the marginal cost of production of firm n, and s_n is firm n's sales share in the common market:

$$s_n = \frac{y_n}{\sum_{n \in M} y_n + \sum_{n^* \in M^*} y_{n^*}} = \frac{P_n^{1-\sigma}}{\sum_{n \in M} P_n^{1-\sigma} + \sum_{n^* \in M^*} P_{n^*}^{1-\sigma}}. \tag{2.2}$$

Firms with lower production costs c_n have higher sales shares and higher markups. I assume that there are no operation fixed costs.[5] This means that all N firms at home and abroad operate in equilibrium: $M = M^* = N$. Firm profit rate, i.e. the share of profits in its revenue, is linear in firm's sales share:

$$\pi_n = \frac{\Pi_n}{y_n} = \frac{y_n - c_n q_n}{y_n} = 1 - \frac{c_n}{P_n} = \frac{1}{\sigma} + \frac{\sigma - 1}{\sigma} s_n. \tag{2.3}$$

Firm-level factor demand comes from their optimality conditions:

$$r k_n = \alpha c_n q_n = \alpha (1 - \pi_n) y_n, \tag{2.4}$$

$$w l_n = (1 - \alpha) c_n q_n = (1 - \alpha)(1 - \pi_n) y_n.$$

Foreign firms operate symmetrically, yielding optimal $\{s_n^*, \pi_n^*, k_n^*, l_n^*\}$ for each firm.

Households. There are two types of households in the economy: workers and capitalists, of measures $(1 - \mu)L$ and μL respectively. Workers supply labor inelastically and earn labor income w. Capitalists also work and earn wages, but, in addition, they are the recipients of the firm profits. Let Π be the aggregate firm profits in the economy. I assume that the firm ownership is pooled across the capitalist households, so each receives $\frac{\Pi}{\mu L}$.

I assume that firm ownership is not transferable. This would be the case if the claims to future profits are not contractible. I make this stringent assumption to match qualitatively the relatively low market capitalization in Europe, and relax it in the quantitative version of the model in the next chapter.

Household utility increases in consumption of the final good. The budget constraint for workers and capitalists is as follows:

$$C^w + s^w = r a^w + w, \tag{2.5}$$

$$C^c + s^c = r a^c + w + \frac{\Pi}{\mu L}, \tag{2.6}$$

5. No fixed costs assumption is made to permit closed form solutions in the stylised model. I relax the assumption of no fixed costs in the next chapter.

where C^i is per-capita consumption by each of the household types, s^i is the period savings, and a^i are the assets held by each household. Capital does not depreciate, so the rental rate of capital and the return on asset holdings is the same, r. I focus on the steady state, so time subscripts are suppressed and $s^i = 0$ for both household types.

For the purposes of the stylized model, I characterize households by an asset demand that is proportional to their per-capita, non-financial income by a factor ζ_i:

$$a^w = \zeta^w w, \quad a^c = \zeta^c \left(w + \frac{\Pi}{\mu L} \right), \tag{2.7}$$

where a^w and a^c are assets held by each household in the worker and capitalist segments of the population. I assume that $\zeta^c > \zeta^w$.[6]

This setup, in a reduced form, captures the idea that asset demand is non-homothetic: the richer, in per-capita terms, capitalist households demand more assets as a share of their non-financial income. This idea has a rich history in economics, dating back to Fisher (1930), and has been supported empirically (Dynan, Skinner, and Zeldes 2004; Straub 2018; Fagereng et al. 2019). Non-homothetic saving behaviour has recently made a return as an explanation for the global fall in natural interest rates, referred to as 'secular stagnation'. There are many possible reasons for the asset demand to feature non-homotheticity. E.g., De Nardi (2004) models it as arising due to the households treating bequests as a luxury good, while Straub (2018) finds that each of non-linear social security system, non-homothetic preferences for bequests and non-homothetic preferences for the distribution of consumption across periods play a role in explaining the disproportionate asset holdings of the rich. Since such non-homothetic asset demand functions do not give rise to closed form policy functions, I defer a full specification of a non-homothetic asset demand until the next chapter, and for now replace it with behavioural equations in (2.7). As I will show, the fully fledged model, in aggregate, behaves very similarly to this reduced specification. Per-capita asset holdings in foreign are symmetric and are denoted by a^*_w, a^*_c.

Markets clearing. The model is closed by pricing the factors of production: capital and labor. Aggregating across firms, home capital demand satisfies:

$$rK = \sum_{n \in N} \alpha(1 - \pi_n) y_n = \alpha(1 - \pi) Y, \tag{2.8}$$

6. One way to formalize this saving behaviour is to specify the preferences of the household as directly dependent on the assets relative to the preferred asset holding level: $u(C^i_t, a^i_t) = C^i_t I(a^i_t = \tilde{a}^i)$, where $\tilde{a}^i$ is the desired asset holdings as per equation (2.7), and function I takes value of one if $a^i_t = \tilde{a}^i$, and zero otherwise. If non-financial income unexpectedly deviates from its steady state level by dy^i at t, then $s^i_t = \zeta^i dy^i$, and $dC^i = -s^i_t$.

where $Y = \sum_{n \in N} y_n$ is the aggregate sales in the economy and π is the aggregate profit rate in the economy:

$$\pi = \frac{\sum_{n \in N} \Pi_n}{\sum_{n \in N} y_n}. \tag{2.9}$$

Asset demand A can be obtained by summing up individual asset demands of domestic workers and capitalists:

$$A = \mu L a_c + (1-\mu) L a_w = \mu L \zeta_c (w + \frac{\Pi}{\mu L}) + (1-\mu) L \zeta_w w. \tag{2.10}$$

If the two economies are in financial autarky, that is the capital flows across borders are forbidden, then capital markets clear domestically (Case (a)). If instead capital can flow freely across borders, then capital markets clear globally (Case (b)) and the interest rates are equalized at home and abroad at some global level r^G:

$$K = A, \tag{2.11a}$$

$$K + K^* = A + A^*, \quad r = r^* = r^G. \tag{2.11b}$$

Wage ensures that the labor supplied by the households satisfies the labor demand of the firms:

$$wL = \sum_{n \in N} (1-\alpha) c_n q_n = (1-\alpha)(1-\pi) Y. \tag{2.12}$$

Aggregate profits in the economy are the sum of firm-level profits:

$$\Pi = \sum_{n \in N} \pi_n y_n. \tag{2.13}$$

Home output is the sum of the sales of domestic firms:

$$Y = \sum_{n \in N} y_n.$$

The foreign is symmetric and yields a set of $\{K^*, A^*, r^*, w^*, Y^*\}$. Finally, I normalize the global expenditure to 1:

$$Y + Y^* = 1. \tag{2.14}$$

This completes the model setup.

Definition 1: **(Steady state equilibrium)** An equilibrium is a sequence $\{s_n, s_n^*, r, r^*, w, w^*, \Pi, \Pi^*\}$ such that (i) each firm's share of the common market satisfies the firm's optimal pricing equation (2.1) and the final good producer's demand (2.2), (ii) the interest rates equalize the aggregate capital demand given in (2.8) and asset demand given in (2.10) subject to the capital market clearing condition (2.11a) in the case of autarky and (2.11b) in the case of financial liberalization, (iii) wages satisfy the respective labour market clearing conditions (2.12), and (iv) aggregate profit rates follow (2.13). The goods markets clear by Walras' law.

2.3.2 Competitiveness, profits and superstar firms

In this subsection, I use the model developed in subsection 2.3.1 to discuss a notion of country-level competitiveness.

From firm-level to country-level competitiveness. It is helpful to begin by discussing what it means for an individual firm to be competitive. A firm is competitive if it performs better than its competitors in the common market. In the simple model of oligopolistic competition presented above, a source of competitiveness of a firm is its cost advantage in the form of relatively low unit production cost c_n. This means that the firm is able to offer a lower price than that of the competitors, attracting a larger share of the market s_n. Being a more competitive firm also translates into charging a higher markup and commanding a higher profit rate π_n. Let $ulc_i = w/(P_i z_i)$ be the price-adjusted unit labour costs of production. In the model, the three objects are linearly related as per equation (2.3):

$$\frac{ulc_i}{1-\alpha} = \frac{\sigma - 1}{\sigma}(1 - s_i) = 1 - \pi_i.$$

This firm-level notion of competitiveness can be generalized to think about country-level competitiveness. Consider the following definition: an economy is competitive in international trade if its firms are competitive. To operationalize this notion, consider the aggregate counterparts to firm level unit production costs, market share and the profit rate:

$$ulc = \sum_{n \in N} d_i ulc_i, \quad s = \sum_{n \in N} d_i s_i, \quad \pi = \sum_{n \in N} d_i \pi_i,$$

where $d_i = y_i / \sum_{n \in N} y_i$ is the Domar share of firm i in the home economy. The first term is the aggregate unit labor costs of production, equal to the ratio of real wage to productivity. The second term is the weighted average share of domestic firms in the common market. The third term is the aggregate profit rate. As before, the three terms are linear transformations of each other:

$$\frac{ulc}{1-\alpha} = \frac{\sigma - 1}{\sigma}(1 - s) = 1 - \pi.$$

Finally, note that the average market share s can be rewritten as follows:

$$s = \frac{\sum_{n \in N} s_i^2}{\eta}, \quad \text{where} \quad \eta = \frac{Y}{Y + Y^*}.$$

This alternative presentation aids the economic interpretation of the average share of domestic firms in the common market, s. An economy with a small population will necessarily have a limited presence in the world markets. However, it may still be an important player internationally. One way to measure this is to ask: how many market leaders (firms with $s_i^2 \gg 0$) does home produce, given its share of the world economy η? I argue that the three metrics can be used interchangeably to measure country-level competitiveness.

Definition 2: **(Competitiveness)** Home economy is more competitive than foreign if, interchangeably: (i) its aggregate unit labor costs of production are lower than in foreign, $ulc < ulc^*$; (ii) it produces relatively more market leaders given its size, than foreign, $s > s^*$; (iii) it commands a larger aggregate profit rate than foreign, $\pi > \pi^*$.

Part (iii) of the definition is equivalent to stating that home commands a large share of the profits made in the common market, in relation to its size:

$$\pi > \pi^* \quad \rightarrow \quad \frac{\Pi/(\Pi + \Pi^*)}{\eta} > 1.$$

A few observations are in order. First, note that unit labour cost are often used as a metric of country-level competitiveness in policy reports. In my setup, these constitute a meaningful measure of country-level competitiveness. Second, observe that in a model with perfect or monopolistic competition, $ulc = ulc^*$. In other words, this popular measure of competitiveness is meaningless, in the long run, in a wide range of models commonly used. Thus, the notion of competitiveness cannot be used atheoretically. I turn to discerning the relationship between oligopoly, superstar firms and country-level competitiveness next.

Fundamental determinants of competitiveness. Each of the unit labor cost of production, average share of the common market and the aggregate profit rate are endogenous objects in the model. Meanwhile, the fundamental source of heterogeneity among countries in the model is the differing productivities of their firms. Thus, in order to understand what, at a fundamental level, makes for a competitive economy, one needs to understand how firm-level productivities affect each of the endogenous metrics for country-level competitiveness.

Let firms be indexed such that the productivities of domestic firms decline in n: $z_1 \geq z_2 \geq ... \geq z_N$. Consider unit labour costs, $ulc = w/y$, where $y = Y/L$ is output per worker. The derivative of the unit labour costs with respect to the firm i's productivity is proportional to the difference between the elasticities of wage and output per worker, both with respect to the firm i's productivity:

$$\frac{dulc}{dz_i} \propto \frac{dw/w}{dz_i/z_i} - \frac{dy/y}{dz_i/z_i}.$$

Moreover, both elasticities are positive: a higher productivity of firm i simultaneously makes for higher output per worker and pushes up the workers' wage. Thus, the effect of firm i's productivity on the aggregate unit labour costs is ambiguous. An increase in the productivity of any one firm does not necessarily make an economy more competitive. In Appendix E.1 I show that:

$$\frac{dw/w}{dz_1/z_1} < \frac{dy/y}{dz_1/z_1}, \quad \text{and thus} \quad \frac{dulc}{dz_1} < 0.$$

Moreover, if $2s_z \leq s$, i.e. if the firm productivity distribution is sufficiently dispersed, then

$$\frac{dw/w}{dz_N/z_N} \geq \frac{dy/y}{dz_N/z_N}, \quad \text{and thus} \quad \frac{dulc}{dz_N} \geq 0.$$

In other words, an increase in productivity of the *most productive* firm decreases the unit labour costs, and if there is sufficient dispersion in firm productivities, then an increase in productivity of the *least productive* firm pushes them up. Thus, it is having more extreme draws for the most productive firms, i.e. many 'superstar firms', that renders an economy competitive.

Proposition 1: **(Fundamental driver of competitiveness)** Country-level competitiveness increases if its draws of firm-level productivity are more extreme in the right tail.

Note that this relationship relies crucially on oligopolistic competition where largest firms earn higher rents. The most productive firm in the economy has the largest market share among the domestic firms. The most productive firm in the economy also hires the most labour. However, under oligopolistic competition, the Domar share of the largest firm is larger than its labour share: $d_1 > l_1$. Not only are firms restricting their supply (and therefore inputs) to earn rents, but the most productive firms do so more. As a result, a superstar firm that expands does not lift the wages much, thereby pushing the unit labour costs down.

In sum, at a fundamental level, an economy is competitive if it features relatively many very large 'superstar' firms. The oligopolistic behaviour of such firms makes for relatively low wages given the country's productivity.

Discussion. In a series of articles, Paul Krugman speaks of country-level competitiveness in no uncertain terms: "[L]et's start telling the truth: competitiveness is a meaningless word when applied to national economies" (Krugman 1994, 1996). The reason for this, he argues, is that intuitions that apply at a level of individual firm break down in the aggregate due to the forces of general equilibrium. Country-level competitiveness, he concludes, is 'poetic way of saying productivity' at best, and a 'dangerous obsession' at worst. The discussion in this subsection clarifies several points in this argument. First, for many commonly used market structures, the general equilibrium forces indeed make the notion of competitiveness meaningless at the national level. However, oligopolistic competition with its strategic behaviour of firms restores the role for country-level generalizations of firm-level competitiveness. Finally, it also clarifies that productivity and competitiveness are distinct: an increase in aggregate productivity may be associated with a decline, no change, and an increase in country-level competitiveness, depending on where in the firm distribution the increase in productivity originates.

2.3.3 Competitiveness, profits and capital flows

Having defined country-level competitiveness and linked it to the prevalence of superstar firms, I now turn to discussing how one of the facets of competitiveness – high aggregate profit rate – interacts with the asset markets.

Steady state under financial autarky. Consider the case of autarky first. The autarkic interest rate r_a clears the domestic asset market:

$$K = \frac{\alpha}{r_a}Y(1-\pi) = \zeta_c(\mu(1-\alpha)(1-\pi)+\pi)Y + \zeta_w(1-\mu)(1-\alpha)(1-\pi)Y = A,$$

where the right-hand side has the per-capita income of the workers and capitalists expressed as a share of GDP using equations (2.9) and (2.12). Note that both the capital demand (thus, asset supply) and household savings (thus, asset demand) are functions of the aggregate profit rate. Consider each in turn.

Aggregate demand for capital as a share of GDP declines in the aggregate profit rate:

$$\frac{K}{Y} = \frac{\alpha}{r_a}(1-\pi), \quad \frac{d\frac{K}{Y}}{d\pi} < 0.$$

This result is closely linked to discussion in subsection 2.3.2: firms that compete oligopolistically restrict their supply to earn rents, which in turn means that fewer inputs are used, in relation to sales. Another way to think about it is to note that firms that command large market power will have a larger share of their revenue construed by rents, as opposed to value added. A lower value added share, for a given interest rate, will require less inputs as a share of sales. At an aggregate level, the more market power the domestic firms hold – the lower will be the aggregate demand for capital as a share of GDP.

Aggregate asset holdings as a share of GDP increase in the aggregate profit rate:

$$\frac{A}{Y} = \zeta_c(\mu(1-\alpha)(1-\pi)+\pi) + \zeta_w(1-\mu)(1-\alpha)(1-\pi), \quad \frac{d\frac{A}{Y}}{d\pi} > 0. \tag{2.15}$$

Aggregate asset holdings are proportional to the average asset holdings in the economy. A higher profit rate redistributes the income in the economy towards the capitalists and, therefore, towards the demographic with a higher demand for assets, raising the aggregate.

Higher aggregate profit rate simultaneously suppresses the asset supply and increases the asset demand, both as a share of GDP. The two effect a decline in the autarkic interest rate:

$$r_a = \frac{\alpha(1-\pi)}{\zeta_c(\mu(1-\alpha)(1-\pi)+\pi) + \zeta_w(1-\mu)(1-\alpha)(1-\pi)}, \quad \frac{dr_a}{d\pi} < 0. \tag{2.16}$$

Since all the parameters other than firm productivities are symmetric between home and foreign, the following proposition holds.

Proposition 2: **(Steady state under financial autarky)** If home is more competitive than foreign, then in the steady state under financial autarky home's autarkic interest rate is lower than in foreign.

Steady state under financial integration. If capital is allowed to flow freely, the home and foreign interest rates will be equalized at some global level r^G and the global capital market will clear subject to (2.11b). It can be shown that the global interest rate will be a function of the global profit rate π^G:

$$r^G = \frac{\alpha(1-\pi^G)}{\zeta_c(\mu(1-\alpha)(1-\pi^G)+\pi^G) + \zeta_w(1-\mu)(1-\alpha)(1-\pi^G)}, \tag{2.17}$$

where $\pi^G = \eta\pi + (1-\eta)\pi^*$ is a weighted average of the home and foreign profit rates and $\eta = Y/(Y+Y^*)$.

Under financial integration, home asset demand need not be satisfied by domestic assets. Countries can both lend and borrow, taking up positive and negative net foreign asset positions. Using equations (2.16) and (2.17) one can show that home net foreign assets as a share of GDP will be a function of the aggregate profit rate differential at home and abroad:

$$\frac{NFA}{Y} = \frac{A-K}{Y} = \zeta_c(1-\eta)\frac{(\pi-\pi^*)}{1-\pi^G}. \tag{2.18}$$

Proposition 3: **(Steady state under financial integration)** If home is more competitive than foreign, home's net foreign asset position is positive in the steady state under financial integration.

