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Evolution of Locations, Specialisation and Factor Returns with Two Distinct Waves of Globalisation

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Abstract
This paper presents an economic geography model with two differentiated sectors that exhibit weaker inter and stronger intra-industry input-output linkages. Labour is also differentiated according to skills in a hierarchy of tasks they can perform. Globalisation occurs in two distinct phases, leading to the agglomeration of an industry (manufacturing) in the first wave, which is subsequently displaced by the other industry (services) when the second wave of globalisation takes place. Because of agglomeration effects, the increase in relative endowment of a factor may increase its relative wages, leading to more inequality. Within and between nations inequality can result.

Keywords: Agglomeration, Wage Inequality, Globalisation
JEL Classifications: F02, F12, F16

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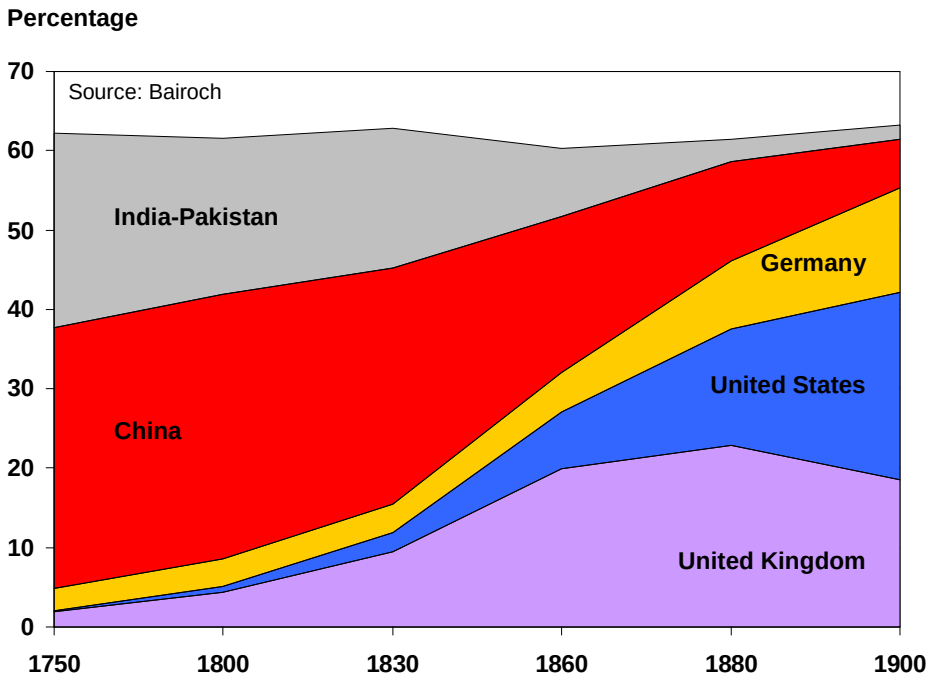
1 Introduction

A Historical and Contemporary Overview In 1750, before the Industrial Revolution, China and India produced almost 60 per cent of the world's manufactured goods. Yet, at the turn of the 20th century, the UK was considered the workshop of the world as it produced and exported a huge range of manufactured goods. China and India's share of world manufacturing became minuscule. Manufacturing was also highly concentrated. Three countries - UK, Germany and the United States - accounted for more than 50 per cent of global manufacturing output in 1900 [Figure 1][1].

Figure 1: Share of World Manufacturing 1750 - 1900

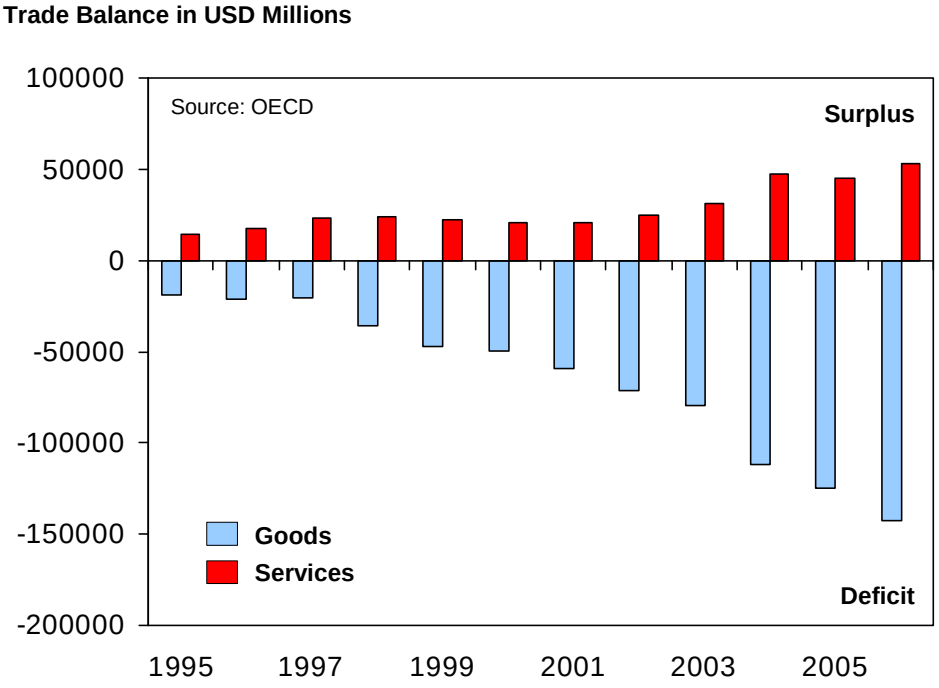


Today, manufacturing is but a small share of the UK's GDP, falling from 30 per cent in 1973 to 16 per cent in 2003[2]. In its place, a thriving service sector has emerged as epitomised by the city of London. UK exports services to the rest of the world in exchange for manufactured goods. Its per capita service exports are the highest among the G-7 major industrialised nations. In 2006, its service trade recorded a US$53 billion

[1] Paul Bairoch, "International Industrialization Levels from 1750 to 1980"
[2] Source: Confederation of British Industries (CBI).

surplus while merchandise trade recorded a deficit of US$143 billion, a persistent pattern of exporting services and importing manufactured goods [Figure 2]. If one considers only two broad categories of production - goods and services - and breaks down the current account as such, a clear pattern of specialisation amongst major developed and emerging economies has also emerged [See Appendix]. English speaking countries like the UK, United States, Australia, and even India are increasingly specialising in services and exporting them on a net basis.

Figure 2: UK Current Account Breakdown into Goods and Services



On the other side of the world, a different process is taking place. East Asian economies, including China, have been rapidly industrialising as they become more integrated with the global economy. Within the last three decades, China has transformed itself from an agrarian economy to become one of the largest exporters of manufactured goods to the developed countries. There is a great concentration of manufacturing activities in the cities along China's eastern coast and in East Asia more generally. Today, China, Japan and Korea are some of the largest net exporters of manufactured goods, alongside Germany and Brazil [See Appendix]. The evolution of industrial structure and the general equilibrium implications for factor prices are important research questions.

Two major themes emerge here. Firstly, some developed economies leading the globalisation process are also witnessing the deindustrialisation and offshoring of manufacturing activities, popularly known as "The Great Sucking Sound". The Anglo-Saxon economies have become some of the largest net importers of manufactured goods, giving rise to the fear of industrial hollowing out and job losses. As Richard E. Baldwin and Philippe Martin (1999) note, "The annual rate of de-industrialisation [of OECD countries] jumped sharply as globalisation picked up pace in the 1980s"[3]. On a smaller spatial scale, the loss of manufacturing for New York and London for example has been well documented [Peter Gripaios (1977); Robert Dennis (1978); Frank P. Romo and Michael Schwartz (1995)].

Secondly, there has been a marked increase in inequality as a result of the stagnation of blue-collar wages [John Bound and George Johnson (1992, 1995); Baldwin and Martin (1999)]. More recently, even the offshoring of some white-collar jobs has become a source of concern. It has led some economists to point out the potential causal link between offshoring and wage stagnation [Robert C. Feenstra and Gordon H. Hanson (1999)]. The link between trade, wages and income inequality is still contentious since many economists find skill-biased technological change to be the more plausible explanation of blue-collar wage stagnation. However, the hypothesis that globalisation has resulted in greater income inequality is still a source of keen academic and policy debate, partly because of the contemporaneous nature of de-industrialisation, offshoring, and blue-collar wage stagnation of developed economies.

The key questions remain: Why has so much manufacturing been offshored to developing countries in recent years? Why has the recent wave of globalisation been marked with blue-collar wage stagnation in developed countries and rising within nation inequality [Baldwin and Martin (1999)]? Can the "Shifts in Economic Geography?" [Anthony J. Venables (2006)] be the missing links that explain the contemporaneous occurrence of de-industrialisation and wage inequality?

[3]David Kucera and William Milberg (2002) estimate that trade expansion between OCED and non-OCED countries has resulted in the loss of 3.4 million manufacturing jobs in 10 OECD countries between 1978 and 1990.

Two Waves of Globalisation The two waves mentioned in this paper have specific definitions[4]. In this paper, the first wave of globalisation is characterised by goods trade liberalisation. This can be interpreted as the lowering of tariffs for merchandise (manufactured) goods or a fall in shipping or freight costs[5]. The earlier rounds of General Agreement on Tariff and Trade (GATT) contributed to the process of multilateral reduction in import tariffs. In this first globalisation wave, the services sector remained largely protected from foreign competition (i.e., high trade costs) by legal frameworks, regulations, language, or possibly even cultural and social norms. The exact nature of these costs will not be investigated in this paper.

Services here refer to a range of activities such as finance, banking, insurance, consulting, advertising, marketing, legal work that supply to global consumers and businesses [see the global city literature, Saskia Sassen (1991)]. These are the "advanced producer and financial services sectors that serve the command and control requirement of transnational capital" [Neil Brenner (1998)] - which in essence are activities that require a high skill content, as opposed to Balassa-Samuelson type of services like haircuts or plumbing.

In the second wave of globalisation, this paper assumes that services trade costs fall. There are several reasons why one should treat the liberalisation of services trade as a distinct process. The first explanation is due to technology. The sharp fall in telecommunication costs (as opposed to shipping costs for goods), digitisation of information, proliferation of the internet, are more recent phenomena compared to the first wave of globalisation. The fall in communication costs has opened up a whole range of services that can be carried out away from where production of goods takes place or where the consumers or downstream firms locate. Similarly, outsourcing of office backroom services would not have been economical without the breakthrough in telecommunication technology. Secondly, many countries have also carried out internal reforms to liberalise their services industries (such as the Big Bang in London's financial services sector), allowing a greater degree of market access by

[4]The historical stylised facts of the two waves of globalisation are described in detail in Baldwin and Martin (1999).

