CENTRE for ECONOMIC PERFORMANCE

CEP Discussion Paper No 734

July 2006

Off-Shoring of Business Services and Deindustrialisation: Threat or Opportunity – and for Whom?

Frédéric Robert-Nicoud

Abstract
This paper takes a new look at the issue of overseas sourcing of services. In framework in which comparative advantage is endogenous to agglomeration economies and factor mobility, the fragmentation of production made possible by the new communication technologies and low transportation costs allow global firms (multinational corporations or individual firms active in global networks) to simultaneously reap the benefit of agglomeration economies in OECD countries and of low wages prevailing in countries with an ever better educated labour force like India. Thus, the reduction of employment in some routine tasks in rich countries in a general equilibrium helps sustain and reinforces employment in the core competencies in such countries. That is, the loss of some jobs permits to retain the 'core competencies' in the 'core countries'. The welfare implications of this analysis are shown to be not as straightforward as in a neoclassical world.

JEL Classifications: F02, F12, L22, R11
Keywords: Outsourcing; wage inequality; communication costs

This paper was produced as part of the Centre's Globalisation Programme. The Centre for Economic Performance is financed by the Economic and Social Research Council.

Acknowledgements
This paper is a much-revised version of chapter 4 of my PhD thesis (Robert-Nicoud, 2002). I thank Gilles Duranton for prodding me to turn this piece of work into a paper; I am also highly indebted to him for detailed and repeated feedback. I also want to emphasize the valuable suggestions and comments from Kristian Behrens, Rod Falvey, Steve Redding, Nicolas Schmitt, Anthony Venables and Gerald Willman. Remarks from Peter Neary, Gianmarco Ottaviano, Yasushiro Sato, and participants at the 2000 LSE trade mini-conference, the 2005 CEPR workshop on economic geography, the 2005 Kiel summer workshop in trade and location, and seminar participants at Milan State University and at the University of Cordoba also contributed to improve this paper. All errors and omissions are of course mine.

Frédéric Robert-Nicoud is an Associate with the Globalisation programme at the Centre for Economic Performance and a Lecturer in the Department of Geography and Environment, London School of Economics.

Published by
Centre for Economic Performance
London School of Economics and Political Science
Houghton Street
London WC2A 2AE

ISBN 0 7530 2020 0

1. INTRODUCTION

This paper links two facets of 'globalisation' to two distinct facets of the reduction of spatial frictions to the flow of goods and information. On the one hand, the ongoing dramatic reduction in communication costs (partly due to the introduction of so-called new technologies) since the end of WWII sets the necessary conditions for the more recent rise in the offshore fragmentation of production. On the other hand, the well-documented but somewhat less dramatic reduction in physical transportation-cum-trade costs interacts in a subtle way with the (de)industrialisation of developed countries relative to overseas countries. Neither of these phenomena has gone unnoticed, of course, and both are being scrutinised by academics, the press and the public (these days, the weekly *The Economist* has about one article per month on 'outsourcing'). Indeed, many people argue that globalisation is the main engine to growing income inequalities and /or a threat to workers in the developed countries (e.g. Milanovic, 2003); blue-collar jobs are flowing from developed countries to countries in the Southern and Eastern hemispheres (these two hemispheres of course intercept). For instance, according to the union AFL-CIO, the United States have lost 2.8 million manufacturing jobs since January 2001. What is relative new is the perception that white-collar jobs in service sectors are in turn being threatened (Scheve and Slaughter 2001); the typical example that springs to people's mind is the outsourcing of IT services to Bangalore, India. As another category of white-collar jobs being moved offshore, one could cite human resources jobs. The publisher of HRO magazine claims that up to 5% of such jobs have been outsourced abroad in 2004.[1]

Less noticed in the mass media, but quantitatively about as important, many jobs are being 'off-shored domestically', a process linked to suburbanisation. As an example of 'domestic off-shoring', Citibank's headquarters are based in New York and the bank carries out its data processing in South Dakota. As an example of foreign off-shoring, American Airlines assembles the accounting material and ticket coupons in Dallas, Texas; uses its own carriages to send it to Barbados where its subsidiary processes nearly a million AA tickets a day; and sends the data by satellite to Tulsa, Oklahoma.