Inasmuch as profits distort asset supply and affect asset demand differentially in the two economies, they will encourage capital flows from a low autarkic interest rate economy to a high autarkic interest rate economy, until in the steady state the two are holding positive and negative net foreign asset positions respectively.

Transition between autarky and financial integration. Suppose the two economies start in autarky and then suddenly undergo full financial liberalization at the time period t. Since in my setup there are no adjustment costs and households do no consumption smoothing (this assumption is relaxed in Section 3.2), the economies jump to the financial integration steady state equilibrium at time $t+1$. The economies run current account imbalances during the transition.

Proposition 4: **(Financial liberalization with no trade costs)** If home is more competitive than foreign and the two economies undergo financial liberalization at t, home runs a current account surplus at $t+1$:

$$ca = \frac{CA}{Y} = \frac{NFA}{Y} = \frac{A-K}{Y} = \zeta_c(1-\eta)\frac{(\pi-\pi^*)}{1-\pi^G}.$$

Foreign runs current account deficits. Current account imbalances are zero thereafter.

The instant transition to the new steady state relies crucially on the assumption of costless trade. At $t+1$, cross-country patterns of spending are away from the steady state, as capital is dismantled at home and built in foreign. However, this leads to no changes in production: the loss in domestic demand for domestically produced varieties is fully offset by the higher demand for exports to foreign:

$$y_i = s_i(Y + CA + Y^* - CA) = s_i Y^G = s_i.$$

Sales shares are thus independent of the current account. Since the steady state conditions apply, the factor prices and sales shares reach the new steady state at time $t+1$.

Suppose now that not all goods are tradable. Specifically, let there be two sectors in the economy: a sector with zero trade costs, and a sector with infinitely costly trade. Suppose that the final goods producer aggregates the two using a Cobb-Douglas production technology with weights $\gamma_T + \gamma_N = 1$. Assume that the non-tradable sector uses labour and capital with the same intensity as the tradable sector, and generates a profit rate of π_N. Take π_N as given: it will be constant under each of perfect, monopolistic, and oligopolistic competition market structures.[7] Let the tradable sector be as before.

Suppose the economies are in autarky and undergo full financial liberalization at time t. As before, the patterns of cross-country expenditure change. Now, however, capital production relies on non-tradable goods. Since these cannot be imported, more goods need to be produced in foreign to build capital. The output in foreign is temporarily above its steady state level, which exerts pressure on the costs of production in foreign. Under mild assumptions, it is possible to show that the pressure on the relative costs leads to current account overshooting at $t + 1$.

Assumption 1:

$$s_i \leq \frac{1}{\sigma} \quad \forall i; \quad \pi^N \leq \pi^T + const.$$

Proposition 5: **(Financial liberalization with a non-tradable sector)** If Assumption 1 holds, home is more competitive than foreign and the two economies undergo financial liberalization at t, then

1. The relative costs of production are suppressed at $t+1$ relative to the steady state:

$$\omega_{t+1} \leq \omega_{ss}, \quad \text{where} \quad \omega = \left(\frac{w}{w^*}\right)^{1-\alpha} \left(\frac{r}{r^*}\right)^{\alpha} = \left(\frac{w}{w^*}\right)^{1-\alpha}.$$

2. Home competitiveness is elevated at $t + 1$ relative to the steady state:

$$\pi^T_{t+1} \geq \pi^T_{ss}, \quad \pi_{t+1} \geq \pi_{ss}, \quad ulc_{t+1} \leq ulc_{ss}$$

3. Current account imbalance overshoots at $t + 1$:

$$CA_{t+1} \geq NFA_{ss}.$$

The reverse holds for foreign. For the proof, see Appendix E.2.

7. Under oligopolistic competition, the profit rate in the non-tradable sector will be pinned down by the distribution of firm productivities in the non-tradable sector, but will not depend on the factor prices as all firms in the market face the same costs of inputs.

The role of the assumptions is as follows: a decline in the relative costs of production at $t+1$ makes domestic tradable varieties cheaper to produce. This means that all domestic varieties increase their share of the common market and enjoy higher profit rates. However, since variable markups imply lower pass-through at the upper tail of firm sales, largest firms grow slower than the smallest firms. This means that the aggregate profit rate in the tradable sector might still decline due to the reallocation effect. Restricting the sales share of the largest firm to be below $1/\sigma$ ensures that such reallocation effects never dominate. Similarly, a current account surplus leads to an increase in the aggregate profit rate in the tradable sector and a reallocation of activity towards it. The aggregate profit rate in the economy increases, unless the profits in the non-tradable sector are so high as to induce a decline in the aggregate profit rate driven by reallocation. Restricting $\pi^N \leq \bar{\pi}^N = \pi^T + const$, with $const > 0$ ensures that the reallocation effect never dominates. The current account overshooting is driven by the temporary worsening in the competitiveness gap between the economies: capital flows from the more competitive home increase the costs of production in foreign, further hurting the competitiveness of foreign firms. Capital outflows likewise impact a decline in the costs of production at home. A temporary boom in profits at home produces a temporary boom in domestic asset demand and a temporary shortage in domestic asset supply. This leads to further capital outflows.

In the next chapter, I develop a quantitative version of the model and use it to study North-South capital flows in Europe on the eve of the Global Financial Crisis.

Chapter 3

The North-South Divide in Pre-Crisis Europe

In this chapter, I calibrate the quantitative version of the model developed in Chapter 2 to eight European economies on the eve of the Global Financial Crisis. I show that the competitiveness gap can explain 27% of variation in the current account imbalances incurred in the period. I conclude by discussing policies for rebalancing.

3.1 Introduction

In this chapter, I ask if the mechanism presented in the previous chapter can help us understand periods of persistent capital flows. I focus on pre-GFC Europe as a case study. To test my mechanism, I construct a quantitative trade model and calibrate it to fit eight European economies. I maintain the Atkeson and Burstein (2008) setup, but now permit costly trade and parameterize the firm distributions to be Pareto. I target bilateral trade flows and sectoral concentration in each of the economies. I use the Orbis Historical database to calibrate firm distributions in my model. I adopt the household side of the model from Straub (2018): an overlapping generations setup with non-homothetic preferences for saving. The two sources of non-homotheticity in the model are bequests which are treated as a luxury, and a preference for higher spending in old age that increases with income. The two together mean that the richer capitalist households accumulate more assets during their life cycle. I calibrate the household side of the model to match a series of moments describing the asset holdings in different groups of population.

Once the model is calibrated, I carry out a series of exercises. First, I show that an episode of financial liberalization between the eight economies leads to surpluses in the North and deficits in the South. Over the course of a decade, my model generates cumulative current account imbalances of 21%, 8% and 20% of GDP in Finland, Sweden and Germany, and −6%, −13% and −7% of GDP in Portugal, Spain and Italy respectively. This explains 27% of variation in the imbalances incurred during the pre-crisis period. The model also generates higher profit rates in the North and lower profit rates in the South, in line with the data. Thus, I argue that the gap in competitiveness did contribute to imbalances in Europe, albeit other forces have been at play. Next, I study the drivers of capital flows in the model. To do so, I conduct a decomposition exercise by re-running the model with one source of country-level heterogeneity at a time. I find that practically all of the variation in capital flows in the model is driven by heterogeneous tail parameters in firm productivity distributions. Thus, the prevalence of 'superstar' firms is the key driver of capital flows in the model.

Once the contribution of the heterogeneity in the firm performance across economies to the pre-crisis capital flows has been quantified and the key dimensions of heterogeneity for the operation of the mechanism have been discussed, I proceed, finally, to discuss a set of policies for rebalancing. I begin by discussing structural reforms that have been suggested in a number of policy reports as means to counter the buildup of current account imbalances, focusing on three interventions in particular: (i) an increase in

Southern productivity, (ii) a decrease in Southern wages, and (iii) an increase in the intensity of competition between Southern firms. I discuss each of these in turn, and show that higher productivity leaves capital flows intact, lower wages modelled as a decrease in the bargaining power of the workers acts to attenuate, and the increased competition among Southern firms acts to amplify the South-North capital flows. I argue that without a setup that models the competitiveness gap and its relationship to capital flows explicitly, a call for structural reforms is premature.

I conclude my analysis by proposing two alternative instruments that can aid rebalancing in the context of capital flows driven by the heterogeneous performance of European firms. The first proposal relies crucially on the origin of heterogeneity in the firm size distribution across economies. I show that the model with heterogeneous tail parameters of firm productivity distributions is isomorphic to a model where firms draw productivities from a Pareto distribution with common sector-specific tail parameters, and where firms are subject to country-specific size-related distortions. In a counterfactual exercise, I show that if the asymmetry in firm performance stems from size-related distortions, then removal of such distortions results in capital flows that are practically nil. The second instrument exploits a further channel through which pure profits affect asset markets: the fact that firm profit flows, if pledgeable, constitute an asset in their own right. With firms' ownership partially tradable, high profit rates act to increase the asset supply in the economy, thus counteracting the main mechanisms in the model. If the depth of the stock markets is a policy variable – I model it as a parameter controlling the share of future profits that can be traded – in the spirit of Caballero, Farhi, and Gourinchas (2008) – then it can be used to attenuate the effect that profit rate asymmetry has in the asset markets. I show that in the counterfactual where stock market capitalization is increased to match the value for the United States in 2007, the current account imbalances are reduced by 20%.

The rest of the chapter is organized as follows. In Section 3.2, I present the fully fledged quantitative trade model with asset markets and discuss calibration. Section 3.3 presents the results of the quantitative model and studies how the competitiveness gaps shaped capital flows within Europe on the eve of the Global Financial Crisis. Section 3.4 discusses the policies for rebalancing, and Section 3.5 concludes.

3.2 Quantitative Model

In this section I extend the stylized model to map more readily to the data and discuss how it is calibrated.

3.2.1 From Stylized to Quantitative Model

Fully fledged model differs from the stylized model in six ways. First, I allow for $I \geq 2$ countries and $K \geq 1$ sectors. Introducing multiple countries is straightforward: the only difference with the stylized model is that the summation in equations (2.2) and (2.14) is now over all trading partners, not just home and foreign. Multiple sectors, in turn, enter through a higher level aggregation in the final goods production function, which now becomes Cobb-Douglas in the sectoral goods with weights γ_{ik}, nested with CES at a variety level:

$$Q_i = \prod_K Q_{ik}^{\gamma_{ik}}, \quad \text{where} \quad Q_k = \left[\sum_{n \in M} q_{kn}^{\frac{\sigma-1}{\sigma}} + \sum_{n^* \in M^*} q_{n^*}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \quad \sum_K \gamma_{ik} = 1.$$

Second, I allow for costly trade. This extension is important as trade costs protect domestic firms from competition, and thus have a first order effect on aggregate profits. While costless trade yields one common market for each sector, costly trade means that there are as many (sector-level) markets as there are economies. Firms may choose whether to export, and what markup to charge on their exports, independently of their domestic sales considerations. Thus, firm sales shares and profit rates are now determined for each of the markets the firm serves, with index j marking the market: s_{jikn}, π_{jikn}. I introduce trade costs as iceberg costs, applying as a percentage over the marginal costs. Thus, costs of production are now market specific:

$$c_{jikn} = \begin{cases} \left(\dfrac{w_i}{1-\alpha} \right)^{1-\alpha} \left(\dfrac{r_i}{\alpha} \right)^{\alpha} \dfrac{1}{z_{in}} & \text{if sold domestically,} \\ \\ \left(\dfrac{w_i}{1-\alpha} \right)^{1-\alpha} \left(\dfrac{r_i}{\alpha} \right)^{\alpha} \dfrac{d_{jik}}{z_{in}} & \text{if sold in } j, \quad d_{jik} \geq 1. \end{cases}$$

Third, the number of firms operating in each market is now endogenous as firms have to pay fixed costs of operation. Fixed costs are paid per market of operation and are denominated in units of labour in the destination. Profits of firm n from country i and sector k, which it generates in market j are now

$$\Pi_{jikn} = (P_{jikn} - c_{jikn}) q_{jikn} - f w_j.$$

Firms which would have negative profits in equilibrium do not enter the market. Thus, the number of operating firms is now endogenous. Following Atkeson and Burstein

(2008), I model entry as a sequential entry game, introducing firms into the market in the increasing marginal costs order, until the marginal entrant is unable to cover the fixed costs of operation.

Fourth, I specify a parametric distribution from which firms make their productivity draws. I assume firms draw productivities from a Pareto distribution, with CDF

$$G_{ik}(z) = 1 - \left(\frac{\underline{z}_{ik}}{z}\right)^{\theta_{ik}},$$

where $\underline{z}_{ik}$ and θ_{ik} are country and sector specific cutoff- and tail parameters of Pareto distribution.

In the stylised model I assumed that firms were non-tradable. For the quantitative version of the model, I relax the assumption that future profit streams can not be capitalized into traded financial claims. Instead, I introduce limited pledgeability of such flows, parameterized by parameter λ. In this setup, I follow Caballero, Farhi, and Gourinchas (2008), who model $\lambda < 1$ since agents can dilute and divert part of the profits. This assumption changes the asset supply in the model, which now is a sum of domestically held capital K_i and the tradable share of the value of firms in the economy, λF, where $F = \sum_t^{\infty}(1 + r_t)^{-t}\Pi_t$. Furthermore, the stream of profits from the non-tradable portion of the firms that accrue to the capitalists is now reduced, at $(1 - \lambda)\Pi$.

Finally, I now introduce a fully-fledged asset demand for the two types of households. I borrow the setup from Straub (2018), stripping away the individual income- and date-of-death uncertainty to aid computation. Households are born and live for T periods in an overlapping generations manner. The birth rate is $1/T$, so the size of the population remains constant. The two groups of population, workers and capitalists, represent dynasties with no mobility between the types: workers give birth to workers and capitalists to capitalists. Within each dynasty, three generations co-exist, with each agent giving birth to one child at the age of $(T+1)/3$. Agents are economically inactive until the age of $(T+1)/3$. Agents enter labour force at age t_0. At age t_3 agents leave the workforce and stay retired until the age of death T. Labour is taxed at τ^{lab}, with the tax receipts paid out as pension transfers T^{soc} to the concurrently living retired. The only difference in the life progression between the workers and capitalists is that capitalists, as the owners of the firms in the economy, pass on the ownership (and therefore the claim to profits) to their child at the age of t_2 (when the child is aged t_1). Thus, the non-financial income of the two types of households is as follows:

$$y_s^w = \begin{cases} w(1-\tau^{lab}) & \text{if } 0 < s \leq t_3, \\ T^{soc} & \text{if } s > t_3, \end{cases} \quad \text{and} \quad y_s^c = \begin{cases} w(1-\tau^{lab}) & \text{if } 0 < s \leq t_1, \\ w(1-\tau^{lab}) + \dfrac{\Pi(1-\lambda)}{\mu L} & \text{if } t_1 < s \leq t_2, \\ w(1-\tau^{lab}) & \text{if } t_2 < s \leq t_3, \\ T^{soc} & \text{if } s > t_3. \end{cases}$$

The social security budget is balanced, so $(T - t_3)T^{soc} = (t_3 - t_0)\tau^{lab}w$. The budget constraint is standard:

$$c_t^i + a_t^i = y_t^i + (1 + r_t)a_{t-1}^i, \quad \text{where} \quad i \in \{w, c\}.$$

Agents receive inheritance from their grandparent at $(T + 1)/3$, so the asset holdings at the start of economic life are the assets held at the date of death by their grandparent, $a_0^i = a_T^i$.

Each agent has a utility function that depends on per-period consumption and on the bequest left at the time of death:

$$U = \sum_{s=T/3}^{T} \beta^s u_s(c_s^i) + U_a(a_T^i).$$

Following Straub (2018), I pick

$$u_s(c) = \frac{(c/o)^{1-\nu_s}}{1-\nu_s}, \quad \text{where} \quad \nu_s > 0,\ o > 0,$$

where ν_s is an age-dependent parameter that governs the income elasticity of consumption over the life-cycle, and

$$U_a(a) = k\frac{((a + \underline{a})/o)^{1-\nu_T}}{1-\nu_T}, \quad \text{where} \quad \sigma > 0,\ k > 0,\ \underline{a} > 0.$$

This setup generates two sources of non-homotheticity in asset holdings. First, the intercept in the bequest part of the utility function ensures that bequeathing is a luxury: richer agents will be saving more to leave a larger inheritance for their grandchild. There is extensive evidence that bequests as a share of income do indeed increase as individuals get richer (Carroll 1998; Dynan, Skinner, and Zeldes 2004). Second, I follow Straub (2018) in parameterizing ν_s to decline in age, with $\nu_{s+1}/\nu_s = \sigma^{slope} < 1$. This generates a higher late-life expenditure amongst the richer agents in the economy, thus encouraging them to accumulate assets for late-life consumption. Such late-life expenditures can be thought of as covering, e.g., college fees for the kids, expensive medical procedures or vacations during retirement, all of which are more prevalent among the higher-income households. The empirical evidence in support of the differing life-cycle expenditure patterns amongst different income groups can be found in Straub (2018). The rest of the model remains unchanged.

The endogenous variables in the quantitative model are $\{s_{jikn}, P_{jikn}, w_i, r_i, Y_i\}$ for each country $i \in I$, trade partner $j \in I$, sector $k \in K$ and firm $n \in N$, and a vector of consumption and asset holdings for each type of agent and each age: $\{c_s^w, c_s^c, a_s^w, a_s^c\}$ for $s \in T$. The parameters of the model are $\{\underline{z}_{ik}, \theta_{ik}, \alpha, d_{jik}, \gamma_{ik}, \sigma, \beta, \sigma^{slope}, \kappa, o, \underline{a}\}$ for each country $i \in I$, trade partner $j \in I$ and sector $k \in K$. The full description of the quantitative model and the definition of the steady state equilibrium can be found in Appendix F.

3.2.2 Calibration

Due to data availability limitations, I choose to calibrate the model to match the data from the year 2007, the year with the best coverage before the effects of the crisis began to be felt in Europe. I assume that by 2007 capital is freely mobile between countries, so the interest rate for all eight economies is equalized.