[5]Bairoch (1989) estimates that the 800-km shipment transport cost for iron goods as a percentage of production cost to be 27 per cent in 1830, 21 per cent in 1850, 10 per cent in 1880, and 6 per cent in 1910. Shipping costs therefore had already fallen significantly prior to the First World War.

foreign firms. The expansion and deepening of the EU as a single market has also increased market access. Even the greater use of English as a business language can be seen as a reduction of trade cost. These are all relatively recent phenomena compared to the earlier goods trade liberalisation.

Economic Geography in Two Historical Episodes Why might it then be useful to consider trade liberalisation in two episodes? The conclusion of most NEG models is that economic activity can become unevenly spread - allowing a core and a periphery structure to develop [see Anthony J. Venables (2006) for an overview of theory and evidence]. When trade costs are high, production is dispersed in order to serve local markets that cannot otherwise be accessed through trade. When trade costs fall to an intermediate level, agglomeration can result. The salient point about these models is that below a certain level of trade cost (break point), the dispersion of economic activity will not be a stable equilibrium. As Krugman and Venables (1995) show with a horizontal linkages model, a small cost advantage in one location brought about by input-output linkages begets a greater cost advantage by attracting more firms, eventually leading to an outcome characterised by the "Inequality of Nations". Stephen J. Redding and Venables (2004) empirically confirm the importance of market access and sources of supply in explaining variation in per capita income across countries. However, most NEG models do not make any distinction between industries, and are generally silent on which industries actually agglomerate where[6].

Following Masahisa Fujita, Krugman and Venables (1999)[7], this paper assumes two differentiated industries (and one homogeneous industry). To help fix ideas, the two differentiated industries are called manufacturing and services respectively. The first main idea of this paper is that unlike the assumption of many NEG models, trade costs for the two different industries do not fall symmetrically. Rather, this paper assumes that goods trade is liberalised before services trade, thereby allowing manufacturing to agglomerate first.

The agglomeration of manufacturing firms gives rise to an endogenous comparative advantage in the sense that the cost of production (ex-

[6]Except for the distinction between homogeneous agriculture (or the numeraire sector) and the differentiated sector.

[7]Henceforth known as FKV.

cluding wages) becomes relatively lower. Also, there exist input-output linkages between industries. As manufacturing agglomerates in one location, it also draws in services firms (without services being liberalised) simply because manufacturing firms also buy services. This gives the manufacturing location a headstart in services even in the absence of services liberalisation. When services are finally liberalised, this head start becomes a lock-in cost of production advantage, making services firms agglomerate there as well, but potentially displacing manufacturing (or deindustrialisation) in the process[8].

Inequality Within Nations While inequality between nations is the result of early NEG models [Krugman and Venables (1995)], much of the recent debate, controversy about, and opposition to, globalisation is that it creates inequality within nations [Baldwin and Martin (1999)]. On an intuitive level, this is connected to the first theme - namely that manufacturing (including outsourcing of intermediate goods) has relocated from developed western economies to East Asia (first Japan, then the Asian Tigers and finally China) - and how this deindustrialisation has put blue-collar workers under downward wage pressures [Feenstra and Hanson (1999)]. Furthermore, Brenner (1998) notes that social research into global cities has been dominated by some inter-related themes, including "deindustrialisation, . . , expansion and spatial concentration of financial and producer services industries, labour market-segmentation, . . . , socio-spatial polarisation."

In summary, the contribution of this paper is to make use of what is already a standard NEG model and embed it with a multi-industries and multi-factors setup, in which globalisation influences the changes in industrial structure, eventually leading to both within and between

[8] A fore-runner to this paper is by Baldwin, Martin and Gianmarco I.P. Ottaviano (2001) - henceforth known as BMO - which shows that intermediate levels of trade costs may cause industries to agglomerate in the North, a result that is consistent with standard NEG predictions. But when the 'cost of trading ideas' falls (that is, greater global spillover of knowledge), it can result in the relative 'deindustrialisation' of the North, which in that exposition is simply the loss of industries (without being precise on what kind of industries are lost). Unlike BMO (2001), there is no accumulation of capital, no technology spillovers, no learning effects and no 'cost of trading ideas'. Furthermore, this paper shows that the loss of manufacturing is not merely relative, but absolute. The second and distinct wave of globalisation can result in a shift in the endogenously determined comparative advantage - away from manufacturing and to services. As the North gains services firms, it can lose manufacturing firms in absolute terms.

nation inequality.

Limitations NEG models are not without their critics[9]. Firstly, many of the results stem from a specific functional form - namely CES preferences. Secondly, some results such as the home market effect depend on the simplifying assumption that there is a homogeneous good (or sometimes known as agriculture) that is competitively produced and costlessly traded to equalise the wage between two locations. Donald R. Davis (1998) shows that the costless trading assumption is not supported empirically, and that the home market effect disappears if one assumes trade costs to be the same for industrial and homogeneous goods. Thirdly, many NEG models make use of the simplifying assumption that consumption of the differentiated good is a small proportion of total income which ensures incomplete specialisation in equilibrium[10]. This assumes away any congestion cost that arises from agglomeration, leading to 'bang-bang' predictions - that is, full agglomeration of all industries in one location or the other - that are not observed in reality. Finally, NEG models are often analytically intractable, particularly those with feedback loops, and are often only solved by numerical methods.

Many of the simplifying assumptions employed in many NEG models will also be used in this paper, and many of the criticisms will also apply. In particular, the model still relies on the agriculture good as the numeraire. It also relies on numerical solutions to illustrate the key points. In defence however, the model that this paper uses is one where input-output linkages drive the agglomeration process. Its conclusions therefore do not depend on the home market effect. In addition, as mentioned in the introduction, one of the objectives of this paper is to capture the displacement effect. This essentially is to move away from the 'bang-bang' predictions of many NEG models, thereby generating more realistic outcomes for industrial locations.

[9] Peter J. Neary (2000) provides an interesting exposition on the shortcoming of various NEG models.

[10] An alternate way of putting this is that the agricultural sector continues to operate in both regions to equalise wages. The monopolistic but atomistic firms in the industrial sector effectively face an infinite supply of labour at the given wage rate.

2 Model Setup

2.1 Regions

There are two regions in the model, North and South, subscripted by $(j = N, S)$. There are three industries - the agricultural industry A acting as the walrasian, costlessly transported, numeraire good, and two differentiated industries - manufacturing and services. Factors of production are immobile between the two regions.

2.2 A Hierarchy of Skills and Industries

There are three primary factors in the model - high-skilled (K), semi-skilled (L) and unskilled labour (O). All workers are immobile between countries. There is a hierarchy of jobs that they can perform. High-skilled labour can work in all industries. Semi-skilled skilled workers can only work in manufacturing and agriculture; they are unproductive in services. Unskilled workers can only work in the agricultural industry, and are unproductive if used in the other two sectors. The skill level of a worker is therefore characterised by the range of tasks that he can perform. For example, a PhD can become equally productive as a farmer when he is deployed to a farm, but a farmer has zero productivity when deployed to a university. Succinctly put, a skilled worker is a perfect substitute for all workers with skills below him but an unskilled or semi-skilled worker is not a substitute for the worker type above him.

There are many reasons why this specification is attractive. Consider an alternative formulation where one allows the more productive worker a Ricardian improvement in his productivity. In effect, this specification then becomes a unit of measure issue - that is, effective labour units. If worker K is twice as productive as worker L, he simply becomes two times worker L and draws twice the wage. In a general equilibrium analysis, one just needs the knowledge of effective labour units to pin down the market size. Furthermore, it also does not matter where each industry agglomerates. Within each location, the ratio of wages will just reflect the Ricardian productivity difference in any full employment equilibrium.

However, by reformulating the problem into one that has a hierarchy of jobs, the effective constraint placed on each industry becomes different. The lowest order industry - agriculture - has the highest potential pool of

workers. The services industry, which can only use K-type workers, has the smallest potential pool of workers. The manufacturing industry is in between. When agglomeration takes place, different industries will have different effective constraints on their expansion. In NEG parlance, the congestion costs will be different for various industries, thereby resulting in different equilibrium wages where different industries agglomerate[11].

To prevent any Hecksher-Ohlin motivation for trade, this paper assumes that both countries have the same endowments of unskilled, semi-skilled and skilled workers[12]

$$O_N = O_S = \bar{O} \qquad L_N = L_S = \bar{L} \qquad K_N = K_S = \bar{K}$$

Even though both locations have exactly the same endowments, "comparative advantage" nevertheless arises in equilibrium because of the agglomeration process driven by the existence of input output linkages.

The characterisation of agricultural unskilled workers requires a little more explanation. In standard NEG models, workers are homogeneous. The presence of the agricultural sector in both regions, implied by a small consumption share of industrial goods, makes it easy to characterise the equilibrium. The agricultural sector simply serves as the buffer sector; any workers not used in industrial production are deployed in agriculture. Labour market clearing is achieved with great simplicity. The same mechanism is at work here with some modifications.

Effectively, the labour market works this way. If the supply of skilled labour is greater than the demand in services for it, the excess supply will be added to the manufacturing sector alongside the semi-skilled labour pool. Given the manufacturing sector labour demand for semi-skilled workers, the excess supply of semi-skilled workers will be used in the

[11] The labour market need not be quite so dichotomous. For example, one can allow both manufacturing and services to use both skilled and semi-skilled workers, with services having a higher skill intensity compared to manufacturing. It is possible to create the same qualitative result. However, the choice of endowment will become more important in this alternative setup. For example, in the first wave of globalisation when manufacturing agglomerates, the wages for semi-skilled workers might rise above skilled workers since they are used more intensively, thereby presenting interpretational difficulties. With the setup presented in this paper, this anomaly will never arise since K-type workers are a perfect substitute for L-types but not the other way around. Less skilled workers will never receive more than their more skilled counterparts in any equilibrium configuration.

[12] This will be relaxed later to highlight the effect of endowment on changes in industrial specialisation and wages.

agricultural sector. Excess labour effectively cascades or overflows downwards. Unskilled labour, together with what is left from manufacturing and services, then becomes the buffer in the same way that the agricultural sector acts as the buffer in many NEG models.

2.3 Consumer

Each worker, regardless of type, maximises utility over all types of goods in a simple Quasi-linear utility[13]

$$U = A + \mu_M \ln X_M + \mu_S \ln X_S \tag{1}$$

where $X_M = \left[\int x_{Mi}^{\frac{\sigma-1}{\sigma}} di\right]^{\frac{\sigma}{\sigma-1}}$ and $X_S = \left[\int x_{Si}^{\frac{\sigma-1}{\sigma}} di\right]^{\frac{\sigma}{\sigma-1}}$ are the CES aggregated manufacturing and services good respectively, and μ_M and μ_S measures the intensity of consumption of both sectors. Furthermore, X_S is aforementioned to be advanced producer services, it is reasonable to assume that $\mu_S < \mu_M$ - in other words, a consumer lower direct purchases from this sector[14].