A comment regarding terminology is in order before I proceed. In this paper, I follow the non-rigorous usage of using the terms 'outsourcing' and 'off-shoring' interchangeably to encompass both multinationals' purchase of services from their foreign subsidiaries (that is, intra-firm international trade) and business-to-business services bought at arm's length. This abuse of language is minor because I leave the issue of the boundaries of the firm beyond the scope of this paper.[2]

One of the reasons put forward to explain the off-shoring of business to business services like call centres and IT support is that communication costs have fallen dramatically, permitting to exploit the supply of educated workers in countries like India at wages that are much lower than in Europe or in the US. To visualise the reduction of communication technological frictions, turn to Figure 1. This figure plots various measures of (transatlantic) transportation and communication costs, with 1940 as the benchmark (1970 for satellite telephone). Two lessons emerge from reading this picture: firstly, both trade and communication unit costs have been substantially reduced.[3] Second, the measures being plotted, the former have stopped falling as from 1980 onwards; by contrast, communication costs have fallen much more than transportation costs—and keep falling. For instance, the transatlantic phone bill has been reduced by a factor 100 over the time period 1940-1990. Also, the annual real cost of a telephone circuit in 1965 in the US was $22,000. In 1980, this figure was down to $800 and in five years later further down to $30 only (Wilson, 1995). These downward trends for prices are matched by upward trends in quantities. In 1986, there were 0.1 millions transatlantic and 0.041 millions transpacific of voice paths, two numbers that rose to respectively 2.022 and 1.889 millions in 1996 (Baldwin and Martin 1999). Over the same time span, the number of Internet hosts surged from .005 to 12.881 millions and numbered about 30 millions at the end of the twentieth century.

Figure 1. Transportation versus Communication Costs, 1940-1990

The premise in this paper is that these improvements in communication technologies have provided with the necessary conditions to 'break up to value chain' (Fujita and Thisse 2003). To people who perceive this evolution as a threat to the manufacturing sector in the Northern hemisphere, and especially to the well being of its unskilled workers, nothing good is to be expected from this aspect of the current wave of globalisation. Specifically, this line of thought views multinationals or global capitalists as being able to hire workers from virtually anywhere on Earth thanks to low transportation costs and to the even more spectacular development in communication technologies. In other words, they can play workers from different areas of the globe against each other; as a result labour demand is more elastic and workers surely are worse off; in the words of Paul Samuelson, "The new labour market clearing real wage has been lowered by this version of dynamic fair free trade" (2004: 137). As a result, globalisation is a zero-sum game that workers are losing and global capitalists are surfing. What is more, workers in the Northern hemisphere are bound to lose even more because they no longer enjoy relatively well paid manufacturing jobs that are delocalised in poor countries.

This paper qualifies this bleak view and provides a more balanced interpretation. In particular, it claims that low transportation costs and new communication facilities have very different effects on the patterns of production and the world distribution of income. The former permits the production process to be located quite far away from its demand (consumers or other businesses). The latter permits the spatial and organisational disintegration of the production process itself and thus the off-shoring of footloose (i.e. routine) tasks to low wage countries. Such tasks include data entry, data processing, and database management; financial and accounting services; processing assurance claims; computer software development and various IT services; or consumer services like call centres. This fragmentation of the production process has led some observers and policy advisors to claim that the theory of comparative advantage provides a very poor way of understanding these processes (see Krugman 1996 for a survey and a witty rebuttal). Partly to give the benefit of the doubt to this point of view, I interpret their view as saying that comparative advantage is endogenous—because, say, technology is transferable and/or agglomeration economies increase productivity.[4] Specifically, I allow the technology gap to be nil (thus indirectly addressing Samuelson's critique) and all the tasks/services to be footloose potentially (see Behrens 2004 on this); even in this case, my analysis suggests that viewing workers in rich countries necessarily as the losers as a result of overseas sourcing is partly misguided and only partial, though there is some truth in it. To make this point, I consider a setting in which the source of comparative advantage is endogenous because of agglomeration economies that result from the interaction between pecuniary externalities and the co-location of firms. In such a framework, Krugman and Venables (1995) establish that incomes and production patterns converge when transportation costs alone are low. With falling communications costs in addition, this is no longer the case: the world can remain specialised and the income gap can widen even if transportation costs are low. Put differently, the off-shoring of some tasks, made possible by much-improved communication infrastructures, triggers a 'functional specialisation' of countries.[5] This specialisation by function rather than by sector *relaxes the pressure to move the entire manufacturing production chain to low wage countries*. This brings somewhat comforting news to workers in the northern hemisphere but contrasting news to poor countries' residents.