The model with free capital flows can be calibrated in blocks. The first block is the goods production part of the model, where the competing firms determine the country-level income, profit rates, sectoral sales and trade flows. Since the interest rate is equalized across countries and since all firms produce with the same production function, the interest rate drops out from the firm sales share equation and is thus irrelevant for the equilibrium in the goods market. This property allows me to parameterize the firm productivity distributions and trade costs that can rationalize the trade flows and sectoral concentration observed in the data independently of the asset side of the model. Once the production block is calibrated, I use the resultant global profit rate to calibrate the parameters of the household side of the model.

Data Sources

I am calibrating the model to eight economies studied in the empirical section: Belgium, Germany, Finland, France, Italy, Portugal, Spain and Sweden. To calibrate the production side of the economy, I need data on population, sectoral output, bilateral trade flows, current account imbalances and concentration. The first four I obtain from World Input-Output Database (WIOD). To measure sectoral concentration, I rely on Orbis firm-level dataset. Finally, to calibrate the household block of the model I rely on data from the OECD and Household Finance and Consumption Survey (HFCS) compiled by the ECB. I use 2010 vintage of HFCS, as the closest to year 2007.

Production Block

External Calibration: I calibrate α, the capital share in production of varieties, and σ, the elasticity of substitution across varieties in CES production of the final good, externally. I set α, the share of capital in production to 0.34, the average value for the eight economies in WIOD, and σ to 10.5 following Edmond, Midrigan, and Xu (2015). Since there are no intermediate inputs in my model, final consumption series are not consistent with the trade flows reported in WIOD. Thus, in order to calibrate final consumption shares in my model, I solve for consumption shares that would rationalize observed trade flows absent intermediate inputs use. The adjusted final expenditure series can be thought of as reflecting both direct final consumption, and indirect consumption in the form of intermediate inputs contained in the goods consumed. Since final good production function is Cobb-Douglas, I solve for parameters γ_{ik} as country specific adjusted expenditure shares. See Appendix G for details.

I set N, the number of potential firms in each country and sector to a value of 100. Recall that profit rates in the model are a function of the firm market sales share, $\pi_i = \pi(s_i)$. For low values of N the market shares in the non-tradable sectors have a lower bound at $1/N$, which in turn results in a lower bound on equilibrium profit rates. At $N = 100$, however, profit rates show little sensitivity to the number of firms operating, provided that the tail parameters of firm productivity distributions are adjusted accordingly. Note that, while in the data the number of firms per sector are orders of magnitude higher, due to the fat tailed distribution of the firm sizes, restricting analysis to the largest 100 firms does not affect the measured sectoral concentration. Setting $N = 100$ speeds up the computation time, at no expense in the fit of the model. WIOD release 2016 features 56 sectors, 23 of which are tradable. However, sector *C19* – manufacture of coke and refined petroleum products – features fewer than 100 firms in my Orbis sample for all but one country, with an average number of firms at 35. While this can be targeted at the expense of introducing sector-specific fixed costs of operation, I opt for bundling sector *C19* with sector *B* – mining and quarrying. This leaves me with 22 tradable sectors. I aggregate the remaining 33 sectors into one non-tradable sector. Thus, I set $K = 23$.

Internal Calibration: having set the external parameters, I am left with three sets of parameters in the production block to estimate internally: $\underline{z}_{ik}, \theta_{ik}, d_{jik}$. Firm productivity distribution parameters and trade costs jointly determine firm-level sales in each of the markets, which in turn shapes the patterns of bilateral trade flows and sectoral sales distributions. Thus, I calibrate the three to match the patterns observed in the data, targeting the sector- and country-pair trade shares X_{jik}/X_{ik}, where X_{jik} is the exports of sector k goods from country j to country i and X_{ik} is i's total expenditure on sector k goods, and sectoral Herfindahl–Hirschman Indices computed using Orbis firm-level data for each country and sector. I further restrict the tail parameters of the country-sector Pareto distributions to be a product of country- and sector-specific terms: $\theta_{ik} = \theta_i \theta_k$. This substantially reduces the number of parameters to estimate and prevents model over-fitting. I search over the parameter space to minimize the distance between (i) the trade shares in the data and in the model, (ii) the coefficients in the regression of HHI on country- and sector fixed effects in the data and in the model. Since the key predictions of the model depend on the calibration of country- and sectoral concentration, I present the coefficients from the HHI regression in Table 3.1 below. Note that, as shown in Section 2.3, non-zero current account imbalances affect trade flows, as well as factor prices and firm-level sales shares. In year 2007, countries in my sample run large current account imbalances. In order to back out the set of parameters that rationalize the patterns in the data in presence of such imbalances, I impose the current account imbalances as observed in the data exogenously when calibrating the trade costs and moments of firm productivity distributions. See Appendix G.2 for details.

Normalization: θ_i and θ_k can not be identified independently, so I set the tail parameter for Germany θ_{DE} to 1. In addition, only the relative costs of production matter for determining sales shares. Thus, productivities in each of the sectors can only be identified up to a constant. I normalize cutoff parameters for Germany such that the average productivity of German firms is 1 in each sector.

Household Block

The next step is to calibrate the demographics and household preferences. In parameterizing the household side, I choose a common set of parameters for all eight economies that I am modelling. I do this so that the simulated capital flows are driven by the heterogeneity on the firm side and not the household side. For this purpose, I target the average moments across the eight economies.

External Calibration: First, I set the age of entry to the labor force to 27 years – the age at which half the age-cohort is in full-time employment. I set the age of retirement to 63 – the average across the eight economies. I set the age of death to the average life-expectancy in the sample – 80. This calibration means that agents give birth at the

Fixed-effect	Coefficient
Country	
Finland	0.0788
Belgium	0.0565
Germany	0.0399
Sweden	0.0283
Portugal	0.0141
France	0.0140
Italy	-0.0082
Spain	-0.0248
Sector	
Manufacture of other transport equipment	0.1750
Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.1572
Manufacture of motor vehicles, trailers and semi-trailers	0.1539
Manufacture of computer, electronic and optical products	0.1380
Manufacture of electrical equipment	0.0934
Mining and quarrying, manufacture of coke and refined petroleum products	0.0893
Repair and installation of machinery and equipment	0.0758
Manufacture of basic metals	0.0737
Forestry and logging	0.0489
Manufacture of paper and paper products	0.0390
Manufacture of chemicals and chemical products	0.0283
Printing and reproduction of recorded media	0.0257
Fishing and aquaculture	0.0212
Manufacture of wood and of products of wood, straw and cork, except furniture;	0.0145
Manufacture of other non-metallic mineral products	0.0074
Manufacture of furniture; other manufacturing	0.0040
Manufacture of machinery and equipment n.e.c.	0.0039
Crop and animal production, hunting and related service activities	-
Manufacture of rubber and plastic products	-0.0007
Manufacture of food products, beverages and tobacco products	-0.0024
Manufacture of textiles, wearing apparel and leather products	-0.0055
Manufacture of fabricated metal products, except machinery and equipment	-0.0164

Table 3.1: Coefficients from Herfindahl–Hirschman index regression

Note: Coefficients in the table come from a regression of country-sector Herfindahl–Hirschman indices on country- and sector fixed effects, with constant term and coefficients of the non-tradable sectors suppressed. I exclude observations where total sales reported and Orbis are $< 15\%$ than the corresponding sectoral sales from the national accounts and sector-country pairs with less than 100 firms.

age of 27. I assume that firm ownership is passed on at the age of retirement, 63. The child of the agent is 37 at this moment, so $t_2 = 37$. I pick T^{soc} to match the average net replacement ratio[1] of 0.7, the average in the data. This gives rise to pension expenditure of 13% of GDP, compared to 11.6% in the data. I set the share of capitalists, μ, to be 0.1 – following Cagetti and De Nardi (2009), the discount factor to 0.97 following De Nardi (2004), and the income elasticity of consumption at the median age, ν_{med}, to 2.5 as in Straub (2018). Finally, I set λ, the parameter governing the pledgeability of profit streams to 0.22, targeting the average stock market capitalization of 89% in my sample.

Internal Calibration: in Straub (2018), κ an $\underline{a}$ are set as to target bequests as a share of GDP (5% for the US) and a 30% share of households with bequests below 6.25% of average income. I target the value of 6.85% for bequests as a share of GDP in Europe following Alvaredo, Garbinti, and Piketty (2017), who estimate values of 7.2% for France and 6.5% for Germany. Moreover, since I do not model the full distribution of incomes, I chose a different target to calibrate the parameters governing the heterogeneity of the household saving behaviour. I target the share of assets held by the top 10% of households, which is 48% in my sample. The scale parameter o anchors the strength of the average income elasticity of consumption. A low o shifts up the asset demand of both types of households. I set the value of o as to match the aggregate assets to GDP ratio that, together with the depreciation rate of 3.7% results in a safe interest rate of 3%.[2] Finally, I set ν_{slope} to match the propensity to consume out of permanent income of 0.699, as estimated in Straub (2018). This exercise yields a $\nu_{slope} = 0.99$. See Table 3.2 for the list of parameters as well as their targets.

3.2.3 Model Fit

Targeted moments – fitting $N \times K$ scale parameters $\underline{z}_{ik}$ and $N \times (N-1) \times K$ trade cost parameters d_{jik} means that I have enough parameters to match the sector- and country-pair trade shares exactly. In addition to matching the expenditure shares one for one as Cobb-Douglas shares, this means that the simulated model matches the sectoral sales and country-level GDP exactly. In turn, restricting the tail parameters of the firm productivity distribution to be a product of country- and sector-specific terms gives me enough degrees of freedom to match the coefficients from regressing HHI in the data on

1. The ratio of pension entitlement to pre-retirement earnings net of social security contributions.

2. Straub (2018) emphasizes that non-homotheticity in the asset demand can be modelled in two ways. On one hand, one can assume scale-invariance in the aggregate, such that should all incomes double, the savings to GDP ratio remains intact. This will be the case if the rich households value holding large assets relative to the average income in the economy. In terms of calibration, this involves parameterizing the scale parameter o in proportion to the steady state GDP per capita. The alternative formulation is to have the scale parameter independent of income, which will result in growing assets to GDP ratio over time. I follow Straub (2018) in picking a scale-invariant formulation.

Parameter	Description	Value	Target/Source
Production			
α	Capital Share	0.34	WIOD
δ	Depreciation	0.037	PWT
σ	Within-sector elasticity of substitution	10.5	Edmond, Midrigan, and Xu (2015)
γ_{ik}	Cobb-Douglas shares in final production	Vector	Sectoral absorption, WIOD
d_{jik}	Bilateral trade costs	Matrix	Bilateral trade flows, WIOD
Firm distribution			
$\underline{z}_{ik}$	Productivity Pareto scale parameter	Matrix	Bilateral trade flows, WIOD
θ_{ik}	Productivity Pareto tail parameter	Matrix	HHI_{ik}, Orbis
N	Number of firms per sector	100	
Population			
t_0	Age of entry into the labor force	27	OECD
t_1	Age of inheriting the firm (capitalists)	37	-
t_2	Age of passing on the firm (capitalists)	63	-
t_3	Age of retirement	63	OECD
T	Age of death	80	OECD
μ	Share of capitalists	0.1	Cagetti and De Nardi (2009)
T^{soc}	Net replacement ratio	0.7	OECD
λ	Pledgeability of income	0.22	World Bank
Preferences			
β	Discount factor	0.97	Cagetti and De Nardi (2009)
ν_{med}	Elasticity of intertemporal substitution	2.5	Straub (2018)
ν_{slope}	Ratio of elasticities ν_{s+1}/ν_s	0.99	Match $\phi = 0.699$
k	Weight on bequest motive	22.3	Alvaredo, Garbinti, and Piketty (2017)
o	Scale term in utility function	11.7% of GDP	r = 0.03, PWT
$\underline{a}$	Intercept in bequest utility	0.0052	Net wealth of top 10%, HFCS

Table 3.2: Baseline calibration

country- and sector fixed effects. Likewise, on the household side, I have a matching number of moments and parameters, resulting in an exact fit.

Untargeted moments – there are two categories of untargeted moments in the calibration. First, the aggregate profit levels depend on the elasticity of substitution across the varieties. The level of aggregate profits was not targeted directly – instead, I picked the value of σ from the literature (note that the value selected, $\sigma = 10.5$, is in the top of the range typically estimated). Thus, the profits in the model are bounded from below by $1/\sigma = 9.5\%$. The average aggregate profit rate in the simulation is 12.1%. This number is not straightforward to compare with the aggregate profit rate in the data, as the profit rates in the data are computed as a share of the total sales, i.e. the sum of the value added, intermediate inputs and profits. Following Basu (2019), I compute for each of the economies a back-of-the-envelope measure of profit rates as a share of the profits and value added only[3]:

$$\pi^{va} = \frac{\pi}{1 - s_m},$$

where s_m is the share of intermediate inputs in production. The average share of inputs is 0.5, so the average aggregate profits to value added in the data are 9.1% in aggregate and 10.2% in the tradable sectors.

Second, there is a number of moments that are not explicitly targeted on the household side of the calibration. For example, while asset side inequality is used to calibrate the strength of the non-homotheticity in utility function, the income inequality is not targeted. Nevertheless, the ratio of non-financial income of the two groups, y_c/y_w is 3.13 in the model, compared to the ratio of 95th to 50th percentile incomes of 3.3 in the data. Recall that the bequest inequality was not targeted directly either. The baseline calibration yields bequest to average non-financial income ratio of 3.9 for workers and 9.2 for capitalists. Thus, in my calibration bequest is indeed a luxury. I compare these numbers to those in Hurd, Smith, et al. (2001), who report bequests left by single decedents at different percentiles using Asset and Health Dynamics among the Oldest Old (AHEAD) data-set, 1993–1995. The 95th percentile of bequests is 250000$, while that at 50th percentile is 33300$, giving a ratio of 7.5. The ratio of bequests between workers and capitalists in my model is, surprisingly, almost exactly spot on, at 7.4 ($9.2/3.9 \times 3.13$). While the model abstracts from the vast majority of sources of income inequality, it is thus fairly successful at capturing the inequality between these two groups. Thus, I conclude that, while certainly simplistic, the model is able to capture, in very broad strokes, a pattern of household heterogeneity seen in the data.

3.3 Simulation Results

In this section I ask the key question of the chapter: what was the contribution of the competitiveness gap between the North and the South to the buildup of the current account imbalances in the pre-crisis Europe? I first outline the modelling of financial liberalization in subsection 3.3.1 and then discuss the predictions of the model for the direction and magnitude of capital flows during the decade prior to the Global Financial

3. See Footnote 8 in Basu (2019) for the formula.

Crisis in subsection 3.3.2. The drivers of capital flows in the model are discussed in Section 3.3.3.

3.3.1 Modelling Financial Liberalization

By year 2001 the spreads between the ten-year yields on sovereign bonds of the Euro-Area countries have disappeared. Thus, I assume that by 2001 the eight economies have undergone full financial liberalization. But when did the liberalization begin? Financial liberalization in European Union involved a range of policies entering into effect between 1995 and 2001. For simplicity, I assume that the eight economies were under full financial autarky before 1998, and that in 1998, they have unexpectedly underwent complete financial liberalization. While it is not clear when the adjustment process would have been completed absent the financial crisis of 2007, the arrival of the crisis has changed the conditions in the financial markets drastically in ways that are beyond the scope of this chapter. I thus stop my analysis in 2007, assuming that by 2007 the economies have reached the new steady state.

I solve for the 1998 steady state using the parameter values obtained in Section 4, but restricting cross-border capital flows. The exercise comparing the two steady states thus studies the effects of financial liberalization between heterogeneous economies, taking the firm productivity distributions, trade costs and household preference parameters as given.

I measure the average current account imbalances during the transition between the steady states as follows:

$$\overline{\frac{CA}{Y}}_i = \frac{1}{T^{tran}}\left(\frac{NFA_i^{lib}}{Y_i^{lib}} - \frac{NFA_i^{aut}}{Y_i^{aut}}\right) = \frac{1}{T^{tran}}\left(\frac{NFA_i^{lib}}{Y_i^{lib}} - 0\right) = \frac{1}{T^{tran}}\frac{NFA_i^{lib}}{Y_i^{lib}},$$

where $NFA_i = A_i - K_i - \lambda F_i$, lib marks variables from capital flow liberalization scenario, aut stands for the autarky counterfactual and T^{tran} is the duration of the transition period.

3.3.2 Financial Liberalization Between 1998 and 2007

The Table 3.3 below summarizes the results of the financial liberalization simulation. First, notice that the model is fairly successful in matching the patterns of aggregate profit rates in the eight economies. Finland and Sweden show highest profit rates in the data and rank second and third in the model, meanwhile Portugal and Italy have the lowest aggregate profit rates in the data and are second and third lowest profit rates in the model. Belgium and France are mid-ranking in both model and data. Two countries where the model over-predicts and under-predicts aggregate profits are Germany and Spain respectively. However, aggregate profit in the tradable sector in the data is 13.9% for Germany and 7.8% for Spain. In light of the difficulties of measuring profit rates accurately in the data, and especially in the services sector, I proceed with the calibration as is. Note also that the profitability was not targeted during the calibration. The patterns of profitability arise endogenously and depend, primarily, on the firm productivity distribution parameters picked as to match the sectoral concentration statistics.

Second, note that the model is also successful in replicating the North-South split of the current account imbalances during the period. Finland, Sweden and Germany run current account surpluses in the model and in the data, while as Italy, Spain and Portugal are running deficits. France runs a small deficit in the simulation but runs a modest surplus in the data. The model is unable to predict the surplus in Belgium, primarily due to the relatively low profitability that my calibration yields for this country. Quantitatively, the model matches the surplus built up by Germany, a third of that in Finland, and under-predicts the surpluses in Sweden. The model can explain a quarter of the deficits accumulated in Spain, and under-predicts the deficits in Portugal substantially. This is, perhaps, unsurprising, as the model has abstracted from other drivers of capital flows. During the pre-crisis decade, Spain experienced a housing bubble and Portugal substantially ran up its public debt, both contributing to the current account deficits in these economies.

I quantify the contribution of the competitiveness gap to the current account imbalances in pre-crisis decade, I compute the explained share of squares in my model as follows:

$$\frac{ESS}{TSS} = 1 - \frac{\sum_i (ca_i^{data} - ca_i^{model})^2}{\sum_i (ca_i^{data})^2}, \quad \text{where} \quad ca_i = \frac{CA_i}{Y_i} - \frac{1}{I}\sum_i \frac{CA_i}{Y_i}.$$

I find that my model is able to explain 27% of the variation in the current account imbalances in my sample.