From equation (1), the demands of each consumer for agriculture, manufacturing and services are given as follows

$$D_A = w - \mu_S - \mu_M \qquad D_M = \frac{\mu_M}{P_M} \qquad D_S = \frac{\mu_S}{P_S} \tag{2}$$

where w is the wage, P_M and P_S are the CES aggregated prices. The coefficients are constrained $\mu_S + \mu_M < w$ so that there will be a positive consumption of the A good.

Within each differentiated sector, each consumer's demands still take the usual CES form

[13]The model works with a Cobb-Douglas utility function as well. In equilibrium, different worker types will be paid different wage rates. With Cobb-Douglas preferences, this implies that expenditures on each class of good is different for each type of worker. The Quasi-linear preferences allow us to ignore these income effect considerations. All workers, regardless of how much they are paid in equilibrium, will demand the same amount of X_M and X_S. Higher income translates to higher demand for the A good. The upshot of this is that there will not be any "home market effect" arising from consumer expenditure for the differentiated industries. All agglomeration is due to forward and backward linkages on the production side.

[14]This assumption has no bearing on the qualitative pattern of results except to note that if the intensity of demand for services is too high, the equilibrium will show dispersion of the services industry even at low levels of services trade costs since skilled workers are assumed to be evenly spread between the two locations.

$$d_M = \frac{p_M^{-\sigma}\mu_M}{P_M^{1-\sigma}} \qquad\qquad d_S = \frac{p_M^{-\sigma}\mu_S}{P_S^{1-\sigma}} \tag{3}$$

In equilibrium, different worker types will potentially receive different wages due to the presence of agglomeration rents. But with the quasi-linear function, there are no income effects for the differentiated sectors. Therefore, following (3), the firm level demands become

$$\bar{d}_M = \frac{p_M^{-\sigma}\bar{\mu}_M}{P_M^{1-\sigma}} \qquad\qquad \bar{d}_S = \frac{p_S^{-\sigma}\bar{\mu}_S}{P_S^{1-\sigma}} \tag{4}$$

where $\bar{\mu}$ simply aggregates across the population of consumers (held as a constant throughout), since all of them have the same expenditure on manufacturing and service.

2.4 Production Technology

Production in sector A is standard - 1 worker to produce 1 unit of the good. Production in sectors M and S exhibits increasing returns to scale with a fixed cost f and variable cost κ. The cost function is homothetic, both fixed and variable costs use the factors in the same intensity. In addition, there are input-output linkages. For manufacturing, within or intra-industry linkages are captured by α_M and external or inter-industry linkages are captured by β_M. Intra-industry input-output linkages are assumed to be stronger than inter-industry input-output linkages. The labour share is $\gamma_M = 1 - \alpha_M - \beta_M$.

The total cost function for M type firm in country j is therefore

$$C_{M_j} = (F + \kappa x_{Mj})\, w_j^{\gamma_M} P_{M_j}^{\alpha_M} P_{S_j}^{\beta_M} \theta_M \tag{5}$$

Similarly, the cost function for firm S firm in country j becomes

$$C_{S_j} = (F + \kappa x_{Sj})\, w_j^{\gamma_S} P_{S_j}^{\alpha_S} P_{M_j}^{\beta_S} \theta_S$$

where P_j is the CES aggregated price over all differentiated goods, κ is the per unit input requirement, and with θ_M and θ_S simply the constants of cost minimisation[15].

[15]It is not necessary to assume that the linkages are symmetric between the two differentiated industries. The input-output table (see Appendix) suggests they are not. However, in the numerical simulations later, the inter and intra-industry linkages are nevertheless assumed to be symmetric as this has no relevance for the qualitative

2.5 Trade Cost

Both manufacturing and services sectors face iceberg trade cost when exporting goods and services. However, in contrast to most Economic Geography models, this paper has elected to model different trade costs τ_M and τ_S for manufacturing and services respectively. The reason behind this is to allow the globalisation process to occur as two distinct and separate processes for the two industries, roughly in keeping with the historical evidence.

The first wave of globalisation is captured by a decrease in τ_M from some arbitrarily high levels, thus freeing up goods trade. While trade in goods becomes freer, trade in services is still not possible due to prohibitive trade barriers - high communication costs, language, legal, regulatory barriers - all captured by τ_S. The second wave of globalisation captures the effect of trade liberalisation in services. Following standard notation, two freeness (phi-ness) of trade indices for the two sectors are defined as phi-M ($\phi_M = \tau_M^{1-\sigma}$) and phi-S ($\phi_S = \tau_S^{1-\sigma}$) respectively.

2.6 Unit Cost and Prices

The CES function gives the standard aggregated prices for the M or S sectors, P_M and P_S respectively (and with asterisk for the South). Given the description of the wages above, the unit cost functions can be written as

$$\begin{aligned} c_M &= w_L^{\gamma_M} P_M^{\alpha_M} P_S^{\beta_M} \theta_M & c_M^* &= w_L^{*\gamma_M} P_M^{*\alpha_M} P_S^{*\beta_M} \theta_M \\ c_S &= w_K^{\gamma_S} P_S^{\alpha_S} P_M^{\beta_S} \theta_S & c_S^* &= w_K^{*\gamma_S} P_S^{*\alpha_S} P_M^{*\beta_S} \theta_S \end{aligned} \quad (6)$$

Therefore, the unit cost functions depend not only on the aggregate prices, but also the kind of wages faced by each industry (which may no longer be 1 for every worker everywhere). The wage of semi-skilled and skilled workers w_L and w_K, together with the counterparts in the South w_L^* and w_K^*, will be endogenised in equilibrium. Their values will depend on the patterns of agglomeration that emerge.

result.

2.7 Profits

The profit function of each manufacturing firm in the North can be written as

$$\pi_M = \frac{1}{\sigma}\left(\frac{\sigma}{\sigma-1}\kappa c_M\right)^{1-\sigma}\left\{\frac{\bar{\mu}_M + \alpha_M R_M + \beta_S R_S}{P_M^{1-\sigma}} + \phi_M\left[\frac{\bar{\mu}_M^* + \alpha_M R_M^* + \beta_S R_S^*}{P_M^{*1-\sigma}}\right]\right\} - c_M F \tag{7}$$

where R_M and R_S are North's aggregate intermediate purchases by the manufacturing and services sector respectively (to be defined later). Hence, the manufacturing firm charges an optimal price of $\frac{\sigma}{\sigma-1}\kappa c_M$, which is a constant mark up over its unit cost. The terms inside the curly brackets provide the total market potential perceived by the firm from home sales (first term) and export sales (second term). The fixed cost is given by $c_M F$. Since the two locations have the same population size, $\bar{\mu}_M = \bar{\mu}_M^*$. Similarly for the services industry, the profit function can be written as

$$\pi_S = \frac{1}{\sigma}\left(\frac{\sigma}{\sigma-1}\kappa c_S\right)^{1-\sigma}\left\{\frac{\bar{\mu}_S + \alpha_S R_S + \beta_M R_M}{P_S^{1-\sigma}} + \phi_S\left[\frac{\bar{\mu}_S^* + \alpha_S R_S^* + \beta_M R_M^*}{P_S^{*1-\sigma}}\right]\right\} - c_S F$$

If more manufacturing firms locate to the North, the market potential in the North increases relative to that in the South because of the presence of backward linkages. There will be more firms at the same location that demand its products as intermediates. At the same time, because of the intra-industry linkages, the unit cost in the North will fall relative to that in the South (forward linkages) since the intermediates are no longer subjected to trade costs.

In the South, the profit functions are exactly analogous and are given by

$$\pi_M^* = \frac{1}{\sigma}\left(\frac{\sigma}{\sigma-1}\kappa c_M^*\right)^{1-\sigma}\left\{\phi_M\left[\frac{\bar{\mu}_M + \alpha_M R_M + \beta_S R_S}{P_M^{1-\sigma}}\right] + \frac{\bar{\mu}_M^* + \alpha_M R_M^* + \beta_S R_S^*}{P_M^{*1-\sigma}}\right\} - c_M^* F \tag{8}$$

$$\pi_S^* = \frac{1}{\sigma}\left(\frac{\sigma}{\sigma-1}\kappa c_S^*\right)^{1-\sigma}\left\{\phi_S\left[\frac{\bar{\mu}_S + \alpha_S R_S + \beta_M R_M}{P_S^{1-\sigma}}\right] + \frac{\bar{\mu}_S^* + \alpha_S R_S^* + \beta_M R_M^*}{P_S^{*1-\sigma}}\right\} - c_S^* F$$

Some Normalisations To simplify the notations, the paper makes a few convenient normalisations [see Economic Geography & Public Policy by Baldwin et al]. Firstly, $\kappa = \frac{\sigma-1}{\sigma}$ thereby simplifying the cost of each

unit to 1. Secondly, $F = \frac{1}{\sigma}$. Take for example a profit function in equation (7). By using these normalisations, the profit function can be written as

$$\pi_M = \frac{1}{\sigma} c_M \left\{ c_M^{-\sigma} \left[\frac{\bar{\mu}_M + \alpha_M R_M + \beta_S R_S}{P_M^{1-\sigma}} + \phi_M \left(\frac{\bar{\mu}_M^* + \alpha_M R_M^* + \beta_S R_S^*}{P_M^{*1-\sigma}} \right) \right] - 1 \right\}$$

where the terms inside the curly brackets represent output given the CES preference. Given these two normalisations, the paper makes use of the standard result that the production scale consistent with zero-profit is

$$\bar{x} = 1$$

This greatly reduces the notations and also simplifies later numerical analysis. Note that in equilibrium, the total input requirement of each firm is given as $(\bar{x}\kappa + f)$, which because of the above normalisation is also equal to 1. Each firm therefore will demand one physical unit of input in equilibrium.

2.8 Workers' Types and Equilibrium Wage Rates

The price of good A is chosen as the numeraire. Since unskilled workers are immobile to other industries, the agricultural sector must operate in both countries, thereby pinning down low-skilled wages as $w_O = 1$. If all K-type workers are employed in the S sector, then $w_K \geqslant w_L$ in equilibrium. Otherwise, K-type workers would be better off in the manufacturing sector, and the labour market cannot be in equilibrium. Writing these explicitly

$$\bar{w_K} = \left\{ \begin{array}{ll} w_K & K_N^d = K_N \\ w_L & K_N^d < K_N \end{array} \right\} \tag{9}$$

where $\bar{w}_K$ indicates the equilibrium wage and K_N^d is the conditional demand for skilled labour in the North. This is given by

$$K_N^d = \left(\frac{\gamma_S}{\alpha_S} \right)^{\alpha_S} \left(\frac{\gamma_S}{\beta_S} \right)^{\beta_S} \left(\frac{P_S}{w_K} \right)^{\alpha_S} \left(\frac{P_M}{w_K} \right)^{\beta_S} n_S \tag{10}$$

which is simply the demand per services firm multiplied by the number of services firms in the North n_S since each firm demands 1 unit of input given the normalisation. Equation (10) is therefore the total derived

demand for skilled labour given the number of firms operating in that particular location[16].