To understand this result, it is important to understand the logic of agglomeration in so-called new economic geography models when communication costs are prohibitive. Imperfectly competitive firms benefit from each other's proximity because in a manufacturing cluster the access to intermediate suppliers and to demand (be it from downstream firms or consumers) increases their profits (insofar as firm lambda does not take these effects into account in her location decision, these are the source of pecuniary externalities); thus, all tings equal, firms will chose to locate near other firms: comparative advantage is endogenous because firms' location is endogenous. When transportation costs decrease, markets become more integrated and the relative attractiveness locations shrinks. However, there is also a downside of being close to other producers because firms compete with each other. In a cluster, firms also face strong market crowding externalities (that is, they have a low market share) and tougher competition for (primary) inputs; thus, all tings equal, firms will chose to locate *away* from other firms. When transportation costs decrease, firms increasingly compete in a global market place and as a result firms' market shares depend ever less on their location. Thus, when transportation costs are low, firms will increasingly base their location decisions on primary factor prices, that is, primary factors scarcity work as the main dispersion force. By contrast, when transportation costs are high, the market crowding dispersion force dominates the agglomeration forces. Thus, as such, both the model I am introducing in this paper and Krugman and Venables' (1995) model predict that net agglomeration forces peak for intermediate values of transportation costs. As a corollary, further economic integration in the form of lower transportation costs makes it more likely that southern countries will emerge as industrial powers (Puga and Venables 1996).

With this background in mind, consider the effect of fragmenting the value chain as a result of improved communication infrastructures. Specifically, consider what happens when firms can locate their core activities (i.e. their main assembly plants and headquarter activities) in their home country and 'hire' workers offshore at some (communication) cost. As a result, global firms can relocate some segments of the value chain to take advantage of low wages prevailing in the southern hemisphere and yet retain the benefits of agglomeration economies in developed northern countries. In other terms, as a result of capital mobility *and* low communication cots, footloose capital faces a more elastic labour supply; this in turn implies that agglomeration forces dominate dispersion forces for a wider set of transportation cost values. In other words, deeper economic integration in the form of lower communication costs makes industrialisation of southern countries a more distant prospect.

In short, two facets of the globalisation process have two different effects, thus reconciling anti-globs from both sides of the poverty line: low trade costs threaten the industrial base of the northern hemisphere whereas low communication costs trap workers in low wage countries in routine tasks and impede the development of their country. Of course, this result can also comfort the optimistic view that low trade and communication costs together favour the convergence in incomes, even if it is not accompanied by a similar convergence in the production patterns.

The rest of the paper is organised as follows. The next section selectively reviews relevant work in the area. Section 3 lays out the assumptions of the model. Section 4 solves for its equilibrium. Section 5 discusses the equilibrium properties of the model and conveys the comparative statics on its key parameters—communication and trade costs. Section 6 establishes the winners and the losers of ‘globalisation’. Finally, Section 7 wraps up the results and concludes.

2. SELECTIVE LITERATURE REVIEW

The issue of fragmentation of the value chain has initially been taken up in a neoclassical framework by Jones and Kierzkowski (1990, 2001). Harris (1995) shows how better transportation and communication technology, and the quasi non-rival nature of the latter, is a major force driving the fragmentation of the production process. Feenstra and Hanson (1996) show that outsourcing in manufacturing sectors has increased dramatically since the late 70’s. Barba-Naveretti, Venables et al. (2005) provide a comprehensive analysis of how vertical multinational enterprises, by investing abroad, might expand their home plant. For instance, Barba-Navaretti and Castelllani (2004) find in a sample of Italian firms that that the total factor productivity and output growth rates of those that invested abroad outpaced the corresponding growth rates of those that did not. The current paper also contributes (albeit marginally) to the debate of the role of trade in the rise of the wage gap between skilled and unskilled workers since WWII in OECD countries (Wood 1998) and developing countries (Chun Zhu and Trefler 2005). In a model in which firm location and human capital accumulation interact, Toulemonde (2006) shows that when moderate transportation frictions create agglomeration rents that are shared with high-skilled workers, this entices them to acquire those skills in the first place. When crossed with the results of the current paper, this suggests that the off-shoring of routine tasks would both reinforce the returns to high education in high income countries and, in developing countries like India, increase the returns to acquiring the English language and other ‘moderately high’ skills such as those that are used intensively in the IT sector in Bangalore.