3.3.3 Fundamental Drivers of Current Account Imbalances

In the model, current account imbalances arise along the transition path from autarky to financial openness due to the differences in income between workers and capitalists at home and abroad, which in turn are generated by the heterogeneity in the production side of the economies. But what are the key drivers of these differences? To address this question, I conduct a series of experiments. In each, I set one of the parameters

	Profit Rate		CA/Y	
	Model	Data	Model	Data
Finland	13.7	10.5	2.0	5.5
Germany	13.0	9.7	1.1	2.1
Sweden	12.6	12.0	0.6	5.5
Belgium	11.9	10.1	-0.3	3.6
France	12.1	8.4	-0.1	1.9
Italy	11.6	5.0	-0.6	-0.1
Portugal	11.3	7.9	-0.9	-9.2
Spain	11.0	9.6	-1.3	-5.1

Table 3.3: Simulation results: Profits and Capital Flows

Note: All variables in percent. Second column presents aggregate profit rates in the data for year 2007, the fourth column presents the average current account as a share of GDP in the data over years 1998-2007.

that differ across the economies to a common value, equal to the simple average across economies. I consider five types of parameters: firm distribution location parameters $\underline{z}$, firm distribution tail parameter θ, trade costs d, final consumption expenditure shares γ and the population size L. Equipped with country level current account imbalances from each of the experiments I compute their variance and conduct a variance decomposition exercise by dividing through by the variance of the current account imbalances in the fully calibrated model. I measure the share explained by variation in a given parameter as one less the ratio of the variances in restricted and fully calibrated models.

The results of the exercise are presented in Table 3.4. Note that the columns do not add up to one, due to the interaction between different kinds of heterogeneity in the model. Nevertheless, it is striking that the only type of variation that is able to measure up to the magnitude of capital flows that the full model generates is heterogeneity in the tail parameters of the firm productivity distributions, θ_i. Why so?

In the model, capital flows from the high-markup to low-markup economies. But what is the source of the market power of the high markup economies? Low costs of export d or high average TFP confer a cost advantage to all firms in an economy. But this cost advantage is eroded by a wage increase associated with higher demand for domestically produced goods. The two effects effectively cancel out so that the market power of domestic firms on international markets remains intact. A fatter right tail of firm productivity draws at home (low θ), on the other hand, ensures that, amongst the firm productivity draws, a few will wind up being very large, leading to the formation

	Variable	Contribution
Productivity location	$\underline{z}$	0.01
Productivity tail	θ	1.00
Trade costs	d	0.04
Expenditure shares	γ	0.03
Population	L	0.01

Table 3.4: Variance Decomposition of Current Account Imbalances

Note: The columns do not add up to one due to the interaction between different kinds of heterogeneity in the model.

of superstar firms. As I argue in Section 2.3.2, the relatively low labour shares of the superstar firms prevent the wages from rising sufficiently to erode the cost advantage of the extreme draws.

Note further that trade costs and expenditure shares are the only other sources of heterogeneity that affect capital flows, albeit the contribution is minor. High trade costs protect domestic firms in the domestic market. Thus, profit rates of economies that have relatively high trade costs are higher. In my sample, economies vary in the extent of their openness to trade. As a result, the effect of exposure to international competition, too, varies in its strength. On the other hand, expenditure shares affect the relative size of sectors in the economy, and contribute to the size of the aggregate profits through a composition effect.

Finally, observe that heterogeneity in the location parameter, $\underline{z}$, has no effect on the capital flows. A higher cutoff parameter increases the productivity of all firms at home by a common factor equal to the ratio of the old to the new cutoff: $\underline{z}'/\underline{z}$. As discussed in Section 2.3.2, higher productivity of the least productive firms raises domestic unit labour costs, whereas higher productivity of the most productive firms suppresses them. On balance, a proportional increase in productivity of all firms leaves the unit labour costs largely intact. As a result, the aggregate profits are practically insensitive to the heterogeneity in the location parameter in the firm productivity distributions.

3.4 Rebalancing Europe

Now that the contribution of the heterogeneity in the firm performance across economies to the pre-crisis capital flows has been quantified and the key dimensions of heterogeneity for the operation of the mechanism have been discussed, I proceed to discuss a set of policies for rebalancing. Note that this is not an exercise in deriving an optimal policy: whether rebalancing is desirable is outside the scope of this chapter. Instead, I centre my discussion on the policy recommendations that a) have been made with the view of reducing imbalances in Europe; and b) have specifically emphasized the ‘failure to remain competitive’ on behalf of the deficit economies as the driver of imbalances. I first assess their effectiveness in reducing the volume of intra-European capital flows, and then proceed by suggesting an alternative set of policies that can aid rebalancing.

3.4.1 Structural reforms

A number of policy reports have suggested structural reforms as means to counter the buildup of current account imbalances (Dieppe et al. 2012; Angelini, Ca’Zorzi, and Forster van Aerssen 2016; Rodriguez-Palenzuela and Dees 2016; Zorell 2017). Three interventions in particular have been recommended: (i) an increase in Southern productivity, (ii) a decrease in Southern wages, and (iii) an increase in the intensity of competition between Southern firms. I discuss each of these in turn, adding slight alterations to the model when necessary to accommodate the analysis. I show that higher productivity leaves capital flows intact, lower wages modelled as a decrease in the bargaining power of the workers acts to attenuate, and the increased competition among Southern firms acts to amplify the South-North capital flows. Thus, I argue that without a setup that models the competitiveness gap and its relationship to capital flows explicitly, a call for structural reforms is premature.

Higher productivity in the deficit economies. I model an increase in aggregate productivity by increasing the productivity cutoff parameters $\underline{z}$ of the deficit economies to match the average sectoral productivity in the surplus economies. In column 1 of the Table 3.6 I show the average yearly current account imbalances during the transition between the autarkic- and financial liberalization steady states in this counterfactual scenario. The imbalances are practically unaffected by this intervention. The reason for this is that, as argued in the previous segment, aggregate profit rates and therefore the associated capital flow dynamics are largely unaffected by uniform shifts in productivity.

Lower bargaining power of the workers. The policy recommendation to reduce wages implies that, in some sense, the wages in the deficit economies are excessive. To model this notion, I introduce ad-hoc bargaining over the pure profits into my model. Suppose bargaining takes a collective form: workers, as a group, have a claim on ω share of the aggregate profits that the firms make. Specifically, each firm gets $1-\omega$ share of its gross profit:

$$\Pi_i^{net} = (1-\omega)(p_n - c_n)q_n,$$

and gives up $\omega(p_n - c_n)q_n$ into the collective pool, which is then split equally between the workers. Firm optimality conditions are as before, so the firms produce exact same quantities as in the model without profit splitting, which in turn means that wages are also unchanged. However, the net income of capitalists is now lower, and that of the workers is higher.

For illustrative purposes, I assume that in the baseline scenario, workers in the Southern economies have a claim on 25% of the profits the firms make, and those in the Northern economies have a claim on 15%. These values generate current account imbalances that match closely the capital flows in the model with no bargaining. I then model a counterfactual episode of financial liberalization with bargaining power of the workers in the Southern economies lowered to 0%. The resultant capital flows can be seen in column 2. The intervention is indeed effective: compared with the baseline, it halves the surpluses in Germany and Finland, removes the surpluses in Sweden altogether, reduces the deficits in Spain by two thirds and turns deficits into surpluses in Portugal and Italy. Notably, now that the Southern economies are no longer on the receiving end of the capital flows from the surplus economies, the two countries that were roughly in balance in the baseline scenario – France and Belgium – end up with larger deficits. However, despite the effectiveness of this measure, it ultimately operates through reducing the take-home income of the workers in deficit economies, by 4.6% in Spain and by 4.8% in Italy and Portugal. Notice further that increasing the bargaining power in the Northern economies in line with that in the Southern economies – to 25%, results in a 30% reduction in current account imbalances across the board, compared to the baseline, and increases the take-home income of workers by 2% in the North. The capital flows under this scenario can be seen in column 3.

Increased intensity of competition among Southern firms. The third type of structural reform mentioned in policy reports is a call for increased competition among the Southern producers. I model this intervention by increasing the number of firms operating in Italy, Spain, and Portugal by a factor of two. I keep the parameters of the model, and the parameters of the firm productivity distributions in particular, at their baseline level. The results of this policy can be seen in column 4: it acts to increase surpluses in Germany, Finland, and Sweden, and to increase deficits in Italy, Spain, and Portugal. Thus, the policy acts to amplify the capital flows. As competition between the Southern firms increases, this puts a squeeze on their profit rates. Indeed, the aggregate profit rates decline by 0.7 percentage points in Spain, and by 0.8 percentage points in Italy and Portugal. As profits shrink, the domestic savings experience a decline. This acts to push up the autarkic interest rate and invites in the savings from abroad.

3.4.2 Alternative policies for rebalancing

Despite the prominence of structural reforms in the discourse around European imbalances, the analysis above shows that such interventions are not necessarily effective, and can lead to the worsening of the living standards and increases in inequality in the deficit economies. In this subsection, I propose two alternative instruments that can aid rebalancing, in the context of capital flows driven by the heterogeneous performance of European firms. First proposal relies crucially on the origin of heterogeneity in the firm size distribution across economies. The second exploits a further channel through which pure profits affect asset markets: the fact that firm profit flows, if pledgeable, constitute an asset in their own right.

Size-related distortions at the firm level. In the model, the heterogeneity in the tail parameter of the firm productivity distributions across countries is treated as a fundamental property of economies. Indeed, it is possible that some economies naturally produce more market leaders than the others. Alternatively, we could think of fundamental firm productivity distributions across countries featuring homogeneous tail parameters, and the resulting asymmetries in the firm sales distributions arising due to the presence of distortions in the markets. One type of distortions that would give rise to such asymmetry are firm-specific distortions which are related to firm size.

Following Bento and Restuccia (2017), suppose that a firm n, after production is completed, is left with $(1 - \tau_n)$ of its produce. Moreover, the size of the firm-specific distortion τ_n is linked systematically to the firm productivity:

$$(1 - \tau_n) = (1 - \bar{\tau}) z_n^{-\psi},$$

where $\bar{\tau}$ is a positive constant controlling the average size of distortions. Bento and Restuccia (2017) refer to ψ as the elasticity of a firm's distortion with respect to its productivity. $\psi > 0$ means that productive firms are penalized disproportionally. In Appendix F.2 I show that a model presented in Section 2.3 is isomorphic to a model where firms draw productivities from a Pareto distribution with common sector-specific tail parameter θ_k, and where firms are subject to size-related distortions with elasticity $\psi_i = 1 - 1/\theta_i$ for some appropriately selected $\bar{\tau}_{ik}$.

The resulting values of ψ_i are presented in Table 3.5. In the data the Southern firms size distribution is compressed in its right tail. Correspondingly, the exercise selects high values of elasticity of distortions with respect to size for Southern economies. Further, note that Hsieh and Klenow (2014) estimate ψ_i for India at 0.5. The values of ψ_i I obtain all fall below this threshold.

	Belgium	Germany	Spain	Finland	France	Italy	Portugal	Sweden
ψ_i	0.20	0	0.36	-0.17	0.21	0.37	0.23	-0.14

Table 3.5: Size Elasticities of Production Distortions

Notes: To identify elasticities I assume that German firms are undistorted. This pins down values of ψ_i for other economies.

If the asymmetry in firm performance stems from size-related distortions that differ across countries, removal of such distortions offers an alternative instrument to curb the buildup of imbalances. I present the current account imbalances in the counterfactual without the size-related distortions in column 5 of Table 3.6. The policy acts to very nearly equalize the aggregate profit rates across the economies, which in turn acts to align the net asset demand in each of the states. The result are capital flows that are practically nil.

Deepening market capitalization. In the stylised model, pure profits have two effects on the asset markets. First, as profits accrue to the demographic that has a higher propensity to save from permanent income, high profit rates increase the demand for assets as a share of GDP. Second, since firms that charge high markups hire less capital per dollar of sales, high profit rates act to contract asset supply as a share of GDP. Both forces suppress the autarkic interest rate in high aggregate profit rate economies. However, the stylised model assumed away the pledgeability of future streams of profits. This assumption is relaxed in the quantitative version of the model laid out in Section 3.2, where a proportion λ of future income can be contracted and traded. With firms' ownership partially tradable, high profit rates act to increase the asset supply in the economy, thus counteracting the first two effects. As a result, the response of the autarkic interest rates to differences in aggregate profitability is muted, when compared to a world with no contractibility. If the depth of the stock markets λ is a policy variable, then it can be used to attenuate the effect that profit rate asymmetry has in the asset markets. In the last column of Table 3.6 I record current account imbalances in the counterfactual where λ is calibrated to match the stock market capitalization of 138% of GDP, the value for the United States in 2007. The current account imbalances are down by 20% for each of the economies.

	Baseline	$\underline{z}_S = \underline{z}_N$	$\omega_S = 0$	$\omega_N = 0.25$	$N_S = 200$	$\psi_i = 0$	$\lambda = \lambda_{US}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Finland	1.9	1.9	1.0	1.3	2.1	0.3	0.9
Sweden	0.6	0.6	-0.1	0.4	0.8	-0.1	0.3
Germany	1.7	1.7	0.9	1.2	2.1	0.0	0.8
Belgium	-0.3	-0.3	-0.8	-0.2	-0.1	-0.3	-0.2
France	-0.4	-0.4	-0.9	-0.3	-0.2	0.0	-0.2
Italy	-0.9	-0.9	0.1	-0.6	-1.6	0.1	-0.4
Spain	-1.5	-1.5	-0.5	-1.1	-2.1	0.0	-0.7
Portugal	-0.8	-0.7	0.2	-0.6	-1.5	-0.2	-0.4

Table 3.6: Policies for Rebalancing

Note: All variables in percent. I assume free capital flows in all policy exercises. Entries in the columns report the average annual current account as a share of GDP incurred during a ten year transition from autarkic steady state to the new steady state following an episode of financial liberalization. Column 1: baseline calibration of the model. Column 2: location parameter of the firm productivity distributions of the Southern economies set to match the average aggregate productivity in the Northern economies. Column 3: bargaining power of the workers in the Southern economies set to 0. Column 4: bargaining power of the workers in the Northern economies set to match that in the Southern economies. Column 5: double the number of the firm productivity draws in the Southern economies. Column 6: remove size-related distortions. Column 7: increase the depth of stock market capitalization to the level of United States.

3.5 Conclusion

In this chapter I have argued that capital flows from the European North to South, in years 1998-2007, have been in part driven by the differential competitiveness of the Northern and Southern firms in the common European market. Better ability to compete on the part of Northern firms translated into larger profits, which in turn generate income without an associated increase in asset supply, and are themselves in a need of an investment opportunity. The two effects cause capital outflows from the North and into the South.

I present my argument in three steps. First, I present three stylized facts: (i) North and South have experienced diverging current account imbalances; (ii) North and South have shown a gap in competitiveness as measured by the relative prevalence among the market leaders, aggregate profit rates and unit labour costs; (iii) current account imbalances correlated, over the period, with the measures of competitiveness. I then construct a stylized two-country model featuring oligopolistic trade and heterogeneous households. The capital flow dynamic during a period of financial liberalization in this model depends on the aggregate profit rate in the two economies. I then further investigate the effects of trade in imperfectly competitive markets on capital flows in pre-GFC Europe by constructing a fully calibrated quantitative model. In the model, I show that capital flow liberalization between eight European economies leads to current account surpluses in the North, and deficits in the South, explaining 27% of variation in the data. Moreover, the differential competitiveness is driven not by higher average productivity in the North, but by the presence of extremely productive 'superstar' firms.

There is renewed recognition that 'fickle' capital flows can be damaging to recipient economies (Caballero and Simsek 2020). In the world increasingly characterized by superstar firm dynamics (Autor et al. 2020), some economies may find themselves locked in in a double-trap of lacking the scale to compete effectively on international markets, and on the receiving end of fickle capital flows that expose them to excess volatility. Thus, a better understanding of how the export competitiveness and capital flows relate to each other is important to assuring equitable growth.

In this chapter, the drivers behind the asymmetry in the prevalence of superstar firms are exogenous, except for the size-related distortions extension. However, even in that case the elasticities of distortions with respect to size are exogenous. So, the question of what fundamental properties of economies cause some to generate more superstar firms remains pertinent. Models of endogenous growth feature a number of parameters that affect the tails of the firm productivity distribution. However, which mechanisms are important in explaining cross-country heterogeneity is an area where more work is needed. I leave this question for future research.