In equilibrium, it is possible that not all K-type workers will work in services ($K_N - K_N^d > 0$). In that case, those K-type workers not employed in services will choose to work in manufacturing and be offered wage w_L. The wage function of w_L becomes

$$\bar{w}_L = \begin{cases} w_L & L_N^d = L_N + (K_N - K_N^d) \\ w_O = 1 & \text{Otherwise} \end{cases} \tag{11}$$

where conditional demand for manufacturing labour is given as

$$L_N^d = \left(\frac{\gamma_M}{\alpha_M}\right)^{\alpha_M} \left(\frac{\gamma_M}{\beta_M}\right)^{\beta_M} \left(\frac{P_M}{w_L}\right)^{\alpha_M} \left(\frac{P_S}{w_L}\right)^{\beta_M} n_M \tag{12}$$

and n_M is the number of manufacturing firms in the North[17]. The same set of equations for w_K^* and w_L^* can also be written for the South analogously, providing a total of four wage equations.

The above equations also give a sense on why an analytical solution might prove difficult. The wage functions are non-differentiable as they are discontinuous at the point at which the supply constraint binds. In contrast, the wage rate is determined by the price of the agricultural good in an equilibrium characterised by incomplete specialisation. As can be seen from the above equations, wages are a function of local conditional demands (which depend on the number of firms at each location), which is also a function of wages. The mapping of wages onto firms and then back onto wages makes it difficult to solve this problem analytically[18].

2.9 Definition of Intermediate Revenues and Total Wage

Intermediate revenues are given in a standard way, simply the total cost of all firms. The intermediate revenues for North and South manufacturing

[16] Off equilibrium, if conditional demand is larger than supply of factor $K_N^d > K_N$, wage w_K has to increase until the equilibrium value $\bar{w}_K$ solves for $K_N^d = K_N$. If conditional demand is not larger than the supply at that location, $\bar{w}_K$ must fall to that of the next skill tier w_L.

[17] Again, in an off equilibrium situation where $L_N^d \geqslant L_N + (K_N - K_N^d)$, then w_L must increase until the equilibrium value $\bar{w}_L$ solves for $L_N^d = L_N + (K_N - K_N^d)$. If $L_N^d < L_N + (K_N - K_N^d)$, then w_L will take the value of 1 since some semi-skilled workers will work in the agricultural sector.

[18] The wage functions are also non-differentiable.

are

$$R_M = n_M c_M(\kappa\bar{x} + F) \qquad R_M^* = n_M^* c_M^*(\kappa\bar{x} + F) \tag{13}$$

Similarly, the intermediate revenues for North and South services are

$$R_S = n_S c_S(\kappa\bar{x} + F) \qquad R_S^* = n_S^* c_S^*(\kappa\bar{x} + F)$$

Total incomes (which are equal to expenditures) are given by

$$E = w_K K_N + w_L L_N + O_N \qquad E^* = w_K^* K_S + w_L^* L_S + O_S \tag{14}$$

With these, agriculture demands are given by

$$A = E - \bar{\mu}_M - \bar{\mu}_S \qquad A^* = E^* - \bar{\mu}_M - \bar{\mu}_S$$

With the quasi-linear preferences, only the demand for agriculture is affected by changes in wage incomes.

3 Solving for Equilibrium

3.1 Equilibrium Conditions

Typically in a NEG model, the number of firms is fixed in the short-run while other endogenous variables adjust. In the long run, all the conditions of the short-run equilibrium are met while allowing the free entry conditions (firms' entry and exit) to be satisfied. But since this paper is concerned with the long-run evolution of industrial locations and factor returns over two episodes of globalisation, it makes no distinction between the short and long-run solution. Instead, all variables are allowed to adjust towards the long-run equilibrium from the onset for every level of given trade costs. The equilibrium is characterised by a vector of eight endogenous variables $\{n_M, n_M^*, n_S, n_S^*, w_K, w_L, w_K^*, w_L^*\}$ that are pinned down by the four zero-profit conditions and four wage equations such that:

(a) all firms make zero profits given entry, exit and relocation and;

(b) goods markets clear and;

(c) there is no excess demand or supply for skilled, semi-skilled or

unskilled labour given the equilibrium wages in both locations.

3.2 Adjustment Process

Given a specific level of trade costs, the numerical solutions begin by imposing a symmetric (arbitrary) number of firms to both locations. A small positive shock ($\varepsilon_F = 0.01$) to the number of manufacturing firms is given to one location, and a small negative shock ($-\varepsilon_F$) is applied to another, to break the initial symmetry.

Step 1 Firms are allowed to enter, exit or relocate. If both North and South firms have positive profits given the number of existing firms, a small increment ($+\varepsilon_F$) in the number of firms is further applied to both locations - this is entry. If both North and South firms continue to have negative profits, a small decrease ($-\varepsilon_F$) in the number of firms is applied due to exit. If the North has higher profits than the South, firms migrate northwards ($+\varepsilon_F$ for the North and $-\varepsilon_F$ for the South) for relocation. Vice versa.

Step 2 Local labour markets adjust. Given the interim number of firms in both North and South after the step 1 adjustments, the demand for labour for the industry for each location can be derived using the cost minimising demand function [see equations (10) and (12)]. If demand for skilled labour from services exceeds supply at a particular location, the local skilled wages will move upwards in a small increment ($\varepsilon_W = 0.0001$)[19]. If not, the excess skilled labour is added to the local pool of semi-skilled labour or downward cascading. Again, the demand for labour from manufacturing is checked against this pool. If demand exceeds supply, even the semi-skilled wage moves upwards (also bumping up skilled wages in the process since skilled wages cannot be lower than semi-skilled labour in equilibrium). Otherwise, any excess overflows into the unskilled labour pool too, which then serves the numeraire sector agriculture.

Iteration Steps 1 and 2 are iterated until the equilibrium conditions stated are met. This will then give the long-run number of firms and

[19]The adjustment parameters ε_F and ε_W represent a search increment of a magnitude that is one-hundredth of a per cent of the underlying variables.

wages in each location.

3.3 Model Parameters

The key parameters in this model are the intra and inter-industry linkages as they determine the strength of the agglomeration forces as well as the wages in equilibrium. In a two-sector setup, it is necessary that the intra-industry linkages are stronger than inter-industry ones for agglomeration to take place. Otherwise, both industries will tend to disperse rather than agglomerate since the benefits of co-location with another industry is greater than each industry locating in one location [see FKV for further exposition]. The input-output table provides strong evidence that intra-industry linkages are indeed stronger [see Appendix][20]. Solutions with other parameters are also provided in the Appendix.

4 Results

4.1 Autarky Results

Economic activity is completely dispersed in the autarky equilibrium. All labour types have the same wage, equal to the numeraire. This is due to the fact that the paper has chosen factor endowment such that factor supplies of skilled and semi-skilled workers exceed the demands for them in the absence of agglomeration. Since prices are also the same in both locations given the symmetry of the regions, real wages are also equal. There is no inequality between or within nations.

4.2 First Wave of Globalisation

In the first wave of globalisation, trade costs in services are kept arbitrarily high such that $\phi_S = 0$ (no services trade is possible). In the numerical solutions, the trade cost for manufacturing is gradually lowered (increase in phi-M). Two sets of equilibrium paths are possible - one with greater a concentration of both manufacturing and services in the North (shares greater than 0.5) and the other with a greater concentration in the South.

[20] In the numerical simulations, this paper assumes the intra- and inter-industry linkages of both sectors to be symmetric. Though the IO table suggests that they are slightly different, it does not change the results qualitatively, so long as intra-industry linkages are stronger.

This can be seen in Figure 3, where the Y-axis shows the share of firms for each industry located in the North plotted against phi-M (X-axis).

Wage-sustain and Wage-break Points The definitions of break and sustain points are slightly different from traditional NEG models since the parameters and endowments are chosen so agglomeration will result in the rise of wages due to the limited endowments. In a symmetric equilibrium, both locations have exactly the same number of services and manufacturing firms, and wages everywhere for all types of workers will be the numeraire wage ($w_K = w_K^* = w_L = w_L^* = 1$).

In order to make a distinction between the break/sustain point as used in the standard NEG literature, this paper introduces the "wage-break or wage-sustain points"[21]. The wage-break point is defined as the level of trade cost (which can be equivalently expressed in terms of trade freeness) that allows wage symmetry between the types of labour within a location to be broken. The wage-sustain point is the level of trade cost that allows a wage differential between the types of labour to be sustained in a location.

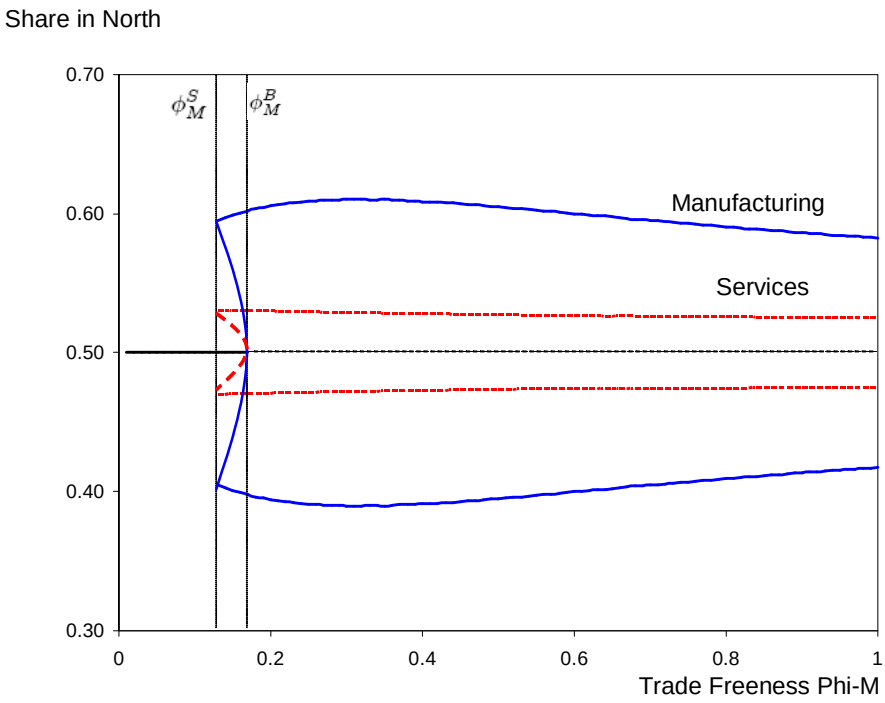
For example, the manufacturing wage-break point is the level of trade freeness ϕ_M^B which allows the symmetric distribution of manufacturing to break in favour of one location, resulting in a premium on manufacturing wages in that location. Similarly, the manufacturing "wage-sustain point" is the level of trade freeness ϕ_M^S that allows manufacturing wages to be sustained at a higher level, with the maximum level of agglomeration as the initial condition.