The paper most closely related to this one is due to Fujita and Thisse (2003). They, too, ask the question of how trade and communication costs affect the supply chain and who are the losers and winners as a result of this evolution. Their approach and the one in this paper are complementary on three accounts at least. First, Fujita and Thisse (2003) are agnostic as to the source of agglomeration economies, thereby providing some generality to the analysis. By contrast, I have chosen to be explicit on this issue and therefore this paper is interested in assessing the positive and normative effects of falling communication costs and the resulting fragmentation of the value chain in a NEG setting. As Duranton and Puga (2004), I believe that pinning down the source of agglomeration economies from first principles is important especially from a welfare perspective.[6] The second difference lies in the *vector* of agglomeration economies. In Fujita and Thisse (2003), this is the mobility of skilled workers (ironically, this was the route I also undertook in the first version of the paper). This, then, is well suited to study the role of trade in the skilled-unskilled wage gap. Here, by contrast, I have chosen to emphasise the role of input-output linkages (firms buy each other's output as intermediate inputs) and the role of capital mobility and the way they interact. As it turns out, the combination of the two gives rise to pecuniary agglomeration economies that are typically encountered in the NEG.

Finally, the third difference between this paper and Fujita and Thisse's involves the location of final production. They consider that low communication costs allow the firm's headquarters to provide services to off-shore assembly plants whereas I consider the possibility of sourcing routine tasks to overseas suppliers but not the 'core' stages of the production process. Thus, Fujita and Thisse's model captures best the off-shoring of manufacturing processes to 'manufacturing dragons' like China, whereas my model fits the patterns of outsourcing to 'IT dragons' like India (the biggest 'insourcer' of business services among non-OECD nations and the world's sixth biggest behind the US, the UK, Germany, France and the Netherlands; see Amiti and Wei 2005). Nevertheless, the positive implications of the two specifications are comparable. However, the normative implications may differ somewhat because shipping final goods is costly.

The empirical paper due to Amiti and Wei (2006) provides support to some of the views I hold in this paper. Specifically, they show that the US manufacturing firms have become more productive over the time period 1992-2002 as the result of sourcing business services to foreign suppliers with negligible impact on employment; see also Slaughter (2000).

3. A THEORETICAL FRAMEWORK

The framework is based on an unpublished thesis chapter of mine.[7] Its distinguishable features are, firstly, a 'New trade/New economic geography' (NT/NEG for short) model that combines elements of Flam and Helpman's (1987) trade model and perfect capital mobility with input-output linkages à-la Ethier (1982) and Venables (1996). The second element of the model is that some tasks in the manufacturing sector, which I dub as 'routine' tasks, can possibly be undertaken in a separate location from the 'core' tasks. The model abstracts from Ricardian and Hecksher-Ohlin comparative advantage for simplicity. In a sense, all comparative advantage is endogenous and stems from agglomeration forces that take the form of pecuniary externalities like in Krugman (1991). Likewise, I abstract from factor migration; extending the model in these two directions would only reinforce the results.[8]

Notation and basic structure of the model

Consider a world economy made of two regions or countries, j=1,2 (sometimes referred to as North and South, respectively), identically endowed with the following primary factors: capital K (the return of which is denoted by π), labour L (denote its return by w) and land T (denote its return by r). The world is endowed with K^w units of capital (which are normalised to unity), L^w units of labour and T^w units of land. The spatial distribution of all primary factors is uniform, that is, residents of country 1 are endowed with an exogenous share s=½ of capital, labour and land.[9] Labour and land are immobile factors but capital is freely mobile; in other words, capital can be used in a country different from the one in which its owner resides.