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Appendix A

Mathematical Appendix for Chapter 1

A.1 Closed Economy Value Added Shares in Vector Form

First rewrite the sectoral sales as a system of equations:

$$Y_k = X_k^{FC} + \sum_{n\in K} X_{nk}^{II} = \alpha_k Y + \sum_{n\in K} \beta_{nk} Y_n \quad \rightarrow \quad \mathbf{Y} = \mathbf{A1}Y + \mathbf{BY},$$

where Y is the household income (it is a scalar in the expression on the right hand side, so not in bold), $\mathbf{Y}$ is a stacked vector of sectoral sales, $\mathbf{B}$ is a matrix of intermediate expenditure shares β_{kn}, $\mathbf{A}$ is a diagonal matrix of final expenditure weights, and $\mathbf{1}$ is a vector of ones. Collecting the sales on the left hand side and multiplying by a diagonal matrix of sectoral labor shares, obtain a vector of sectoral value added in levels:

$$(\mathbf{I} - \mathbf{B})\mathbf{Y} = \mathbf{A1}Y, \quad \mathbf{Y} = (\mathbf{I} - \mathbf{B})^{-1}\mathbf{A1}Y, \quad \mathbf{VA} = diag(\mathbf{1} - \mathbf{B1})(\mathbf{I} - \mathbf{B})^{-1}\mathbf{A1}Y.$$

Value addded shares are simply both sides divided by the GDP Y:

$$\mathbf{va} = diag(\mathbf{1} - \mathbf{B1})(\mathbf{I} - \mathbf{B})^{-1}\mathbf{A1}.$$

A.2 Open Economy Value Added Shares in Vector Form

Again, rewrite the sectoral sales as a system of equations:

$$Y_{ik} = \sum_j \Pi_{jik} \left(\alpha_{jk} D_j \sum_n (1 - \sum_k \beta_{jnk}) Y_{jn} + \sum_n \beta_{jnk} Y_{jn} \right) \quad \rightarrow \quad \mathbf{Y} = \mathbf{\Pi AD\Sigma VA} + \mathbf{\Pi B}$$

Collecting the sales on the left hand side and multiplying by a diagonal matrix of sectoral labor shares, obtain a vector of sectoral value added in levels:

$$\mathbf{Y} = (\mathbf{I} - \mathbf{\Pi B})^{-1}\mathbf{\Pi AD\Sigma VA}, \quad \mathbf{VA} = diag(\mathbf{1} - \mathbf{B1})(\mathbf{I} - \mathbf{\Pi B})^{-1}\mathbf{\Pi AD\Sigma VA}.$$

This system has infinitely many solutions. Normalize the value added of the last country and sector, $VA_{IK} = 1$. Denote $\mathbf{\Phi} = diag(\mathbf{1} - \mathbf{B1})(\mathbf{I} - \mathbf{\Pi B})^{-1}\mathbf{\Pi AD\Sigma}$, and let $\mathbf{\Phi}_{IK-1}$ stand for the first $IK - 1$ rows and columns of matrix $\mathbf{\Phi}$ and ϕ for the first $IK - 1$ elements of the last column of matrix $\mathbf{\Phi}$. The normalized system then is as follows:

$$\mathbf{VA}_{IK-1} = \mathbf{\Phi_{IK-1}}\mathbf{VA}_{IK-1} + \phi, \quad \mathbf{VA}_{IK-1} = (\mathbf{I} - \mathbf{\Phi_{IK-1}})^{-1}\phi.$$

The value added shares are simply the value added in levels divided element-wise by the GDP.

$$\mathbf{va} = (\mathbf{I} - \mathbf{\Phi_{IK-1}})^{-1}\phi \oslash \left(\mathbf{\Sigma}(\mathbf{I} - \mathbf{\Phi_{IK-1}})^{-1}\phi\right).$$

A.3 Changes in Sectoral Value Added Shares in General Equilibrium

Rewrite the sectoral sales in matrix form:

$$\mathbf{Y} = \mathbf{\Pi A D \Sigma V A} + \mathbf{\Pi B Y}$$

Consider the derivative with respect to the full set of possible changes in final expenditure weights $\mathbf{A}$. Let $\mathbf{dA}$ stand for a matrix of infinitesimal changes in $\mathbf{A}$, and analogously for $\mathbf{d\Pi}$ and $\mathbf{dY}$. The total derivative with respect to shocks in $\mathbf{A}$ is then

$$\mathbf{dY} = \mathbf{d\Pi}(\mathbf{AD\Sigma VA} + \mathbf{BY}) + \mathbf{\Pi dAD\Sigma VA} + \mathbf{\Pi}(\mathbf{AD\Sigma}\mathit{diag}(\mathbf{1} - \mathbf{B1}) - \mathbf{B})\mathbf{dY},$$

where the first term in the last bracket makes use of the relationship between value added and sales $\mathbf{VA} = \mathit{diag}(\mathbf{1} - \mathbf{B1})\mathbf{Y}$. The first two terms are just matrix versions of the partial derivative vectors $P(\mathbf{Y}|P(\mathbf{\Pi}|A))$ and $P(\mathbf{Y}|A)$. Substituting in and collecting the changes in sectoral sales on the right hand side:

$$(\mathbf{I} - \mathbf{\Pi}(\mathbf{AD\Sigma}\mathit{diag}(\mathbf{1} - \mathbf{B1}) - \mathbf{B}))\mathbf{dY} = P(\mathbf{Y}|A) + P(\mathbf{Y}|P(\mathbf{\Pi}|A)),$$

$$\mathbf{dY} = (\mathbf{I} - \mathbf{\Pi}(\mathbf{AD\Sigma}\mathit{diag}(\mathbf{1} - \mathbf{B1}) - \mathbf{B}))^{-1}(P(\mathbf{Y}|A) + P(\mathbf{Y}|P(\mathbf{\Pi}|A))).$$

Finally, note that $\mathbf{dVA} = \mathit{diag}(\mathbf{1} - \mathbf{dB1})\mathbf{Y} + \mathit{diag}(\mathbf{1} - \mathbf{B1})\mathbf{dY}$. For all shocks other than to $\mathbf{B}$,

$$\mathbf{dVA} = \mathbf{G}\left(P(\mathbf{Y}|X) + P(\mathbf{Y}|P(\mathbf{\Pi}|X))\right)$$

where

$$\mathbf{G} = \mathit{diag}(\mathbf{1} - \mathbf{B1})(\mathbf{I} - \mathbf{\Pi}(\mathbf{AD\Sigma}\mathit{diag}(\mathbf{1} - \mathbf{B1}) - \mathbf{B}))^{-1}.$$

For shocks to $\mathbf{B}$,

$$\mathbf{dVA} = \mathit{diag}(\mathbf{1} - \mathbf{dB1})\mathbf{Y} + \mathbf{G}\left(P(\mathbf{Y}|X) + P(\mathbf{Y}|P(\mathbf{\Pi}|X))\right).$$

A.4 Model in Changes

Suppose that base year values of endogenous variables Y_{ik}, Π_{jik}, α_{ik}, β_{ikL}, β_{ikn} and D_i (and their combinations X^{FC}_{jik} and X^{II}_{jink}) are known, as are the shocks to the exogenous variables $\hat{A}_{ik}, \hat{\tau}_{ijk}, \hat{L}_i, \hat{D}_i, \hat{\alpha}_{ik}, \hat{\beta}_{ink}$ for all $i, j \in I$ and $k, n \in K$. Equations (2) to (4) constitute the equilibrium of the changes formulation of the model and can be used to solve for all the endogenous objects in the next period:

[i] Changes in production costs can be derived from (1.2):

$$\hat{c}_{ik} = \hat{w}_{ik}^{\beta_{ikL}} \prod_n \hat{P}_{in}^{\beta_{ikn}}.$$

[ii] Changes in trade shares and price indices can be derived from conditions (1.3) and (1.4):

$$\hat{\Pi}_{jik} = \left(\frac{\hat{c}_{ik}\hat{\tau}_{jik}}{\hat{A}_{ik}\hat{P}_{jk}}\right)^{-\theta} \qquad \hat{P}_{ik} = \left[\sum_l \Pi_{ilk}\Big(\frac{\hat{c}_{lk}\hat{\tau}_{ilk}}{\hat{A}_{lk}}\Big)^{-\theta}\right]^{-\frac{1}{\theta}}.$$

[iii] Using equation (1.5), wages change as to clear the labor market in the next period:

$$\hat{w}_i \hat{L}_i \sum_{k \in K} \beta_{ikL} Y_{ik} = \sum_{k \in K} \hat{\beta}_{ikL} \beta_{ikL} \hat{Y}_{ik} Y_{ik}.$$

[iv] $\hat{Y}_{ik}$ satisfies the sectoral market clearing condition in the next period, a combination of conditions (1.6) and (1.7):

$$\hat{Y}_{ik} Y_{ik} = \sum_{j \in I} \hat{\Pi}_{jik} \Pi_{jik} \left(\hat{\alpha}_{ik} \hat{D}_i \hat{w}_i \hat{L}_i X^{FC}_{jik} + \sum_{n \in K} \hat{\beta}_{ink} \hat{Y}_{in} X^{II}_{jink}\right).$$

[v] Finally, the next period global output is normalized as per (1.8):

$$\sum_i \hat{w}_i \hat{L}_i w_i L_i = 1$$

Appendix B

Data Appendix for Chapter 1

B.1 Dataset Description

List of countries: Australia, Brazil, Canada, China , Germany, Denmark, Spain, Finland, France, United Kingdom, Greece, India, Italy, Japan, Republic of Korea, Mexico, Portugal, Sweden, Taiwan, United States.

List of sectors: see Table B.1.1.

ISIC Rev. 3.1 Title	Type
Agriculture, Hunting, Forestry and Fishing	Primary
Mining and Quarrying	Primary
Food, Beverages and Tobacco	Manufacturing
Textile, Leather and Footwear	Manufacturing
Pulp, Paper, Printing and Publishing	Manufacturing
Coke, Petroleum and Nuclear Fuel	Manufacturing
Chemicals and Chemical Products	Manufacturing
Rubber and Plastics	Manufacturing
Other Non-Metallic Mineral	Manufacturing
Basic Metals and Fabricated Metal	Manufacturing
Machinery, Nec	Manufacturing
Electrical and Optical Equipment	Manufacturing
Transport Equipment	Manufacturing
Manufacturing, Nec; Recycling	Services
Electricity, Gas and Water Supply	Services
Construction	Services
Wholesale and Retail Trade	Services
Hotels and Restaurants	Services
Transport and Storage	Services
Post and Telecommunications	Services
Financial Intermediation	Services
Real Estate, Renting and Business Activities	Services
Community Social and Personal Services	Services

Table B.1.1: Sectors in Long Run WIOD

Note: I include Manufacturing, Nes; Recycling into the services sector. This sector contains manufacturing of jewellery, musical instruments, games equipment, and toys; and recycling of metal- and non-metal scrap. Thus, this sector combines both manufacturing production, but also the provision of the service of recycling. I attribute it wholly to services.

Appendix C

Additional Results for Chapter 1

C.1 Counterfactual Shares in Low- and High-Skilled Manufacturing

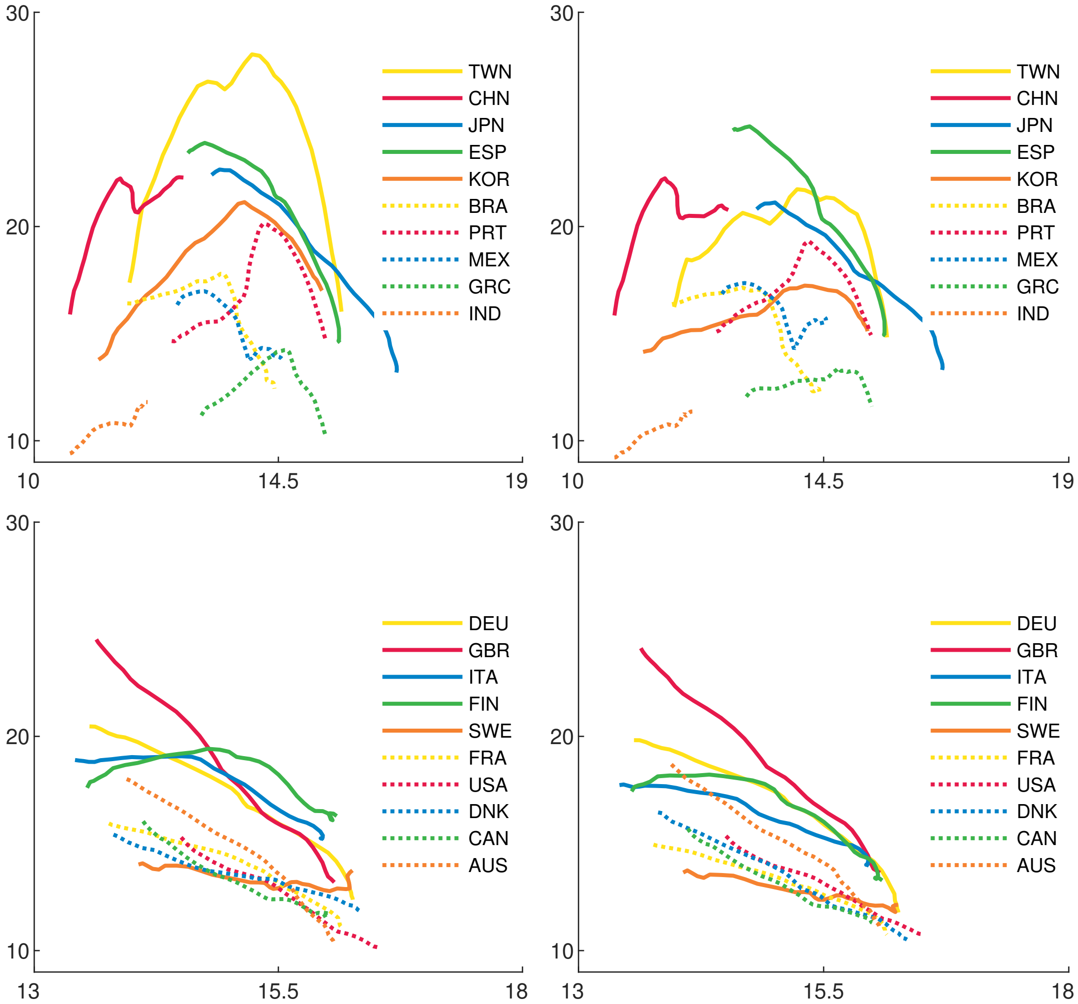

Figure C.1.1: Low-Skilled Manufacturing Value Added Share as Income Grows

Note: On the left panels, the value added shares in manufacturing as a share of GDP on the y-axis, logarithm of the GDP per capita in \$ on the x-axis. On the right panels, the counterfactual closed economy value added shares in manufacturing as a share of GDP, computed using equation (1.1) on the y-axis, logarithm of the GDP per capita in \$ on the x-axis. All for 1965 to 2000.

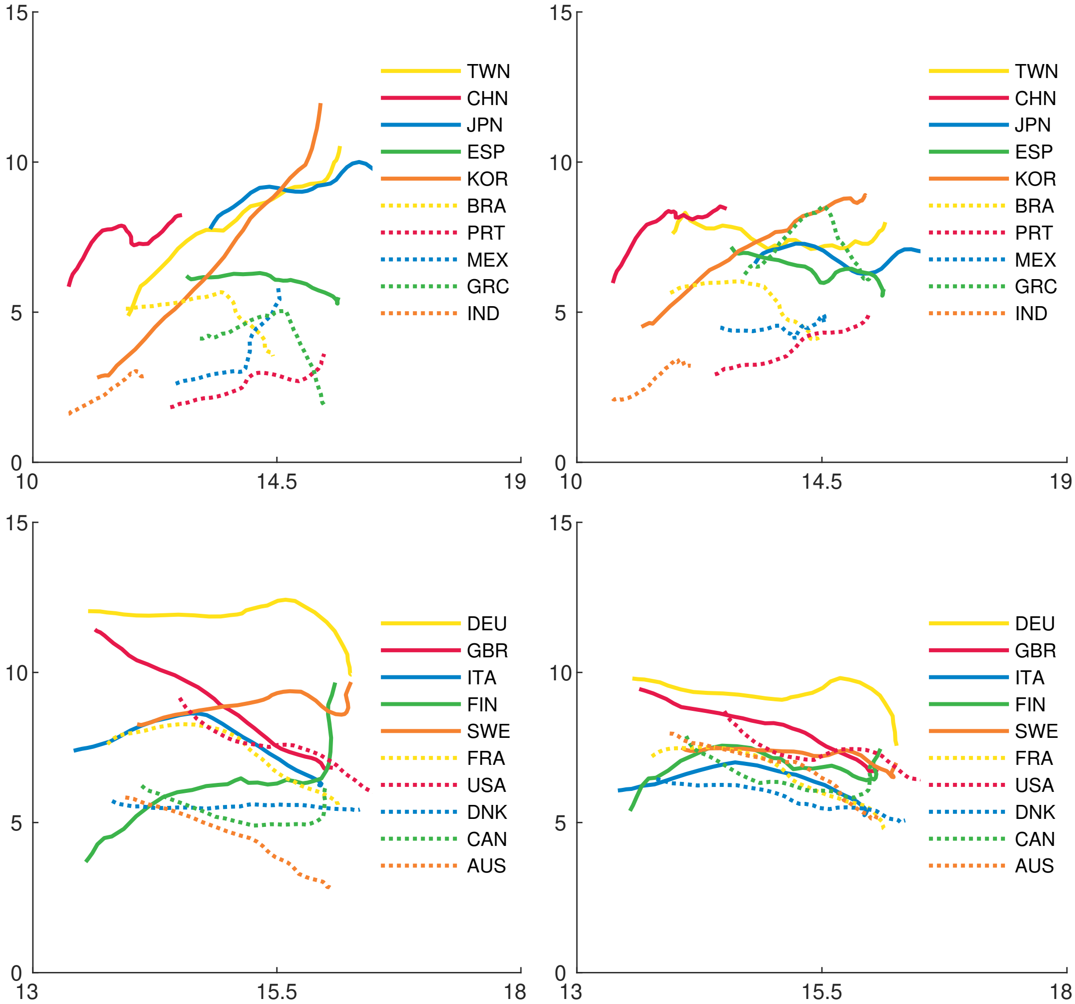

Figure C.1.2: High-Skilled Manufacturing Value Added Share as Income Grows

Note: On the left panels, the value added shares in manufacturing as a share of GDP on the y-axis, logarithm of the GDP per capita in \$ on the x-axis. On the right panels, the counterfactual closed economy value added shares in manufacturing as a share of GDP, computed using equation (1.1) on the y-axis, logarithm of the GDP per capita in \$ on the x-axis. All for 1965 to 2000.

C.2 Relative Contribution Tables

Sector	Local	Global
Food, Beverages and Tobacco	67%	33%
Textile, Leather and Footwear	74%	26%
Pulp, Paper, Printing and Publishing	74%	26%
Coke, Petroleum and Nuclear Fuel	74%	26%
Chemicals and Chemical Products	56%	44%
Rubber and Plastics	54%	46%
Other Non-Metallic Mineral	81%	19%
Basic Metals and Fabricated Metal	73%	27%
Machinery	57%	43%
Electrical and Optical Equipment	37%	63%
Transport Equipment	44%	56%
Country	Local	Global
Australia	78%	22%
Brazil	80%	20%
Canada	53%	47%
China	71%	29%
Germany	76%	24%
Denmark	51%	49%
Spain	80%	20%
Finland	38%	62%
France	74%	26%
United Kingdom	75%	25%
Greece	56%	44%
India	80%	20%
Italy	68%	32%
Japan	75%	25%
Republic of Korea	44%	56%
Mexico	38%	62%
Portugal	58%	42%
Sweden	39%	61%
Taiwan	39%	61%
United States	80%	20%
Rest of World	85%	15%

Table C.2.1: Local and Global Components of MVA Share Change by Sector and Country

Note: The relative contributions are computed using equations (1.18) and (1.19).