Tomahawk Diagram The tomahawk diagram plots the shares of firms of the North (South's shares are simply the complement) on the Y-axis against the level of trade freedom phi-M on the X-axis. The firm share diagram is a 'multiple pitchfork' as there is more than one industry. The wage-break and wage-sustained points can be clearly seen in the Figure 3[22].

[21] In the standard NEG literature, the break point is the value of trade costs at which the symmetric equilibrium with equal shares of industry between two locations becomes unstable. The sustain point is the value of trade costs at which the asymmetric equilibrium (with agglomeration) can be sustained.

[22] As standard in NEG models, the sustain point comes before the break point since the value of trade costs at which the symmetric equilibrium becomes unstable is lower (or phi-ness higher) than the value of trade costs at which the asymmetric equilibrium (agglomeration) can be sustained. There is a region of overlap between the two (see

Figure 3: Tomahawk Diagram (First Wave)



The outer pitchfork lines (in solid blue) show the equilibrium shares of manufacturing while the inner pitchfork shows the equilibrium shares of services (in dotted red). Though there is no services trade, its shares are influenced by the shares of manufacturing as a result of the inter-industry linkages, as shown in the inner pitchforks. Since supply of skilled and semi-skilled labour is finite and wages increase when these constraints are reached, the pitchfork lines represent the maximum shares that do not reach 1 or 0. In other words, the equilibrium does not exhibit a 'bang-bang' outcome.

The level of endowments relative to the size of consumption will determine how much agglomeration can take place. For example, given a constant consumption intensity in the preferences, a symmetric increase in the endowment of K-type labour in both the North and South will widen the pitchforks by allowing more agglomeration to take place before

ϕ_M^B and ϕ_M^S in Figure 3) where both the agglomeration or symmetric equilibrium are stable, depending on the initial conditions. Because of the possibility of multiple equilibria in this region of overlap, expectations become important since some firms may shift location in anticipation that this will change the initial conditions enough to trigger agglomeration. To keep exposition simple, this paper ignores the role of expectation.

resource constraints start to bind.

Agglomeration Rents When the labour resource limits are reached, labour begins to earn agglomeration rents. For example, when manufacturing agglomerates in one location and exhausts the pool of skilled and semi-skilled labour, entry firms bid up the equilibrium wages according to equations (9) and (11). The evolution of wages is given in Figure 4. As a result of manufacturing agglomeration, skilled and semi-skilled workers begin to command a wage premium over unskilled workers (whose wage is set to 1). The standard hump-shape feature of the equilibrium wage path is that inequality is highest at intermediate levels of merchandise trade costs - rising quickly after the wage-sustain point ϕ_M^S and falling gradually as trade cost falls further.

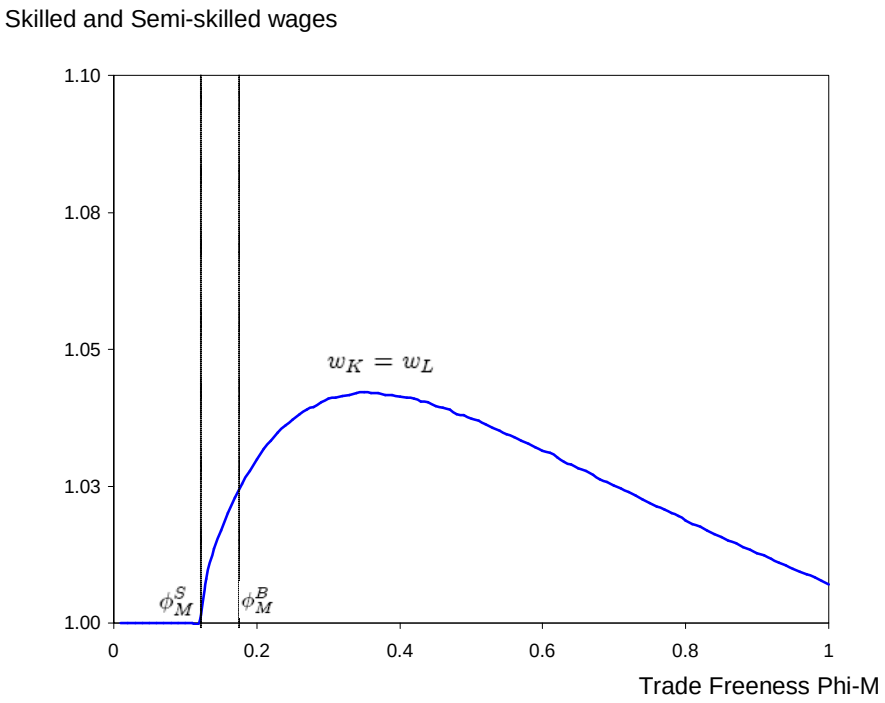
From the wage break point ϕ_M^B, there is a small discrete jump in the wages as the symmetric equilibrium is broken. In this first wave, the change in wage structure is driven by the agglomeration of manufacturing. As manufacturing uses both K and L types, the agglomeration rent is shared between these two types of workers. This also implies that services demand for skilled workers does not exhaust the supply of all skilled workers, and some of them are employed in the manufacturing sector in equilibrium.

4.3 Second Wave of Globalisation

Goods trade costs are held at a constant level ($\phi_M = 0.7$ or $\tau_M = 1.10$). Given this level of ϕ_M, the paper solves for the long-run equilibrium when services trade becomes free (from $\phi_S = 0$ to 1). The services "wage-break point" is the level of services trade cost, below which services reaches maximum agglomeration and exhausts the sector specific factor. In other words, the services wage-break point is reached when K type wages become higher than L type wages ($w_K > w_L$ or $w_K^* > w_L^*$).

In order to reduce the number of possible equilibrium development paths and to simplify the exposition, the paper shows only one set of equilibrium paths for the second wave of globalisation - one that assumes that the North has a larger share of manufacturing in the first wave. This is broadly consistent with the historical pattern since the Industrial Revolution. The fact that trade costs fall sequentially (goods first then services) becomes important here. The key thing to note is that even

Figure 4: North's Equilibrium Wages (First Wave)

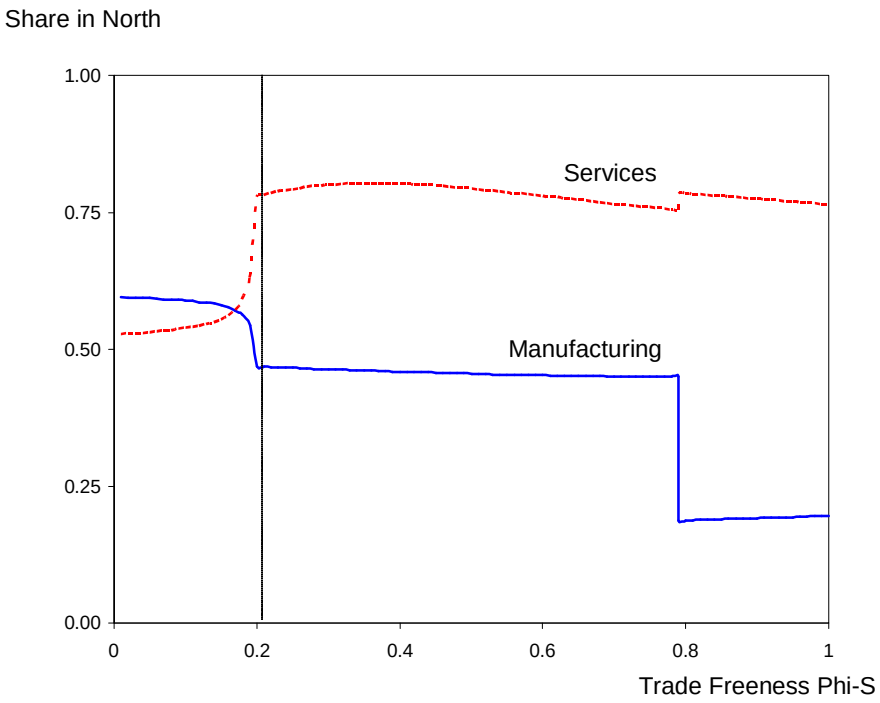


though services is not liberalised in the first wave, the North has an initial advantage in services. From an arbitrarily high level of trade costs, services trade becomes freer (moving right on the X-axis in Figure 5).

As services trade is freed, services sector firms begin to agglomerate in the North quickly as a result of the initial advantage (see Figure 5). As skilled workers begin to migrate away from manufacturing and into services, there is a contraction of manufacturing activities in the North, relocated to the South. The wage-break point occurs at around $\phi_S = 0.2$ (this can be related to Figure 6, at the same ϕ_S where w_K becomes higher than w_L). There is location hysteresis, but only for the services sector. Since this is a model with horizontal linkages, the relocation of manufacturing activities to the South effectively becomes offshoring since firms in the North will use a greater share of intermediates produced in the South (pseudo-offshoring).

When services trade becomes very liberalised at around $\phi_S = 0.8$ (Figure 5), the North experiences a precipitous loss of manufacturing or large scale deindustrialisation. This discontinuity occurs because of the following reason. When services trade is initially liberalised, the presence

Figure 5: Tomahawk Diagram (Second Wave) North



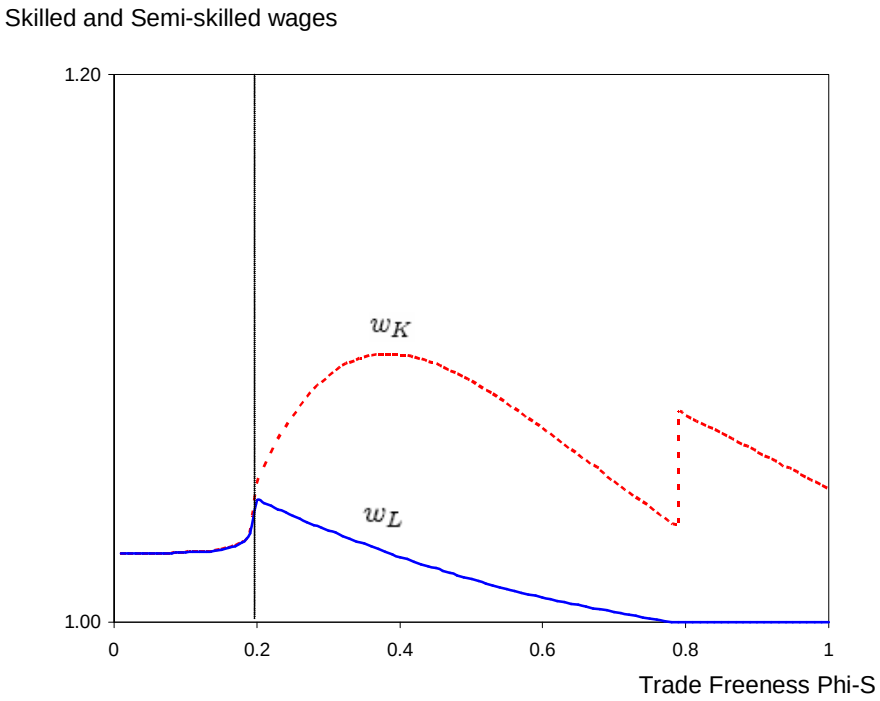
of a large services sector agglomerating in the North offers manufacturing firms lower cost of production, since manufacturing firms also demand services intermediates. The inter-industry forward linkages induce a sizeable number of manufacturers to maintain their presence in the North at intermediate levels of services trade liberalisation (from ϕ_S values of 0.2 to 0.8). However, further liberalisation of services can bring the equilibrium into a tipping point when even the South can access services intermediates from the North cheaply. North's advantage in cheaper services intermediates becomes outweighed by the cheaper labour in the South (which is $w_L^* = 1$). As a manufacturing firm relocates to the South to take advantage of the cheaper cost of labour there, it further reinforces the attraction of the South through intra-industry input-output linkages. Because of this process of cumulative causation, more manufacturing firms relocate to the South until equilibrium is restored[23]. The key point is that the advantage Northern manufacturers have in terms of lower services intermediates cost is no longer enough to sustain a large number of