Preferences

There are two goods in this economy: A, the 'traditional' or agricultural good, which is homogenous, and M, the 'manufactured' good, that comes in many imperfectly substitutable varieties. Preferences over the two broad types of goods take a Cobb Douglas form between A and M, with a fraction μ of income being spent on the latter good. As usual, M involves differentiated varities, with a constant elasticity of substitution $\sigma>1$ between any pair of varieties (Dixit and Stiglitz, 1977). Formally, these assumptions imply the following indirect utility function:

(1) $$V_j = \frac{y_j}{p_A^{1-\mu} G_j^{\mu}}, \qquad G_j \equiv \Delta_j^{\frac{1}{1-\sigma}}, \quad \Delta_j \equiv \int_0^N p_j(i)^{1-\sigma} di; \quad 0<\mu<1, \quad \sigma>1$$

where y_j denotes the income of a typical individual residing in j and $p_A^{1-\mu}G_j^{\mu}$ denotes the perfect consumer price index (CPI) of that individual. The CPI has two elements: p_A denotes the consumer price of good A and G denotes the perfect price index of the bundle M (it often proves more convenient to work with Δ, which is monotonically decreasing in G); $p_j(i)$ is the consumer price of a typical variety. The elasticity of substitution between any pair of M-varieties is parameterised by $\sigma>1$. N is the aggregate mass of available varieties.

Production

Sector A produces a homogenous good under perfect competition and constant returns and makes use of both labour and land. Good A chosen as the numéraire. Also, good A is costlessly tradable, thus the law of one price holds. Specifically, I take a Cobb-Douglas functional form such that minimizing costs and perfect competition in the A-sector together yield:

(2) $$r_j^{1-\theta} w_j^{\theta} = p_A \equiv 1$$

where 0<θ<1. Viewing land as a hidden factor, this is equivalent to saying that there are decreasing returns to L in the A-sector. The assumption θ<1 implies that the M-sector faces an imperfectly elastic labour supply in both regions.[10]

Turn next to the manufacturing sector M produces a differentiated good under increasing returns using capital, labour, and intermediates. Specifically, the representative firm's cost function is:

(3) $$C_j(x_j) = a_{KM}\pi_j + a_{LM}x_j\tilde{w}_j^{1-\alpha}G_j^{\alpha}; \qquad 0<\alpha<1$$

where x denotes output, $\tilde{w}_j$ is the unit labour cost that firms located in j are facing, G denotes the price of intermediates, α is the share of intermediates in the variable production costs and the *a*'s are input-output coefficients. Note that the M-sector output serves both as a final good and as an intermediate good to M-sector firms and that this bundle of goods is aggregated using the same elasticity of substitution σ as in (1); this loss of generality simplifies the analysis considerably (Fujita et al., 1999).

By choice of units, I normalise a_{KM} to unity, namely, each firm needs one unit of K to operate. This cost function in (3) is not homothetic: the fixed component is intensive in capital and the variable component is intensive in labour and intermediates; think of the former as non-production costs (e.g. R&D, marketing, HQ services) and to the latter as production costs. For simplicity, the fixed cost consists in capital only; conversely, capital does not enter the variable costs. Like in Krugman and Venables (1995) and Fujita et al. (1999, chapter 14), firms in the M sector combine outputs from other firms in the same sector as an intermediate input. Trade in the manufacturing sector is impeded by iceberg transportation costs à-la Samuelson (1952). Specifically, τ>1 units of good M need be shipped from region 1 for one unit of this good to reach region 2.

Off-shoring and communication costs

In the model the possibility of off-shoring comes in two ways. The first one comes very naturally in NT/NEG models with vertical linkages: as long as some manufacturing firms locate in both regions, and because such firms buy each other output as intermediates, some activities might be conveyed in the South and, as such, be perceived in the North as being 'off-shored'. This kind of off-shoring happens at arm's length. I also introduce another source of off-shoring by allowing manufacturing firms to hire workers abroad (to convey tasks that I shall dub as 'routine tasks'). This is related to the 'breaking-up of the value chain.'