C.3 Decompositions Using Different Values of φ

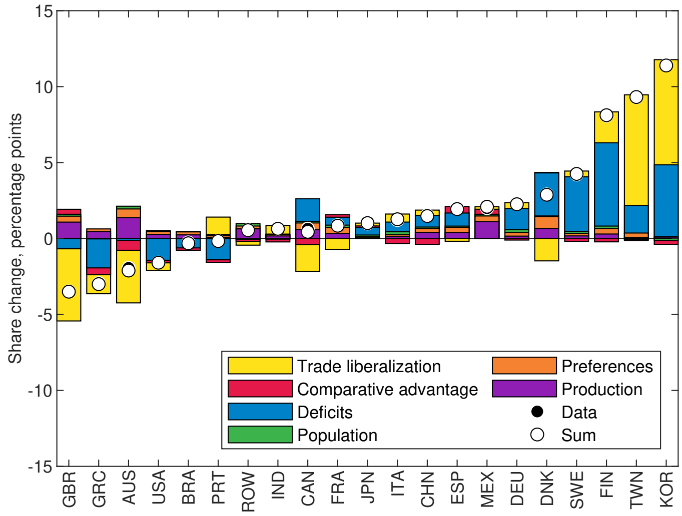

Figure C.3.1: Global Drivers of Manufacturing Value Added Shares, $\varphi = 1.01$

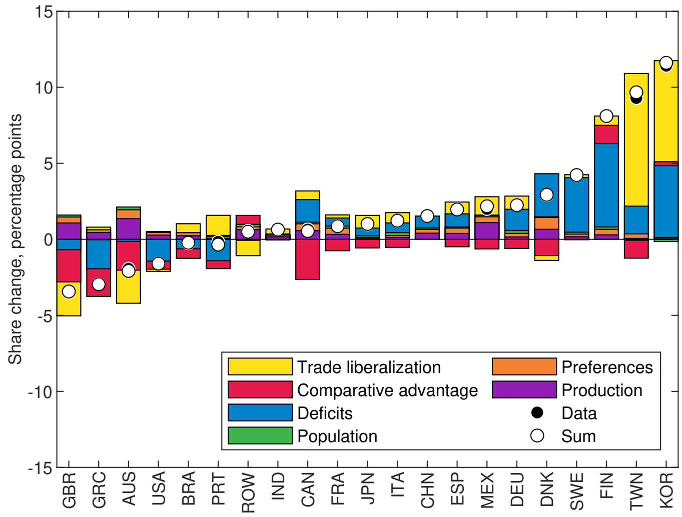

Figure C.3.2: Global Drivers of Manufacturing Value Added Shares, $\varphi = 1.1$

Note: The black circles mark the 'global' component of the change in the manufacturing value added share between 1965 and 2000. The bars correspond to the simulated changes in manufacturing value added share using different subsets of shocks estimated in Section 1.4: trade cost, productivity, aggregate trade deficit, population size, foreign preference parameter, and production function parameter shocks, respectively. The white circles mark the sum of the 'local' and 'global' components.

Sector	τ	A	D	L	α_{-i}	β_{-i}
Food Beverages and Tobacco	47%	17%	10%	3%	18%	5%
Textile Leather and Footwear	39%	22%	9%	2%	18%	10%
Pulp Paper Printing and Publishing	34%	23%	21%	3%	13%	7%
Coke Petroleum and Nuclear Fuel	50%	22%	6%	3%	6%	11%
Chemicals and Chemical Products	38%	23%	21%	3%	8%	7%
Rubber and Plastics	35%	22%	15%	4%	9%	15%
Other Non-Metallic Mineral	36%	22%	13%	5%	15%	9%
Basic Metals and Fabricated Metal	27%	22%	21%	3%	12%	15%
Machinery	38%	23%	18%	5%	7%	10%
Electrical and Optical Equipment	41%	16%	12%	1%	12%	18%
Transport Equipment	46%	21%	11%	2%	10%	11%

Country	τ	A	D	L	α_{-i}	β_{-i}
Australia	40%	21%	2%	3%	15%	18%
Brazil	46%	21%	10%	4%	11%	8%
Canada	45%	18%	14%	2%	9%	13%
China	45%	16%	12%	4%	15%	8%
Germany	31%	17%	17%	4%	13%	17%
Denmark	24%	24%	19%	2%	19%	11%
Spain	41%	30%	9%	1%	10%	9%
Finland	25%	28%	28%	3%	8%	9%
France	23%	25%	8%	3%	22%	19%
United Kingdom	40%	23%	6%	3%	14%	14%
Greece	39%	20%	18%	2%	13%	8%
India	31%	25%	3%	9%	19%	13%
Italy	41%	15%	7%	3%	20%	15%
Japan	50%	30%	6%	2%	5%	7%
Republic of Korea	43%	19%	19%	1%	9%	8%
Mexico	55%	14%	5%	4%	9%	12%
Portugal	43%	18%	11%	2%	15%	12%
Sweden	22%	21%	30%	3%	8%	16%
Taiwan	50%	17%	8%	2%	13%	10%
United States	31%	14%	33%	2%	9%	11%
Rest of World	37%	17%	4%	4%	19%	20%

Table C.2.2: Decomposition of Global Component of MVA Share Change by Sector and Country

Note: The relative contributions are computed using equations (1.18) and (1.19), but using each of $\Delta va_{ik}(A)$, $\Delta va_{ik}(\tau)$, $\Delta va_{ik}(D)$, $\Delta va_{ik}(\alpha_{-i})$, $\Delta va_{ik}(B_{-i})$ in the numerator and the sum of all five in the denominator respectively.

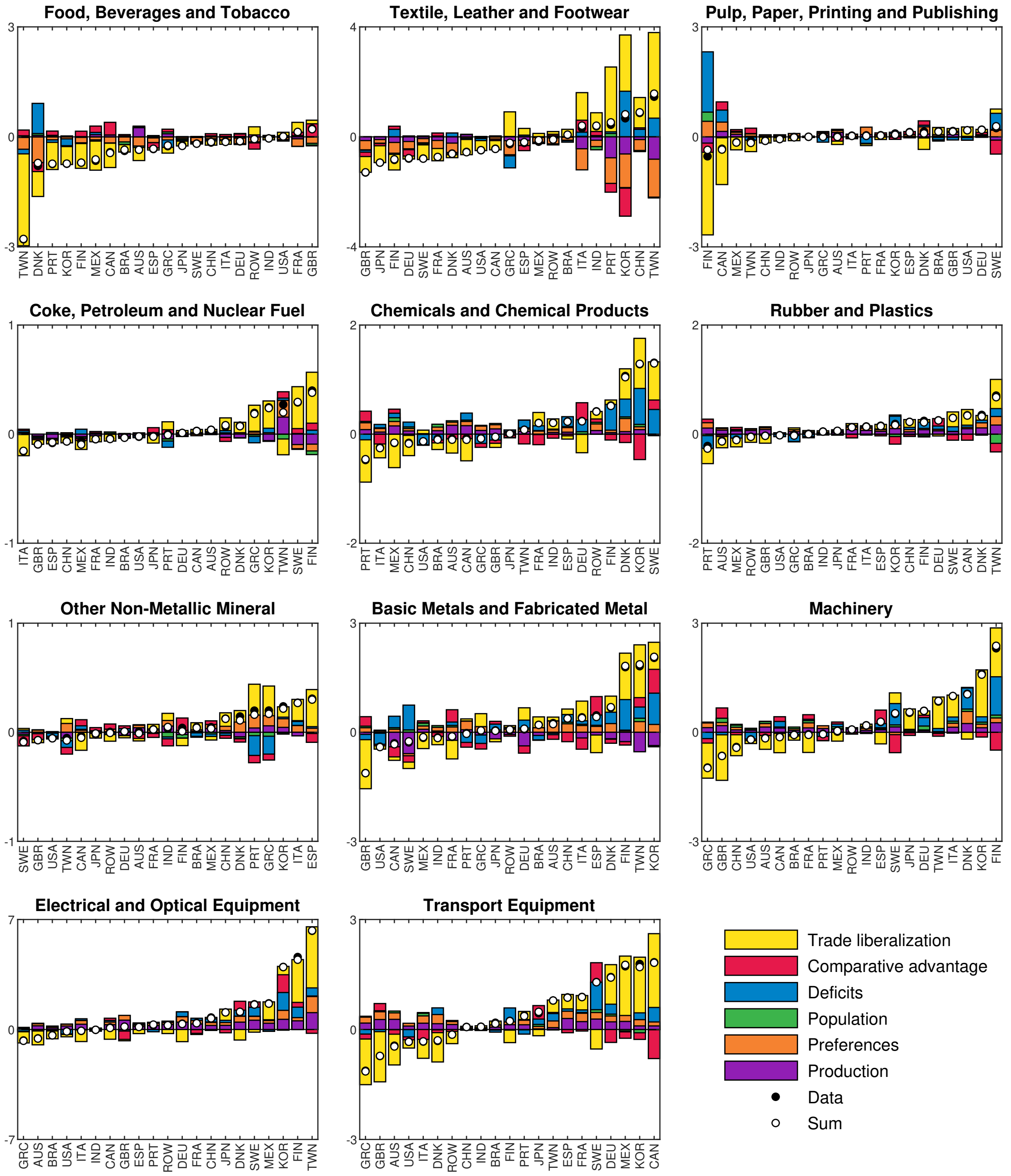

Figure C.3.3: Global Drivers of Structural Transformation within Manufacturing, $\varphi = 1.01$

Note: The black circles mark the 'global' component of the change in the manufacturing value added share between 1965 and 2000. The bars correspond to the simulated changes in manufacturing value added share using different subsets of shocks estimated in Section 1.4: trade cost, productivity, aggregate trade deficit, population size, foreign preference parameter, and production function parameter shocks, respectively. The white circles mark the sum of the 'local' and 'global' components.

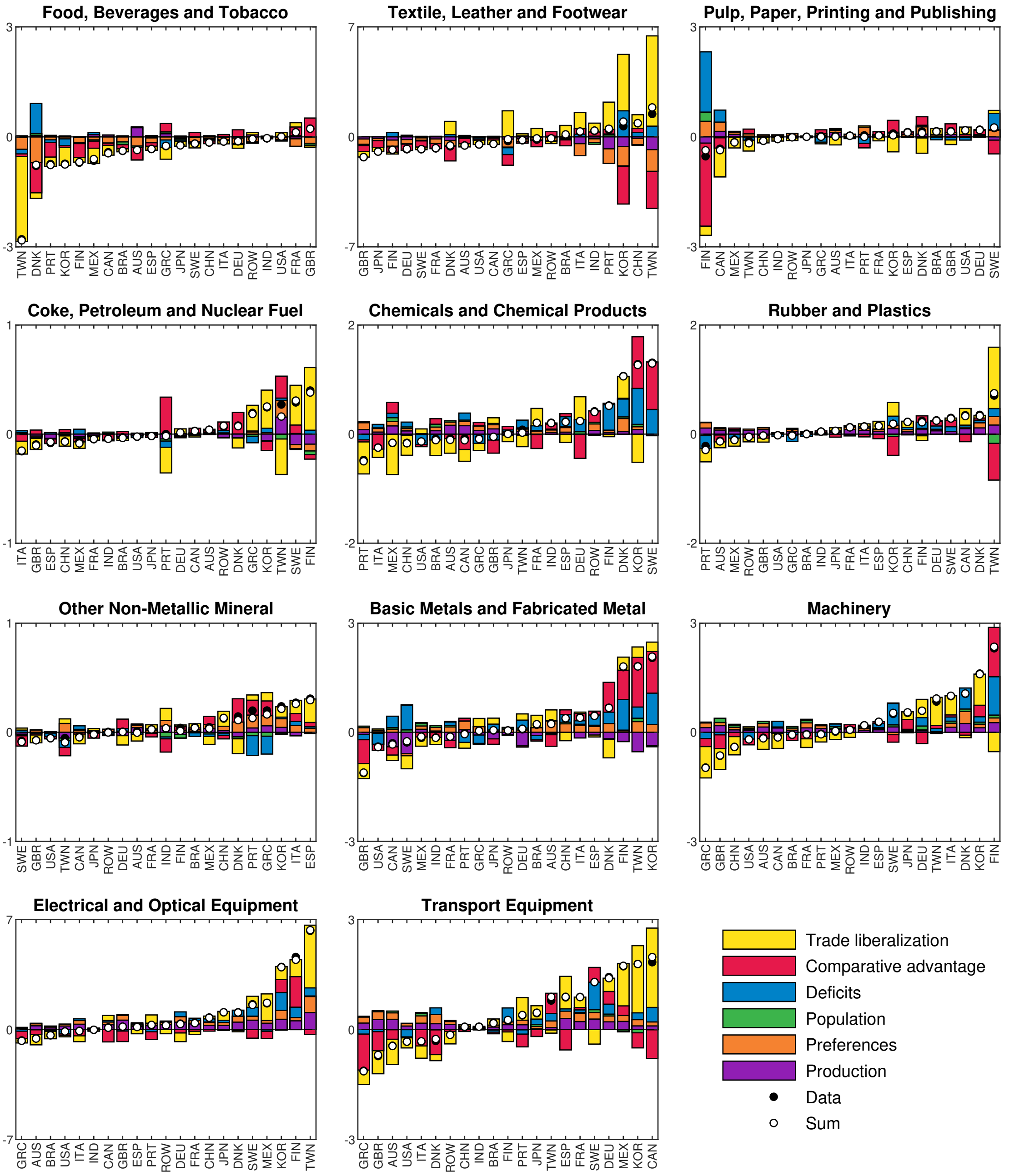

Figure C.3.4: Global Drivers of Structural Transformation within Manufacturing, $\varphi = 1.1$

Note: The black circles mark the 'global' component of the change in the manufacturing value added share between 1965 and 2000. The bars correspond to the simulated changes in manufacturing value added share using different subsets of shocks estimated in Section 1.4: trade cost, productivity, aggregate trade deficit, population size, foreign preference parameter, and production function parameter shocks, respectively. The white circles mark the sum of the 'local' and 'global' components.

Country	Largest gain sectors	Change	Largest loss sectors	Change
Australia	Mining and Quarrying	-0.03	Electrical and Optical Equipment	-0.97
	Coke, Petroleum and Nuclear Fuel	0.03	Transport Equipment	-0.96
	Basic Metals and Fabricated Metal	5.02	Textile, Leather and Footwear	-0.56
Brazil	Textile, Leather and Footwear	0.24	Electrical and Optical Equipment	-0.54
	Basic Metals and Fabricated Metal	0.28	Food, Beverages and Tobacco	-0.19
	Mining and Quarrying	0.39	Chemicals and Chemical Products	-0.19
Canada	Mining and Quarrying	0.17	Pulp, Paper, Printing and Publishing	-1.06
	Transport Equipment	1.29	Chemicals and Chemical Products	-0.50
	Rubber and Plastics	2.32	Electrical and Optical Equipment	-0.45
China	Textile, Leather and Footwear	0.10	Machinery	-0.63
	Rubber and Plastics	0.11	Chemicals and Chemical Products	-0.40
	Manufacturing, Nec; Recycling	1.16	Pulp, Paper, Printing and Publishing	-0.17
Germany	Transport Equipment	0.15	Electrical and Optical Equipment	-0.78
	Machinery	0.18	Textile, Leather and Footwear	-0.34
	Basic Metals and Fabricated Metal	0.74	Mining and Quarrying	-0.18
Denmark	Mining and Quarrying	0.30	Food, Beverages and Tobacco	-0.97
	Chemicals and Chemical Products	0.41	Transport Equipment	-0.85
	Basic Metals and Fabricated Metal	2.03	Agriculture, Hunting, Forestry and Fishing	-0.44
Spain	Transport Equipment	0.09	Food, Beverages and Tobacco	-0.22
	Other Non-Metallic Mineral	0.27	Electrical and Optical Equipment	-0.21
	Textile, Leather and Footwear	0.35	Agriculture, Hunting, Forestry and Fishing	-0.16
Finland	Electrical and Optical Equipment	0.86	Pulp, Paper, Printing and Publishing	-2.54
	Basic Metals and Fabricated Metal	1.16	Agriculture, Hunting, Forestry and Fishing	-1.49
	Machinery	3.08	Food, Beverages and Tobacco	-0.52
France	Agriculture, Hunting, Forestry and Fishing	0.35	Mining and Quarrying	-0.60
	Transport Equipment	0.36	Machinery	-0.41
	Food, Beverages and Tobacco	1.42	Textile, Leather and Footwear	-0.33
United Kingdom	Mining and Quarrying	0.46	Transport Equipment	-1.15
	Agriculture, Hunting, Forestry and Fishing	0.86	Basic Metals and Fabricated Metal	-1.08
	Food, Beverages and Tobacco	4.43	Machinery	-0.96

Table C.3.1: Largest Gain and Largest Loss Sectors due to Changes in Specialization

Country	Largest gain sectors	Change	Largest loss sectors	Change
Greece	Agriculture, Hunting, Forestry and Fishing	0.52	Transport Equipment	-1.39
	Textile, Leather and Footwear	1.00	Machinery	-1.10
	Mining and Quarrying	1.27	Electrical and Optical Equipment	-0.75
India	Agriculture, Hunting, Forestry and Fishing	0.11	Mining and Quarrying	-1.36
	Textile, Leather and Footwear	0.83	Basic Metals and Fabricated Metal	-0.33
	Chemicals and Chemical Products	1.06	Pulp, Paper, Printing and Publishing	-0.11
Italy	Textile, Leather and Footwear	0.40	Electrical and Optical Equipment	-0.79
	Machinery	0.59	Transport Equipment	-0.79
	Mining and Quarrying	1.39	Chemicals and Chemical Products	-0.44
Japan	Electrical and Optical Equipment	0.20	Textile, Leather and Footwear	-0.70
	Machinery	0.50	Mining and Quarrying	-0.31
	Transport Equipment	0.55	Food, Beverages and Tobacco	-0.15
Republic of Korea	Electrical and Optical Equipment	1.45	Agriculture, Hunting, Forestry and Fishing	-6.46
	Manufacturing, Nec; Recycling	1.70	Mining and Quarrying	-2.25
	Transport Equipment	1.73	Food, Beverages and Tobacco	-0.54
Mexico	Transport Equipment	1.24	Agriculture, Hunting, Forestry and Fishing	-2.18
	Mining and Quarrying	1.24	Food, Beverages and Tobacco	-0.65
	Electrical and Optical Equipment	1.46	Chemicals and Chemical Products	-0.56
Portugal	Textile, Leather and Footwear	0.44	Agriculture, Hunting, Forestry and Fishing	-2.18
	Manufacturing, Nec; Recycling	0.86	Food, Beverages and Tobacco	-0.66
	Mining and Quarrying	2.09	Chemicals and Chemical Products	-0.62
Sweden	Chemicals and Chemical Products	0.16	Textile, Leather and Footwear	-0.56
	Coke, Petroleum and Nuclear Fuel	0.43	Basic Metals and Fabricated Metal	-0.34
	Rubber and Plastics	0.87	Pulp, Paper, Printing and Publishing	-0.29
Taiwan	Electrical and Optical Equipment	1.80	Agriculture, Hunting, Forestry and Fishing	-6.00
	Textile, Leather and Footwear	3.29	Mining and Quarrying	-3.28
	Manufacturing, Nec; Recycling	3.94	Food, Beverages and Tobacco	-2.39
United States	Agriculture, Hunting, Forestry and Fishing	0.21	Textile, Leather and Footwear	-0.36
	Pulp, Paper, Printing and Publishing	0.25	Transport Equipment	-0.30
	Mining and Quarrying	0.44	Electrical and Optical Equipment	-0.19

Table C.3.2: Largest Gain and Largest Loss Sectors due to Changes in Specialization

Appendix D

Data Appendix for Chapter 2

D.1 Description of the Dataset

Orbis: data selection. I collect my firm-level dataset using Orbis Historical. I select countries following Bajgar et al. (2020), who study the coverage and representativeness of Orbis against the industry-level and firm population data benchmarks. They offer a 'preferred' sample of countries and years where a) Orbis data covers a significant amount of aggregate sales, b) coverage is stable over time, c) correlation of Orbis- and population-derived moments is high. I work with the seven economies in the 'preferred' sample, and add Spain, which was not a part of the representativeness analysis for lack of a benchmark. Bajgar et al. (2020) further argue that time variation in Orbis is contaminated by selection. Thus, I dispense with the time dimension and focus on one year only. I pick 2007, which is the latest year before the Great Financial Crisis and which falls within the 'preferred' sample for each of the economies. I drop all firms in NACE Rev. 2 Sections D (Electricity, gas, steam and air conditioning supply), E (Water supply; sewerage, waste management and remediation activities), O (Public administration and defence; compulsory social security), T (Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use) and U (Activities of extraterritorial organisations and bodies). I drop all observations with NACE Rev. 2 4-digit industry classification ending in '00' or '000', as these are over-represented, compared to non-round industries, potentially indicating imprecise classification.