[23]In equilibrium, there will still be some manufacturing firms in the North. The presence of a large number of services firms means that there will still be demand for manufacturing intermediates.

manufacturers in the North at low levels of services trade cost. This is an interesting result since the loss of manufacturing or deindustrialisation in the North is not triggered by greater goods trade liberalisation (ϕ_M is kept constant in this set of results). Services trade liberalisation alone can trigger the deindustrialisation process.

The evolution of equilibrium wages is given in Figure 6. Trade costs are falling from the left to the right of the diagram. The boundary line at around $\phi_S = 0.2$, representing the services wage-break point, is the point where all skilled workers become fully employed in services. To the right of this point, skilled workers begin to earn a premium $w_K > w_L$. The biggest difference between w_K and w_L occurs at intermediate levels of τ_S (around $\phi_S = 0.43$ or $\tau_S = 1.23$).

Figure 6: Equilibrium Wages (Second Wave) North



At around $\phi_S = 0.8$ when the North suffers from a precipitous loss of manufacturing, K type workers in the North experience a wage spike. Consider what happens at this point. North's manufacturing sector has become so small that w_L becomes 1. In other words, some L type workers are reduced to working in agriculture, earning the same wage as O type workers. Much of manufacturing intermediates are now mainly imported from the South and they are subjected to trade cost. Due to the sud-

den relocation of manufacturing to the South, the CES price aggregate for manufacturing increases sharply in the North. Firms in the services sector demand three types of inputs - K-type workers, services intermediates and manufacturing intermediates. As the cost of manufacturing intermediates increases, firms substitute away from the last source of input towards the previous two. The effect of this is that w_K will rise sharply to restore equilibrium in the factor market.

5 Factor Responses and Changes in Endowments

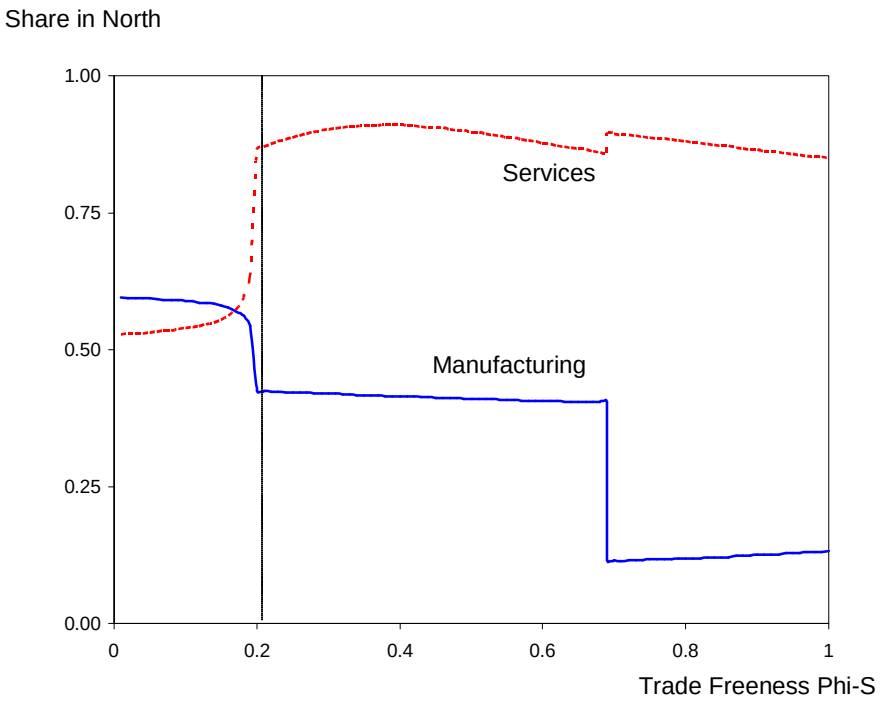
International trade can be driven by inherent differences between countries giving rise to comparative advantage or by increasing returns to scale. Yet surprisingly little is known of the relative importance between the two except for the study by Davis and David E. Weinstein (1999). In this model, relative factor abundance (skilled, semi-skilled, unskilled workers) may determine where industries locate, but not necessarily so. If a region is relatively abundant in skilled labour, one would naturally expect that region to have a comparative advantage in the production of services. However, the overall cost of production depends on intermediate inputs as well as labour. The cost of intermediates in turn depends on the number of firms located in the region and the level of trade freedom. Comparative advantage therefore is not only due to the relative factor abundance but also the accidents of history - which industry agglomerates where first.

Davis and Weinstein (1999) find evidence that Economic Geography (or increasing returns as a motivation for trade) operates at a subnational scale but not for international trade which is still largely dominated by comparative advantage. However, as agglomeration of an industry often gives rise to economic rent, it is also possible that the composition of local factors begin to change in response to the agglomeration rent. Therefore, to the extent that factors shift endogenously in response to the kind of industries that agglomerate, there may in fact be more Economic Geography at work than evidence suggests. In a limited way, the next subsection discusses the endogeneity of Economic Geography and endowment-driven comparative advantage.

5.1 Comparisons with Neoclassical Theories

Consider the following thought experiment. K-type workers in the North earn a premium over L-types if services trade is sufficiently liberalised. Suppose there is an increase in K-type workers relative to L-types, what will happen to industrial locations and wages[24]? In this set of numerical solutions, the number of K-type workers in the North is increased by 10 units (or 10 per cent increase from baseline) and the number of L type workers is correspondingly decreased by 10 units (10 per cent decrease). For the world as a whole, this implies an increase in the number of K-type workers (by 5 per cent from baseline) and decrease in the number of L-types (by 5 per cent). The resulting industry shares are presented in Figure 7, which one can compare to Figure 5 showing the shares before the changes in endowment occur.

Figure 7: Tomahawk Diagram (Second Wave) with K Type Increase in North

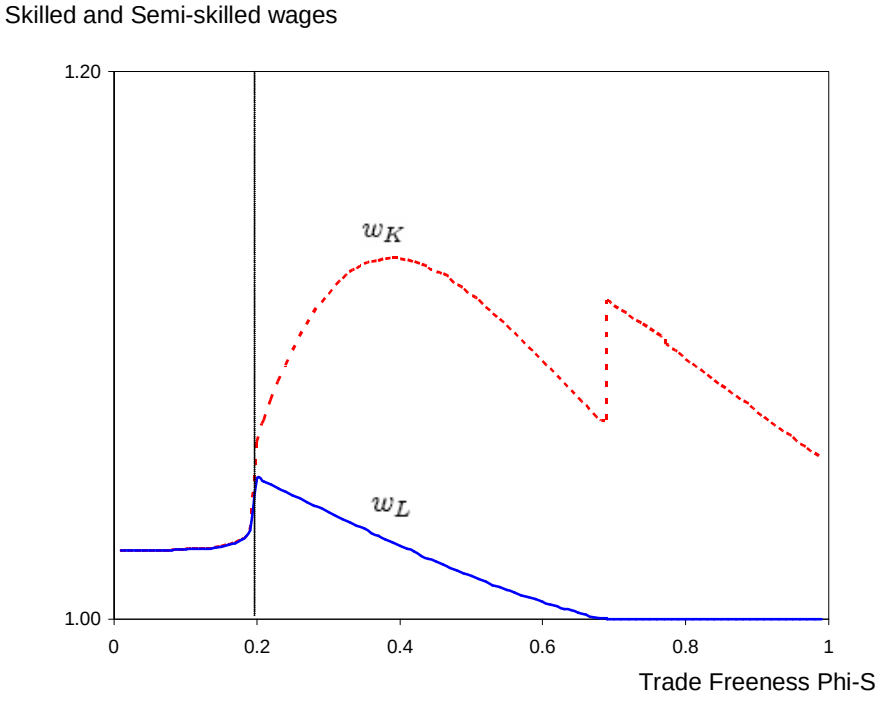


As more semi-skilled workers become skilled, this further expands the

[24]One can think of the increase in K-types workers to arise from a process of skill acquisition, where the L-type workers acquire skills in response to the higher wages (or agglomeration rent) in the services sector. This paper does not model the dynamics of skills acquisition. Instead, the initial endowment is changed to reflect the acquisition of skills and a comparative static analysis is carried out.

services sector in the North by facilitating more services agglomeration. Compared to Figure 5, the comparative static shows that the share of North's manufacturing is even lower now at every level of services trade cost. Together, these present a quasi-Rybczynski effect, that is the expansion of the sector that uses the increased factor and a contraction of the other sector. Since inter-industry linkages are stronger than intra-industry ones, the cost of intermediates for manufacturing rises while that for services falls.

Figure 8: Equilibrium North Wages with Increase in K



In equilibrium, it is possible that w_K rises even more, even though there is a relative increase in K-type workers in the North (and globally as well)[25]. This can be seen by comparing the wages shown in Figure 8 to that of Figure 6, without the increase in K-types. This is different from the prediction of neoclassical theories where one would expect the increase in a factor relative to another to either lead to decrease in relative wage (for a large country) or to have no effect at all (for a small country).

[25]Obviously, the result is dependent on the parameters chosen. If the number of K-type skilled workers is so abundant in the North that the full agglomeration of services there does not exhaust the pool of K workers, then $w_K = w_L$. In other words, even after allowing for the increase in K type workers, the employment constraint must bind (all K workers employed in services).

To draw the link between globalisation and developed economies' blue-collar wage decrease under the neoclassical model, economists have to demonstrate the price effect - that is, how trade liberalisation has reduced the relative price of goods which use blue-collar workers intensively [Feenstra and Hanson (1999)]. Simply put, the terms of trade have to move against a sector in order to account for the fall in the relative return of the factor used intensively in that sector in any neoclassical setting. This is simply a restatement of the Stolpher-Samuelson theorem.