Orbis: data cleaning. I follow Kalemli-Ozcan et al. (2015) abstract A.5.3 steps 3 to 10 when cleaning the data. This involves (3) dropping all observations with missing information on total assets and operating revenue and sales and employment (simultaneously), (4) dropping the entire company (all years) if total assets is negative in any year, (5) dropping the entire company if employment (in persons) is negative in any year and companies with employment larger than that of Walmart (2 million) in any year, (6) dropping the entire company if sales are negative in any year, (7) dropping the entire company when reporting in any year a value of employment per million of total assets larger than the 99.9 percentile of the distribution, (8) dropping the entire company when reporting in any year a value of employment per million of sales larger than the 99.9 percentile of the distribution, (9) dropping the entire company when reporting in any year a value of sales to total assets larger than the 99.9 percentile of the distribution, (10) dropping the entire company if Tangible Fixed Assets (such as buildings, machinery, etc.)is negative in any year. If the firm ID appears more than once in my sample, I pick the observation with the latest account date.

Tradable sector classification. I use Mian and Sufi (2014) tradable industry classification when assigning industries into 'tradable' and 'non-tradable'. I pick classification method #1, which designates industry as tradable if it has imports plus exports equal to at least $10,000 per worker, or if total exports plus imports for the NAICS four-digit industry exceed $500M. When no classification is available, I designate all sectors in NACE Rev. 2 sections A, B and C to 'tradable'.

Appendix E

Proofs for Chapter 2

E.1 Proof of Proposition 1

Begin with the derivative of unit labour costs with respect to a shock in firm i productivity:

$$\frac{dulc}{dz_i} = -\frac{\sigma-1}{\sigma}\frac{\sum_i s_i^2}{\sum_i s_i}\sum_i (2h_i - d_i)\frac{ds_i}{dz_i}\frac{1}{s_i},$$

where $h_i = s_i^2/\sum_j s_j^2$ and $d_i = s_i/\sum_j s_j$. Sales shares respond to the change directly, but also to the changes in the relative factor costs:

$$\frac{ds_i}{dz_i}\frac{1}{s_i} = \left(\frac{1}{z_i} - \frac{s_i v(s_i)}{v^G}\frac{1}{z_i} - \frac{v^*}{v^G}\frac{d\omega}{dz_i}\frac{1}{\omega}\right)v(s_i),$$

$$\frac{ds_j}{dz_i}\frac{1}{s_j} = -\left(\frac{s_i v(s_i)}{v^G}\frac{1}{z_i} + \frac{v^*}{v^G}\frac{d\omega}{dz_i}\frac{1}{\omega}\right)v(s_j),$$

$$\frac{ds_j^*}{dz_i}\frac{1}{s_j^*} = -\left(\frac{s_i v(s_i)}{v^G}\frac{1}{z_i} - \frac{v}{v^G}\frac{d\omega}{dz_i}\frac{1}{\omega}\right)v(s_j^*), \text{ where}$$

$$v(s_i) = \left((\sigma-1)^{-1} + \frac{s_i}{1-s_i}\right)^{-1}, \quad v^* = \sum_i s_i v(s_i), \quad v^* = \sum_i s_i^* v(s_i^*), \quad v^G = v + v^*.$$

Plugging in,

$$\frac{dulc}{dz_i} = \frac{\sigma-1}{\sigma}\frac{\sum_i s_i^2}{\sum_i s_i}\left[\sum_j (2h_j - d_j)\,v(s_j)\left(\frac{s_i v(s_i)}{v^G}\frac{1}{z_i} + \frac{v^*}{v^G}\frac{d\omega}{dz_i}\frac{1}{\omega}\right) - (2h_i - d_i)\,v(s_i)\frac{1}{z_i}\right].$$

Suppose the economies are in financial autarky. In this case, the relative factor costs are as follows:

$$\omega = \left(\frac{w}{w^*}\right)^{1-\alpha}\left(\frac{r}{r^*}\right)^{\alpha} = \frac{(1-\pi)Y/L}{(1-\pi^*)Y^*/L^*}, \text{ and}$$

$$\frac{d\omega}{dz_i} = \omega\left(-\frac{d\pi}{dz_i}\frac{1}{1-\pi} + \frac{d\pi^*}{dz_i}\frac{1}{1-\pi^*} + \frac{dY/Y^*}{dz_i}\frac{1}{Y/Y^*}\right), \text{ where}$$

$$\frac{d\pi}{dz_i} = \frac{\sigma-1}{\sigma}\frac{\sum_i s_i^2}{\sum_i s_i}\sum_i (2h_i - d_i)\frac{ds_i}{dz_i}\frac{1}{s_i},$$

$$\frac{d\pi^*}{dz_i} = \frac{\sigma-1}{\sigma}\frac{\sum_i s_i^{*2}}{\sum_i s_i^*}\sum_i (2h_i^* - d_i^*)\frac{ds_i^*}{dz_i}\frac{1}{s_i^*},$$

$$\frac{dY/Y^*}{dz_i}\frac{1}{Y/Y^*} = \sum_i d_i\frac{ds_i}{dz_i}\frac{1}{s_i} - \sum_i d_i^*\frac{ds_i^*}{dz_i}\frac{1}{s_i^*}.$$

Plugging in and combining with the sales share derivative equations,

$$\frac{d\omega}{dz_i}\frac{1}{\omega} = b_i\frac{1}{z_i} - b\left(\frac{s_i v(s_i)}{v^G}\frac{1}{z_i} + \frac{v^*}{v^G}\frac{d\omega}{dz_i}\frac{1}{\omega}\right) + b^*\left(\frac{s_i v(s_i)}{v^G}\frac{1}{z_i} - \frac{v}{v^G}\frac{d\omega}{dz_i}\frac{1}{\omega}\right),$$

$$\frac{d\omega}{dz_i}\frac{1}{\omega} = \frac{b_i v^G - (b-b^*)s_i v(s_i)}{v^G + bv^* + b^* v}\frac{1}{z_i}, \text{ where } \quad b_i = d_i v(s_i) - \frac{\sigma-1}{\sigma}\frac{1}{1-\pi}\frac{\sum_i s_i^2}{\sum_i s_i}(2h_i - d_i)\,v(s_i),$$

$$b = \sum_i b_i, \text{ and } \quad b^* = \sum_i\left(d_i^* v(s_i^*) - \frac{\sigma-1}{\sigma}\frac{1}{1-\pi^*}\frac{\sum_i s_i^{*2}}{\sum_i s_i^*}(2h_i^* - d_i^*)\,v(s_i^*)\right).$$

Plugging back into the derivative of unit labour costs,

$$\frac{dulc}{dz_i} = \frac{\sigma-1}{\sigma}\frac{\sum_i s_i^2}{\sum_i s_i}\left[\sum_j (2h_j - d_j)\,v(s_j)\left(\frac{s_i v(s_i) + b_i v^* + b^* s_i v(s_i)}{v^G + bv^* + b^* v}\right) - (2h_i - d_i)\,v(s_i)\right]\frac{1}{z_i}.$$

Note that $\frac{\sigma-1}{\sigma}\frac{\sum_i s_i^2}{\sum_i s_i}(2h_i - d_i)\,v(s_i) = (1-\pi)\,(d_i v(s_i) - b_i)$. Plugging in,

$$\begin{aligned}\frac{dulc}{dz_i} &= -\frac{1-\pi}{v^G + bv^* + b^* v}\times \\ &\left[\left(\sum_i d_i v(s_i) - b\right)(s_i v(s_i)(1+b^*) + v^* b_i) - (d_i v(s_i) - b_i)\left(v^G + bv^* + b^* v\right)\right] = \\ &-\frac{(1-\pi)}{v^G + bv^* + b^* v}\left[\frac{v^*}{Y}(s_i v(s_i) - b_i Y) + \left(1 + b^* + \frac{v^*}{Y}\right)(s_i v(s_i) b - b_i v)\right] = \\ &-\frac{(1-\pi)}{v^G + bv^* + b^* v}\left[\frac{v^* s_i v(s_i)}{Y(1-s)}(2s_i - s) + \left(1 + b^* + \frac{v^*}{Y}\right)\frac{2s_i v(s_i)}{Y(1-s)}\left(\sum_j s_j v(s_j)\,(s_i - s_j)\right)\right].\end{aligned}$$

$1 + b > 0$, $1 + b^* > 0$, so the denominator in the first sum is positive.
$s_1 \geq s_j$ and $s_1 \geq s = \sum_j d_j s_j$, so the square bracket is positive and $\frac{dulc}{dz_1} < 0$.
$s_N \leq s_j$, so the last term is non-positive for the least productive firm. A sufficient condition for the whole expression in the square brackets to be non-positive is that $2s_z \leq s$, in which case $\frac{dulc}{dz_N} \geq 0$.

E.2 Proof of Proposition 5

The first step is to show that $\frac{d\omega}{dca} \leq 0$, where ω is the relative factor costs:

$$\omega = \left(\frac{w}{w^*}\right)^{1-\alpha}\left(\frac{r}{r^*}\right)^{\alpha} = \left(\frac{w}{w^*}\right)^{1-\alpha} = \left(\frac{(1-\pi)Y/L}{(1-\pi^*)Y^*/L^*}\right)^{1-\alpha}.$$

Let $ca = CA/Y$ be the current account to GDP ratio of home. Let $ca = 0$ at t.

$$\frac{d\omega}{dca} = (1-\alpha)\omega\left(-\frac{d\pi}{dca}\frac{1}{1-\pi} + \frac{d\pi^*}{dca}\frac{1}{1-\pi^*} + \frac{dY/Y^*}{dca}\frac{1}{Y/Y^*}\right).$$

First, solve for the derivatives as functions of objects in the tradable sector:

$$\begin{aligned}
1-\pi =& \frac{Y_m}{Y}(1-\pi_m) + \frac{Y_s}{Y}(1-\pi_s), \quad \frac{Y_m}{Y} = \gamma_m + \gamma_s ca \quad \rightarrow \quad \frac{d\pi}{dca} = \gamma_m\frac{d\pi_m}{dca} - \gamma_s(\pi_s - \pi_m),\\
1-\pi^* =& \frac{Y_m^*}{Y^*}(1-\pi_m^*) + \frac{Y_s^*}{Y^*}(1-\pi_s^*), \quad \frac{Y_m^*}{Y^*} = \gamma_m - \gamma_s ca\frac{Y}{Y^*} \quad \rightarrow \quad \frac{d\pi^*}{dca} = \gamma_m\frac{d\pi_m^*}{dca} + \gamma_s(\pi_s^* - \pi_m^*),\\
\frac{Y}{Y^*} =& \frac{Y_m/(\gamma_m + \gamma_s ca)}{Y_m^*/(\gamma_m - \gamma_s caY/Y^*)} \quad \rightarrow \quad \frac{dY/Y^*}{dca}\frac{1}{Y/Y^*} = \frac{dY_m/Y_m^*}{dca}\frac{1}{Y_m/Y_m^*} - \frac{\gamma_s}{\gamma_m}\left(1+\frac{Y}{Y^*}\right).
\end{aligned}$$

Plugging in,

$$\begin{aligned}
\frac{d\omega}{dca} =& (1-\alpha)\omega\Bigg(-\frac{\gamma_m}{1-\pi}\frac{d\pi_m}{dca} + \frac{\gamma_s(\pi_s-\pi_m)}{1-\pi} + \frac{\gamma_m}{1-\pi^*}\frac{d\pi_m^*}{dca} + \frac{\gamma_s(\pi_s^*-\pi_m^*)}{1-\pi^*} + \ldots\\
&+ \frac{dY_m/Y_m^*}{dca}\frac{1}{Y_m/Y_m^*} - \frac{\gamma_s}{\gamma_m}\left(1+\frac{Y}{Y^*}\right)\Bigg) = \ldots\\
=& \left(\frac{1}{1-\alpha}\frac{1}{\omega} - \frac{\gamma_m}{1-\pi}\frac{d\pi_m}{d\omega} + \frac{\gamma_m}{1-\pi^*}\frac{d\pi_m^*}{d\omega} + \frac{dY_m/Y_m^*}{d\omega}\frac{1}{Y_m/Y_m^*}\right)^{-1} \times\\
&\gamma_s\left(\frac{\pi_s-\pi_m}{1-\pi} - \frac{1}{\gamma_m} + \left(\frac{\pi_s^*-\pi_m^*}{1-\pi} - \frac{1}{\gamma_m}\right)\frac{Y}{Y^*}\right).
\end{aligned}$$

The second bracket is always non-positive:

$$\frac{\pi_s-\pi_m}{1-\pi} - \frac{1}{\gamma_m} + \left(\frac{\pi_s^*-\pi_m^*}{1-\pi} - \frac{1}{\gamma_m}\right)\frac{Y}{Y^*} \leq 0 \quad \text{as} \quad \frac{\pi_s-\pi_m}{1-\pi} \leq \frac{1}{\gamma_m}.$$

The rest of the proof is concerned with showing that the first bracket is non-negative.

$$\frac{d\pi_m}{d\omega} = \frac{\sigma-1}{\sigma}\frac{\sum_i s_i^2}{\sum_i s_i}\sum_i (2h_i - d_i)\frac{ds_i}{d\omega}\frac{1}{s_i}, \text{ where } \frac{ds_i}{d\omega}\frac{1}{s_i} = -\frac{v^*}{v^G}\frac{1}{\omega}v(s_i),$$

$$v(s_i) = \left((\sigma-1)^{-1} + \frac{s_i}{1-s_i}\right)^{-1}, \quad v^* = \sum_i s_i v(s_i), \quad v^* = \sum_i s_i^* v(s_i^*), \quad v^G = v + v^*.$$

$h_i = s_i^2/\sum_j s_j^2$ and $d_i = s_i/\sum_j s_j$.

$$\frac{d\pi_m^*}{d\omega} = \frac{\sigma-1}{\sigma}\frac{\sum_i s_i^{*2}}{\sum_i s_i^*}\sum_i (2h_i^* - d_i^*)\frac{ds_i^*}{d\omega}\frac{1}{s_i^*}, \text{ where } \frac{ds_i^*}{d\omega}\frac{1}{s_i^*} = \frac{v}{v^G}\frac{1}{\omega}v(s_i^*).$$

$$\frac{dY_m/Y_m^*}{d\omega}\frac{1}{Y_m/Y_m^*} = \sum_i d_i\frac{ds_i}{d\omega}\frac{1}{s_i} - \sum_i d_i^*\frac{ds_i^*}{d\omega}\frac{1}{s_i^*} = -\left(\frac{vv^*}{Yv^G} + \frac{vv^*}{Y^*v^G}\right)\frac{1}{\omega}.$$

Plugging back into the bracket,

$$\frac{1}{1-\alpha}\frac{1}{\omega} - \frac{\gamma_m}{1-\pi}\frac{d\pi_m}{d\omega} + \frac{\gamma_m}{1-\pi^*}\frac{d\pi_m^*}{d\omega} + \frac{dY_m/Y_m^*}{d\omega}\frac{1}{Y_m/Y_m^*} = \dots$$

$$\frac{1}{\omega}\left(\frac{1}{1-\alpha} - \frac{v^*}{v^G}\left(\frac{\gamma_m}{1-\pi}\frac{\sigma-1}{\sigma}\frac{\sum_i s_i^2}{\sum_i s_i}\sum_i (2h_i - d_i)\,v(s_i) - \sum_i d_i v(s_i)\right) - \dots\right.$$
$$\left. -\frac{v}{v^G}\left(\frac{\gamma_m}{1-\pi^*}\frac{\sigma-1}{\sigma}\frac{\sum_i s_i^{*2}}{\sum_i s_i^*}\sum_i (2h_i^* - d_i^*)\,v(s_i^*) - \sum_i d_i^* v(s_i^*)\right)\right).$$

The bracket is non-negative if

$$\frac{\gamma_m}{1-\pi}\frac{\sigma-1}{\sigma}\frac{\sum_i s_i^2}{\sum_i s_i}\sum_i (2h_i - d_i)\,v(s_i) - \sum_i d_i v(s_i) \leq 1.$$

If $s_i \leq 1/\sigma$, then $\dfrac{\sum_i s_i^2}{\sum_i s_i} \leq 1/\sigma$, $\quad \sum_i (2h_i - d_i)\,v(s_i) \leq \dfrac{3(\sigma-1)}{4}$, $\quad \sum_i d_i v(s_i) \leq \dfrac{\sigma-1}{2}$.

Since $\pi_s \leq 1$ and $1/\sigma \leq \pi_m \leq 1$, the minimal value that $\dfrac{\gamma_m}{1-\pi}$ can take is $\dfrac{1}{1-\pi_m} = \left(\dfrac{\sigma}{1-\sigma}\right)^2$.

Plugging in,

$$\frac{\sigma}{1-\sigma}\frac{1}{\sigma}\frac{3}{4} \leq \left(\frac{1}{\sigma-1} + \frac{1}{2}\right)\left(\frac{\sigma}{\sigma-1}\right)^2 \to \frac{3}{4} \leq 1 + \frac{\sigma-1}{2}$$

which always holds. Thus, $\dfrac{d\omega}{dca} \leq 0$.

Finally,

$$\frac{d\pi}{dca} = \gamma_m \frac{d\pi_m}{d\omega}\frac{d\omega}{dca} - \gamma_s(\pi_s - \pi_m).$$

If $s_i \leq 1/\sigma$, then $\dfrac{d\pi_m}{d\omega} = -\dfrac{\sigma - 1}{\sigma}\dfrac{v^*}{v^G}\dfrac{1}{\omega}\dfrac{\sum_i s_i^2}{\sum_i s_i}\sum_i (2h_i - d_i)\, v(s_i) \leq 0$.

If $\pi_s \leq \pi_m$, then $\dfrac{d\pi}{dca} \geq 0$.

If $\pi_s \geq \pi_m$, then $\dfrac{d\pi}{dca} \geq 0$ if $\pi_s = \pi_m + cnst$, where $cnst \leq \dfrac{\gamma_m}{\gamma_s}\dfrac{d\pi_m}{d\omega}\dfrac{d\omega}{dca}$.

Appendix F

Quantitative Trade Model for Chapter 3

F.1 Quantitative Trade Model

The quantitative model features I economies, K sectors, and N firms in each sector. Production functions are as before:

$$q_{ikn} = a_{ikn} k_{ikn}^{\alpha} l_{ikn}^{1-\alpha}.$$

The intermediate goods are combined into a final good by a final good producer, using a CES technology with an elasticity of substitution $\sigma > 1$ at the variety level, and a Cobb-Douglas technology at the sectoral bundle level:

$$Q_i = \prod_K Q_{ik}^{\gamma_{ik}}, \quad \text{where} \quad Q_{ik} = \left[\sum_{j \in I} \sum_{n \in M_{ijk}} q_{ijkn}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \quad \sum_K \gamma_{ik} = 1,$$

where M_{jik} denotes the set of firms from j that sell sector k varieties in i. Final good producer in i spends γ_{ik} of their revenue on sector k goods:

$$P_{ik} Q_{ik} = \gamma_{ik} Y_i.$$

Firm prices are now:

$$P_{jikn} = \frac{\sigma}{\sigma - 1} \frac{c_{jikn}}{1 - s_{jikn}}, \tag{F.1}$$

where marginal costs of production are market specific:

$$c_{jikn} = \begin{cases} \left(\dfrac{w_i}{1-\alpha} \right)^{1-\alpha} \left(\dfrac{r_i + \delta}{\alpha} \right)^{\alpha} \dfrac{1}{a_{ikn}} & \text{if sold domestically,} \\ \\ \left(\dfrac{w_i}{1-\alpha} \right)^{1-\alpha} \left(\dfrac{r_i + \delta}{\alpha} \right)^{\alpha} \dfrac{1}{a_{ikn}} d_{jik} & \text{if sold in } j. \end{cases} \tag{F.2}$$

Now that capital depreciates, I assume that the firms are required to maintain the capital they borrow by investing enough to make up for the depreciated stock. The capital is produced by the final good producer. Firm sales shares are now defined as a share of sales in a given market j, k. Firm sales shares are a function of the price the firm charges vis-à-vis that of its competitors:

$$s_{jikn} = \frac{P_{jikn} q_{jikn}}{P_{jk} Q_{jk}} = \frac{P_{jikn}^{1-\sigma}}{\sum_{i \in I} \sum_{n \in M_{jik}} P_{jikn}^{1-\sigma}}. \tag{F.3}$$

Now that the firms pay a fixed cost of operation, there is a distinction between the gross and net profit. The gross profit rate in each of the markets the firm serves is as before:

$$\pi_{jikn} = \frac{\Pi_{jikn}}{P_{jikn}q_{jikn}} = \frac{P_{jikn}q_{jikn} - c_{jikn}q_{jikn}}{P_{jikn}q_{jikn}} = 1 - \frac{c_{jikn}}{P_{jikn}} = \frac{1}{\sigma} + \frac{\sigma - 1}{\sigma} s_{jikn}.$$

The net profit is the gross profit net of the fixed costs of operation paid in the labour units of the destination market:

$$\Pi^N_{jikn} = \Pi_{jikn} - w_j F.$$

Only firms with non-negative net profits operate in a given market. Let ι_{jikn} be an indicator function that takes the value of one if the firm n is active in market j and zero otherwise:

$$\iota_{jikn} = \begin{cases} 1 & \text{if } \Pi^N_{jikn} \geq 0, \\ 0 & \text{if } \Pi^N_{jikn} < 0. \end{cases} \tag{F.4}$$

Finally, the equilibrium set of firms operating in each market, M_{jik}, is such that (i) it contains the firms in the increasing order of their marginal costs in market j, c_{jik}; (ii) all of them are choosing to operate in j, i.e. $\iota_{jikn} = 1$; (iii) and, if a firm with the next higher marginal cost from any origin were to enter the market, its net profits would have been negative.

Note that the households only consume domestically produced final good, and firms can only buy capital stock locally. Thus, the revenue of the final good producer equals the total expenditure on consumption plus the investment by the firms and the households,

$$E_i = C_i + \Delta A_i + \delta K_i = w_i L_i + r_i A_i + \Pi_i + \delta K_i,$$

where A_i is the aggregate assets held by the domestic households, ΔA_i is the aggregate household investment, and the right hand side expression plugs in the household income. The GDP, on the other hand, is the sum of the revenue of the varieties goods producers:

$$Y_i = w_i L_i + (r_i + \delta) K_i + \Pi_i.$$

If asset markets are in autarky, the two coincide (Case a); if instead capital can cross borders, the two are distinct (Case b):

$$A_i = K_i + \lambda F_i \quad \rightarrow \quad E_i = Y_i, \tag{F.5a}$$

$$A_i \neq K_i + \lambda F_i \quad \rightarrow \quad E_i = Y_i\left(1 + r^G\frac{(A_i - K_i)}{Y_i}\right) = Y_i\left(1 + r^G\frac{NFA_i}{Y_i}\right). \tag{F.5b}$$

Goods market clearing links the two through the optimality conditions of the final good producer:

$$Y_i = \sum_{j\in I}\sum_{k\in K}\sum_{n\in M_{jik}} s_{jikn}\gamma_{jk}E_j. \tag{F.6}$$

Firm level factor demands,

$$(r_i + \delta)k_{ikn} = \sum_{j\in I} \iota_{ijkn}\alpha c_{jikn}q_{jikn},$$

$$w_i l_{ikn} = \sum_{j\in I} \iota_{ijkn}\left((1-\alpha)c_{jikn}q_{jikn} + w_i F\right),$$

can be summed to obtain the aggregate factor demand. The labour market clearing condition is then:

$$w_i L_i = \sum_{j\in I}\sum_{k\in K}\left(\sum_{n\in M_{jik}}(1-\alpha)\frac{\sigma-1}{\sigma}(1-s_{jikn})s_{jikn}\gamma_{jk}E_j + \sum_{n\in M_{ijk}} w_i F\right). \tag{F.7}$$

The asset market clearing condition, once again, differs between autarky (a) and free capital flow (b) cases:

$$r_i\left(K_i + \lambda F_i\right) = \sum_{j\in I}\sum_{k\in K}\sum_{n\in M_{jik}} \alpha\frac{\sigma-1}{\sigma}(1-s_{jikn})s_{jikn}\gamma_{jk}E_j = r_i A_i, \tag{F.8a}$$

$$r^G\sum_{i\in I}\left(K_i + \lambda F_i\right) = \sum_{i\in I}\sum_{j\in I}\sum_{k\in K}\sum_{n\in M_{jik}} \alpha\frac{\sigma-1}{\sigma}(1-s_{jikn})s_{jikn}\gamma_{jk}E_j = r^G\sum_{i\in I} A_i, \tag{F.8b}$$

where F_i is the value of financial assets in economy i:

$$F = \sum_t^{\infty}(1+r_i)^{-t}\Pi_t.$$

Finally, the aggregate profits are as follows:

$$\Pi_i = \sum_{j\in I}\sum_{k\in K}\sum_{n\in M_{jik}} \Pi^N_{jikn} = \frac{1}{\sigma} + \sum_{j\in I}\sum_{k\in K}\sum_{n\in M_{jik}} \frac{\sigma-1}{\sigma} s^2_{jikn}\gamma_{jk}E_j. \tag{F.9}$$

On the household side, non-financial income of domestic workers and capitalists is age specific and follows the following schedule:

$$y^w_s = \begin{cases} w(1-\tau^{lab}) & \text{if } 0 < s \le t_3, \\ T^{soc} & \text{if } s > t_3, \end{cases} \quad \text{and} \quad y^c_s = \begin{cases} w(1-\tau^{lab}) & \text{if } 0 < s \le t_1, \\ w(1-\tau^{lab}) + \dfrac{\Pi(1-\lambda)}{\mu L} & \text{if } t_1 < s \le t_2, \\ w(1-\tau^{lab}) & \text{if } t_2 < s \le t_3, \\ T^{soc} & \text{if } s > t_3, \end{cases}$$

where the country subscripts are suppressed for ease of exposition. The budget constraint is standard:

$$c^i_t + a^i_t = y^i_t + (1+r_t)a^i_{t-1}, \quad \text{where} \quad i \in \{w, c\}. \tag{F.10}$$

The agent receives the inheritance from their grandparent, so the asset holdings at the start of life are the assets held at the date of death by their grandparent, $a^i_0 = a^i_T$. Utility function for each type is as follows:

$$U = \sum_{s=0}^{T} \beta^s \frac{(c^i_s/o)^{1-\nu_s}}{1-\nu_s} + k\frac{((a^i_T + \underline{a})/o)^{1-\nu_T}}{1-\nu_T},$$

where $\nu_{s+1} = \nu_{slope}\nu_s$ and all parameters are positive. First order conditions require that

$$c^i_{s+1} = [\beta(1+r_{t+1})]^{\frac{1}{\nu_{s+1}}} o^{\frac{1-\nu_{slope}}{\nu_{slope}}} \left(c^i_s\right)^{\frac{1}{\nu_{slope}}}, \tag{F.11}$$

$$c^i_T = k^{-\frac{1}{\nu_{slope}}}(a^i_T + \underline{a}). \tag{F.12}$$

Aggregate asset demand in economy i is the sum of assets held by agents of each age and summed across types:

$$A_i = (1-\mu)L_i \sum_{s=0}^{T-1} a^w_s + \mu L_i \sum_{s=0}^{T-1} a^c_s. \tag{F.13}$$

Definition 1A: **(Steady state under financial autarky)**. The autarkic steady state equilibrium is a set of firm-level shares of each of country-specific sectoral goods markets $\{s\}_{jikn}$, the associated entry decisions $\{\iota\}_{jikn}$ and the set of entrants $\{M\}_{jik}$, as well as wages $\{w\}_i$, autarkic interest rates $\{r\}_i$, and the levels of GDP $\{Y\}_i$ and expenditure $\{E\}_i$ for each economy such that:

[i] Each firm's share of each of the markets it serves satisfies the firm's optimal pricing equations (F.1) and (F.2) and the final good producers' demand (F.3),

[ii] Firms optimally choose which markets to serve subject to (F.4), and the set of firms operating in each market M_{jik} satisfies the free entry condition,

[iii] Each $\{Y\}_i$ and $\{E\}_i$ satisfy the GDP accounting condition (F.5a) and the final good market clearing condition (F.6),

[iv] Each wage in $\{w\}_i$ satisfies the respective labour market clearing condition (F.7),

[v] Each interest rate in $\{r\}_i$ satisfies the asset market clearing condition (F.8a), where domestic asset demand is determined according to (F.9), (F.10), (F.11), (F.12), (F.13).

Definition 1A: **(Steady state under financial integration)**. The free capital flow steady state equilibrium is a set of firm-level shares of each of country-specific sectoral goods markets $\{s\}_{jikn}$, the associated entry decisions $\{\iota\}_{jikn}$ and the set of entrants $\{M\}_{jik}$, the global interest rate r^G, as well as wages $\{w\}_i$, the levels of GDP $\{Y\}_i$ and expenditure $\{E\}_i$ for each economy such that:

[i] Each firm's share of each of the markets it serves satisfies the firm's optimal pricing equations (F.1) and (F.2) and the final good producers' demand (F.3),

[ii] Firms optimally choose which markets to serve subject to (F.4), and the set of firms operating in each market M_{jik} satisfies the free entry condition,

[iii] Each $\{Y\}_i$ and $\{E\}_i$ satisfy the GDP accounting condition (F.5b) and the final good market clearing condition (F.6),

[iv] Each wage in $\{w\}_i$ satisfies the respective labour market clearing condition (F.7),

[v] The global interest rate r^G satisfies the global asset market clearing condition (F.8b), where each country's asset demand is determined according to (F.9), (F.10), (F.11), (F.12), (F.13).

F.2 Isomorphism

The first order condition of the firm in the world with no size-related distortions is as follows:

$$P_{jikn} = \frac{\sigma}{\sigma - 1} \frac{c_{jik}}{z_{ikn}(1 - s_{jikn})},$$

where c_{jik} is the unit cost of a firm with unit productivity and

$$s_{jikn} = \frac{P_{jikn}^{1-\sigma}}{\sum_{i \in I} \sum_{n \in N} P_{jikn}^{1-\sigma}}.$$

The first order condition of the firm in the world where size-related distortions apply is as follows:

$$P_{jikn} = \frac{\sigma}{\sigma - 1} \frac{c_{jik}}{(1 - \tau_{ikn}) z'_{ikn}(1 - s_{jikn})} = \frac{\sigma}{\sigma - 1} \frac{c_{jik}}{(1 - \bar{\tau}_{ik}) {z'_{ikn}}^{1-\psi_i}(1 - s_{jikn})},$$

where s_{jikn} is as before and $\bar{\tau}_{ik} < 1$ is a constant. The two first order conditions coincide for $z_{ikn} = (1 - \bar{\tau}_{ik}) {z'_{ikn}}^{1-\psi_i}$. Since no other elements of the model change, the two worlds are observationally equivalent. Knowing that z is distributed according to the following CDF:

$$G_{ik}(z) = 1 - \left(\frac{\underline{z}_{ik}}{z}\right)^{\theta_i \theta_k},$$

we can also see that z' is distributed according to

$$G'_{ik}(z') = 1 - \left(\frac{(\underline{z}_{ik}/(1 - \bar{\tau}_{ik}))^{\frac{1}{1-\psi_i}}}{z'}\right)^{\theta_k}, \quad \text{where} \quad \psi_i = 1 - \frac{1}{\theta_i}.$$

In other words, the world with heterogeneous tail parameters $\theta_{ik} = \theta_i \theta_k$ and no distortions, and the world with homogeneous tail parameters (that vary by sector) θ_k and size-related distortions with elasticity ψ_i are observationally equivalent.

Note that while the equivalence result holds for any set of $\bar{\tau}_{ik}$, the results of the counterfactual with the size-related distortions removed in Section 3.4 depend on the size of $\bar{\tau}$. Following the literature, I consider a counterfactual experiment of removing the size-dependence of the distortions without changing the average distortion that applies. Since my baseline model features no distortions, this means picking $\bar{\tau}$ such that

$$\sum_n (1 - \tau_{ikn}) d_{ikn} = \sum_n (1 - \bar{\tau}_{ik}) (z'_{ikn})^{-\psi_i} d_{ikn} = 1, \quad \text{where} \quad d_{ikn} = \frac{\sum_j p_{jikn} q_{jikn}}{\sum_n \sum_j p_{jikn} q_{jikn}}.$$

Appendix G

Calibration of the Quantitative Model for Chapter 3

G.1 Calibration of the Expenditure Shares

In the data, the output is used both for final consumption and as intermediate inputs into production. For ease of exposition, I abstract from the intermediate inputs use in my model. This means that the objects in the data do not readily correspond to ones in the model. I choose to match the trade shares in the data and the levels of GDP precisely. This means that the consumption and production series in the data need to be adjusted.

WIOD provides the final and intermediate expenditure series, X_{jik}^{FC} and X_{jikn}^{II}. I use the absorption, $X_{jik} = X_{jik}^{FC} + X_{jikn}^{II}$, to obtain trade shares:

$$\Pi_{ijk} = \frac{X_{ijk}}{\sum_l X_{ilk}}.$$

Next, I solve for the expenditure shares, sectoral value added shares, and aggregate deficits that are consistent with trade shares and the GDP series in the data on one hand, and the market clearing conditions in the model on the other:

$$va_{ik} Y_i = \sum_j \Pi_{jik} \gamma_{jk} D_j Y_j.$$

G.2 Calibration with Non-Zero Current Account

In the data, the current account imbalances are non-zero in my target year 2007. As shown in Proposition 5, this affects the sales shares of the economies. In order to calibrate the production side parameters that justify the observed concentration and trade flow series, I add wedges between the aggregate final expenditure and the GDP during the calibration, such that in my calibration, the equation (F.5b) becomes

$$E_i = Y_i + CA_i,$$

where CA is current account imbalance observed in the data.