With increasing returns, input-output linkages and Economic Geography, this paper shows that a non-standard, or even surprising result, can emerge. The increase in the number of K-type workers in the North has led to a relative decrease in the (aggregated) price of services, yet this is accompanied by an increase in the returns to workers employed in that sector. In other words, the further agglomeration of services in the North results in the worsening of terms of trade or price effects, but at the same time leads to the relative increase in the factor return to skilled workers used in that sector. This is in sharp contrast to the Stolper-Samuelson prediction. The wage ratio, or relative wage, between skilled and unskilled becomes higher.

5.2 Offshoring and Wages

More recently, Gene Grossman and Esteban Rossi-Hansberg (2006), after further slicing the production of goods into a continuum of tasks, also show that offshoring of low-skilled work does not depress low-skilled wages if there are no terms of trade effects (such as in the case of a small country). In fact, offshoring of low-skilled work could increase low-skilled wages due to the productivity effect (or if the productivity effect is stronger than the terms of trade effect). However, the authors' framework is still very much neoclassical in nature.

In this paper with increasing returns to scale and input-output linkages, the prediction is again different. As more and more manufacturing firms migrate to the South, the sector becomes effectively offshored and intermediates have to be imported from the South. This represents a loss of intra-industry forward linkages, leading to an absolute decline in w_L in order to restore the equilibrium [see Figures 4 and 6]. By considering the effects forward linkages have on equilibrium wages, the conclusion about offshoring becomes less favourable for the less-skilled workers.

5.2.1 Worsening Inequality in the North

The upshot of all this is that the increase in skilled workers endowment in the North may worsen rather than ameliorate income inequality there. Indeed, Bound and Johnson (1995) point out that "One of the major puzzles about the wage structure during the 1980s [for the US] is why the returns to observed skills (education and experience) rose while the labour force has become more educated and older." There is indeed much evidence suggesting that skill-biased technology change can to a large extent explain this puzzle. However, skill-biased technological change does not account for one of the key stylised facts of the recent wave of globalisation, which is the deindustrialisation of many OECD countries.

Furthermore, Feenstra (1998) notes that "we should not assess the proximate cause of the decline in employment and wage of unskilled workers by attributing all within-industry shifts in labour to technology, and allowing trade to operate only via between industry shifts . . . as soon as trade in intermediates is permitted, as with outsourcing, then the changes in demand for labour within industry can occur due to trade as well. In fact, the whole distinction between 'trade' and 'technology' becomes suspect when we think of corporations shifting activities overseas."

5.3 Wage Inequality in the South

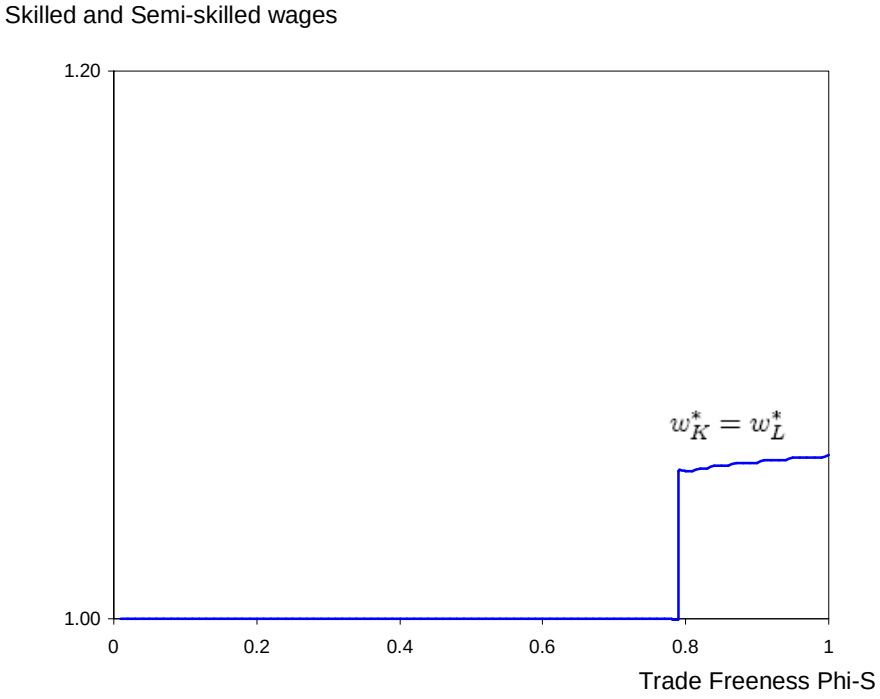
In the various sets of numerical solutions shown thus far, wage inequality appears only for the North. However, with a suitable choice of parameters, it is possible to show that inequality also arises in the South. The concentration of manufacturing in the South in the second wave of globalisation can lead to skilled and semi-skilled workers earning a wage premium above their unskilled counterparts (exactly the same process that occurred in the North during the first wave)[26]. Figure 9 is the South's counterpart to Figure 6. As trade costs fall from the left to the right of the diagram, it shows the effect of South's skilled and semi-skilled wages when manufacturing agglomerates in the second wave[27]. At around $\phi_S = 0.8$ (when manufacturing shifts dramatically to the South),

[26] Some economists have noted that inequality in developing countries can arise since the production that is offshored from developed countries allows the skilled workers in the developing countries to earn a wage premium above the rest of the population.

[27] An example of such a situation would be the income disparity between the urbanised manufacturing workers and the rural farmers in China.

there is an increase in the skilled and semi-skilled wages in the South over their unskilled counterparts. Again, note that this is entirely triggered by services trade liberalisation, which displaces manufacturing from the North. What began as sharp inequality between nations can end up becoming sharp inequality within nations.

Figure 9: Skilled and Semi-Skilled Wages in South (Second Wave)



6 Conclusion

NEG models often rely on some simplifying assumptions, for example the presence of a homogeneous and costlessly traded good that equalises wages everywhere. In addition, due to the feedback mechanism in many NEG models, full analytical solutions are sometimes not possible. In its place, numerical solutions are often used to derive the economic understanding. In this paper, the tractability problem faced by a standard NEG model is made even more complicated with labour market segmentation, adjustments and wage dynamics. Furthermore, agglomeration forces operate in two different channels (inter and intra-industry) asymmetrically for given values of trade costs. Because of these complexities, only numerical solutions are provided. Naturally, numerical solutions

have to be interpreted with a degree of caution. The results often change with parameter specifications. Without a full analytical solution, it is sometimes difficult to tell if the results are general enough for them to be plausible explanations of reality, a point this paper concedes. The advantage of numerical solution however is that it shows the rich equilibrium paths of locations and wages that can emerge in the model, and allows one to understand the complex dynamics of the globalisation process.

The contribution of this paper is that it reconciles several key stylised facts within a single Economic Geography framework. The story runs as follows. The improvement of communication technology in the recent wave of globalisation brings about a change in the specialisation of developed economies by allowing greater services agglomeration from their position of initial advantage in the first wave. Firstly, it results in a loss of workers from North's manufacturing sector due to competition for skilled workers. Secondly, greater services trade liberalisation results in the loss of forward linkages for North's manufacturing firms by allowing South's manufacturing sector to access services inputs cheaply. If services trade is free enough (such as in $\phi_S = 0.8$ in Figure 5), this can trigger a precipitous shift of manufacturing to the South or deindustrialisation (which implies greater offshoring). The loss of employment and forward linkages in North's manufacturing sector then reduces the wage of semi-skilled workers in the North. The increase in skilled labour in the North further accentuates this process and results in even greater inequality. By explicitly modelling the agglomeration process with labour markets constraints, and treating the globalisation process as two distinct waves, this paper shows how the shifts in economic geography can explain many stylised facts.This paper therefore provides a stylised understanding of the history of North-South industrial development and the patterns of trade.

7 Appendix

7.1 Patterns of Specialisation in Major Developed and Developing Economies

Table 1: Current Account Balances (US Millions) of Goods (Top) and Services (Bottom) of Major OECD and Emerging Economies

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Australia	-4223	-637	1766	-5355	-9751	-4715	1738	-5423	-15147	-18031	-13319	-9596
	-917	224	151	-852	128	938	736	1220	1818	511	533	837
Brazil	-3157	-5452	-6654	-6604	-1261	-698	2651	13121	24794	33666	44757	46115
	-7495	-8057	-9309	-9041	-6977	-7162	-7759	-4957	-4931	-4677	-8148	-9656
China	18050	19535	46222	46614	35982	34474	34017	44167	44652	58982	134189	
	-6093	-1984	-3398	-2777	-5341	-5601	-5933	-6784	-8573	-9699	-9391	
France	11004	14957	26955	24873	17627	-3300	3535	7506	3237	-4759	-28523	-37692
	14339	15107	16713	17347	18607	19805	17841	17128	15819	14554	13229	10382
Germany	65320	70890	71157	76047	69662	55986	88364	126607	145928	187445	189691	199775
	-53440	-51714	-48149	-51606	-57917	-55018	-54142	-43192	-50712	-51164	-51989	-47899
Italy	38710	53985	39995	36335	23488	9555	15587	13241	11209	11001	666	-11964
	6338	7183	7785	4891	1199	1076	16	-2868	-2668	1465	-649	-1851
India	-10721	-14635	-14787	-15613	-13705	-16496	-12047	-9556	-14633	-28075	-46915	-61239
	175	347	1276	2086	2238	3412	2865	4435	6401	13050	22225	29043
Indonesia	6533	5948	10075	18429	20643	25042	22696	23513	24563	20152	22323	
	-8071	-8538	-9666	-7609	-7777	-10423	-10380	-10382	-12108	-8811	-10803	
Japan	131231	83595	101740	122116	123063	116506	70191	93675	105863	132903	94978	81200
	-57298	-62297	-54072	-49311	-54006	-47608	-43750	-42029	-35501	-38991	-27905	-20131
Korea	-4444	-14965	-3179	41627	28371	16954	13488	14777	21952	37569	32683	29214
	-2979	-6179	-3200	1024	-651	-2848	-3872	-8198	-7424	-8046	-13658	-18763
Netherlands	23790	22702	20925	20274	15916	17870	19174	18407	36528	41846	46328	48107
	1120	1970	3258	2511	2570	-2109	-2467	-1042	-699	4258	6796	5608
Russia	19816	21593	14913	16429	36014	60172	48121	46335	59860	85825	118364	139234
	-9637	-5384	-5945	-4083	-4284	-6665	-9131	-9886	-10894	-12693	-13894	-13812
Spain	-18612	-16048	-14219	-21459	-31938	-37076	-34569	-34409	-45008	-66670	-85261	-100593
	17420	18965	18239	19744	20498	19421	20559	21100	26212	26943	27677	27657
United Kingdom	-18973	-21413	-20216	-36140	-47001	-49920	-59358	-71570	-79387	-111575	-125044	-142739
	14135	17416	23130	24292	22052	20804	20804	24863	31259	47525	44828	53351
United States	-174170	-191000	-198428	-248221	-347819	-454690	-429519	-484955	-550892	-669578	-787149	-838271
	77786	86935	90155	82081	82729	74855	64393	61230	53977	57488	72778	79749

Countries with persistent goods deficits and services surpluses are: India, Spain, UK and United States. Countries with persistent goods surpluses and services deficits are: China, Germany, Indonesia, Japan, Korea and Russia. Countries with persistent goods surpluses: Netherlands. Countries with persistent services surpluses: France.

7.2 Model Parameters

Intra and Inter-industry Linkages The 1998 UK Input-Output Table with a total of 40 sectors covering both goods and services is used as a reference for parameter choice. The first 6 sectors spanning mostly primary products - agriculture, mining, food and tobacco, textile, wood, paper - are dropped. The utility sectors like construction and power gen-

eration are also dropped since they are infrastructural in nature (sectors 25-26). Services sectors that are mostly domestically oriented like hotels and restaurants (sector 28), real estate (sector 32), public administration and security (sector 37) are also dropped.

Of the remaining, sectors 7 to 24, spanning all industrial manufactured goods are taken as a whole to be the goods cluster. Sectors 27 to 40, spanning a whole range of services including wholesale and retail, finance, insurance, research and development, post & telecommunication, transport & storage and business services are considered as a whole to be the services cluster.

Ignoring the effects of production taxes, this paper checks for the intra- and inter-cluster linkages, taking the two broad clusters as defined. Checking the within and between cluster demands for intermediates, the goods cluster's inter and intra-industry linkages are 0.40 and 0.21 respectively. For the services cluster, the corresponding numbers are 0.43 and 0.06.

Instead of using cluster aggregate demands for intermediates, another measure would be to use the average intermediate demands of all defined sectors within the specified cluster. Taking the average for sectors in the goods cluster, the inter-industry and intra-industry linkages then become 0.44 and 0.24 respectively. Taking the average for sectors in the services cluster, the corresponding numbers are 0.50 and 0.07. The evidence therefore points to stronger inter-industry input-output linkages.

Elasticity David Hummels (1999) estimates that the elasticities of most goods are in the range of 3 to 8, with an average of 5.6. This implies an average mark-up of 22 per cent. This paper rounds down the elasticity to 5 for both services and manufacturing sectors, implying a mark-up of 25 per cent.

Consumption Intensities The consumption intensities for manufacturing and services are given as 0.4 and 0.2 respectively. The choice of parameters here have no bearing on the qualitative results except to note that they must be large enough (relative to endowments) so that one location cannot hold all firms. This is to ensure that the endowment constraints are binding enough to generate wage increases in equilibrium.

Summary The numerical solution is carried out using MATLAB. The baseline parameters are provided in the table below.

Table 2: Baseline Parameters for Numerical Solutions

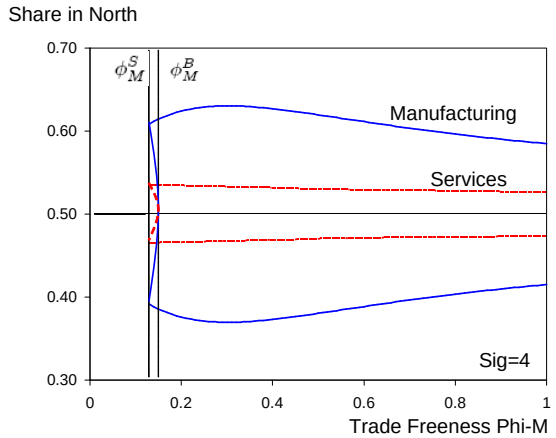
Endowments	$K_N = L_N = U_N$	100
	$K_S = L_S = U_S$	100
Industry Linkages	α_M	0.40
	β_M	0.10
	α_S	0.40
	β_S	0.10
Elasticities	σ	5
	μ_M	0.40
	μ_S	0.20
Adjustment / Increment	ε_F	0.01
	ε_W	0.0001

7.3 Sensitivity Analysis

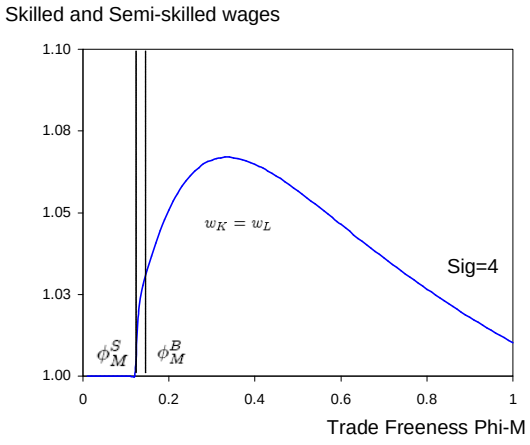
The effects of changing endowments are already discussed in the paper. In this small section, the paper presents some results with changes to other parameters.

7.3.1 Lower Elasticity of Substitution ($\sigma = 4$)

In this set of numerical solutions, all parameters are as per baseline specification in Table 2 except that the elasticity of substitution is lowered to 4.

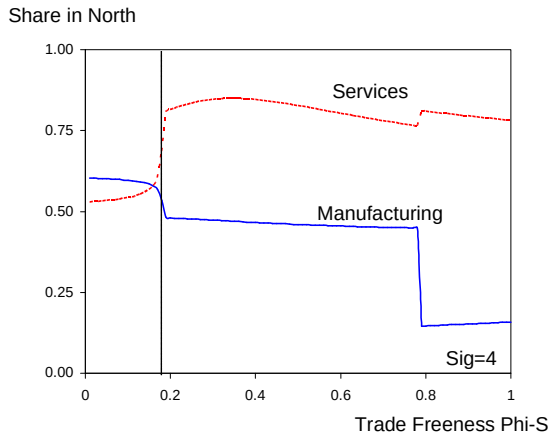


First Wave Locations

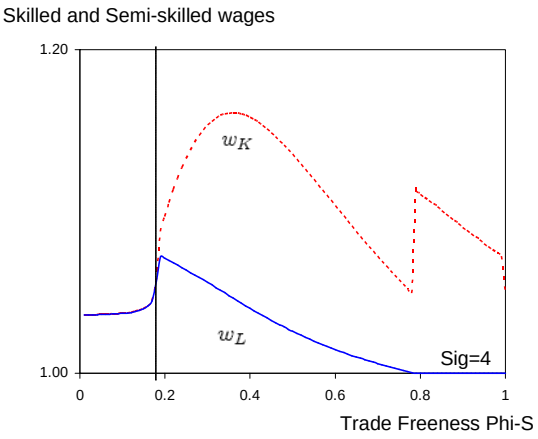


First Wave Wages

The effects of lowering the substitution elasticity does not change the analysis qualitatively. However, due to the lower elasticity, the strength of agglomeration is higher, thereby resulting in lowering the break / sustained points and increasing the location shares. The wage impact for the semi and skilled workers is also higher compared to when $\sigma = 5$. For the second wave, the paper again assumes that the first wave agglomeration has occured in the North.



Second Wave Locations (North)

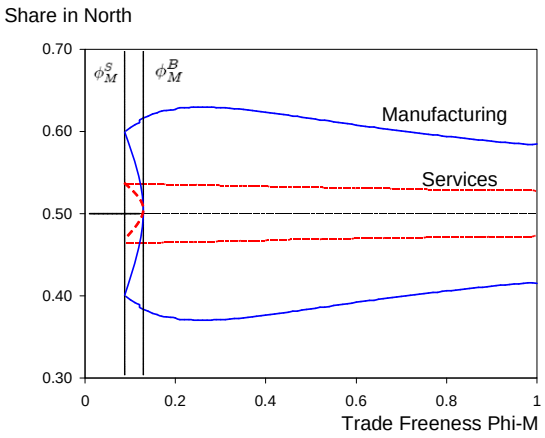


Second Wave Wages (North)

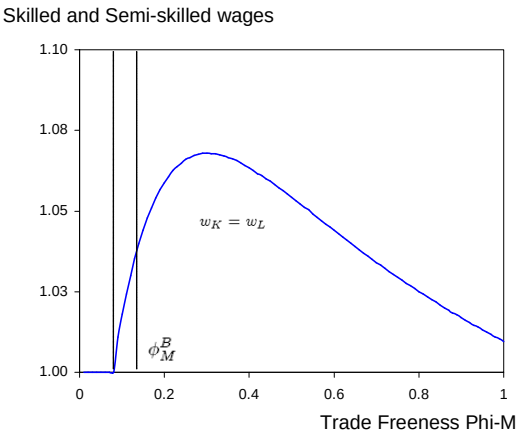
Again, the effect of lowering elasticity is to increase the strength of agglomeration and its impact on wages.

7.3.2 Increasing Strength of Intra Industry Linkage ($\alpha_M = \alpha_S = 0.45$)

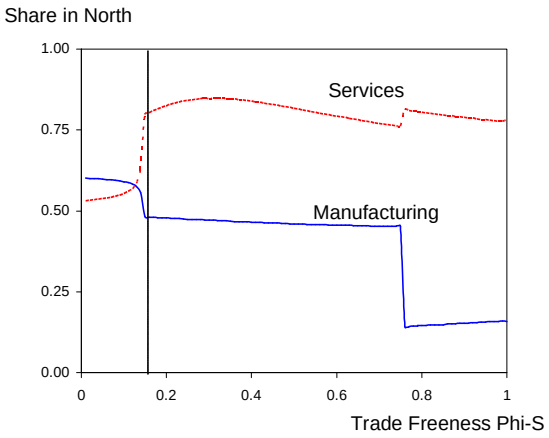
In this set of numerical solutions, all parameters are as per baseline specification except that the strength of intra-industry linkage is increased from 0.4 to 0.45.



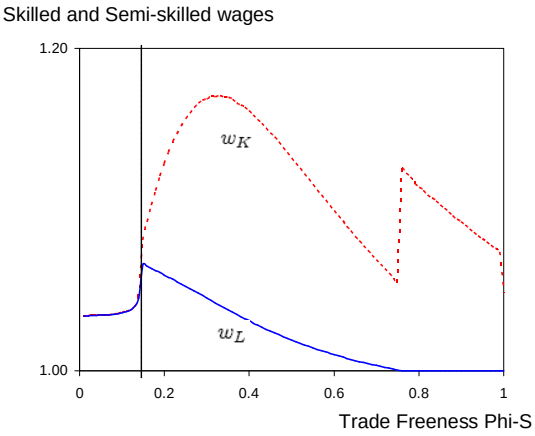
First Wave Locations



First Wave Wages



Second Wave Locations (North)



Second Wave Wages (North)

Increasing the strength of the intra-industry linkage has the same qualitative effect as lowering the elasticity. Namely, the force of agglomeration increases, resulting in higher wage impact.

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