Off-shoring routine tasks is costly to the firm. Some of these costs are related to technology: managers in one country have to give orders and guidance over the phone and the internet, using emails, facsimile, or other means: all these are more costly if they have to cross international borders, especially if they operate in different time zones. In addition, in-house outsourcing also involves managerial costs (the extra time needed to codify information to distant workers) and more intangible costs like cultural barriers and the misunderstandings that can also result from using different languages (Mokyr 2002, Fujita and Thisse 2003). I group all these costs under the same umbrella, which I refer to as 'communication costs', but it should be clear that only a fraction of this costs can be reduced by technological improvements in telecommunication infrastructures.

Specifically, I assume that communication costs take the iceberg form; these costs are parameterised by $\varepsilon>1$. That is, a fraction $1-1/\varepsilon$ of working time is lost communicating when the manager (or headquarter) is located in region 1 and the worker is located in region 2. As a result, one effective unit of labour costs w_1 to the firm whose manager is established in 1, but one such unit hired in country 2 would cost εw_2 to this firm. Thus, we get the following expression for $\tilde{w}_j$ in (3):

(4) $$\tilde{w}_1 \equiv \min\{w_1, \varepsilon w_2\}, \quad \tilde{w}_2 \equiv \min\{w_2, \varepsilon w_1\}$$

As a result, if nominal wages differ significantly in the two regions, some arbitrage is feasible. An improvement in communication facilities or technology increases the scope for arbitrage.

4. Equilibrium

Following a now well-established convention in the NEG literature, I solve for the equilibrium in two steps: in step one, the spatial allocation of manufacturing firms is taken as given and all markets clear; this is the so-called instantaneous equilibrium. In step two, the spatial allocation of firms is also endogenous and a so-called long run equilibrium emerges when the returns of the mobile factor—here, capital—are equalised wordwide.

Instantaneous equilibrium

Define n (resp. 1-n) as the share of manufacturing firms that establish their 'core activities', 'headquarters' or 'plants' in country 1 (resp. 2). Following convention in the NEG literature, I now solve for the so-called instantaneous equilibrium of the model. In such an equilibrium, the spatial allocation of firms, n, is given and firms maximise profits, consumers maximise utility and all markets clear. The endogenous variables to determine are eight in total, one of each of the following for each country : expenditure, price index, wage, operating profits. Recall that (2) describes what concerns sector A, so let me turn to the M-sector.

Operating profits in the M-sector

As usual with Dixit-Stiglitz monopolistic competition, profit maximisation results in mill pricing, that is, $p_j(1-1/\sigma)= a_{LM}w_j^{1-\alpha}G_j^{\alpha}$ for a typical firm in j (the term in the right-hand side is the marginal cost). As a result, p_j is larger than marginal cost (by a constant mark-up), thus firms active in the M-sector earn operating profits and these are a fraction $1/\sigma$ of sales revenue, p_jx_j. To operate, these firms also need to hire one unit of capital; thus, would-be entrepreneurs bid for units of K competitively ; as a result, the capital rental rate π is equal to the operating profit. Therefore, these considerations together ensure that the following hold:

(5) $$\pi_j = \frac{p_j x_j}{\sigma} \quad \text{and} \quad p_j = w_j^{1-\alpha} G_j^{\alpha}$$

It proves useful for further convenience to define π as the average operating profit in the world economy, that is, $\pi \equiv n\pi_1+(1-n)\pi_2$.

We are now able to get three (out of four) sets of expressions that characterise our instantaneous equilibrium. Denote the expenditure on manufacturing output as E and index it by country. Applying Roy's identity on (1) to get consumer's demand and Shepard's lemma on (3) to get intermediate input demand and plugging this into (5), we get the following expressions for the operating profits:

(6) $$\pi_1 = \frac{1}{\sigma} w_1^{(1-\sigma)(1-\alpha)} \Delta_1^{\alpha} \left(\frac{E_1}{\Delta_1} + \phi \frac{E_2}{\Delta_2} \right), \quad \pi_2 = \frac{1}{\sigma} w_2^{(1-\sigma)(1-\alpha)} \Delta_2^{\alpha} \left(\phi \frac{E_1}{\Delta_1} + \frac{E_2}{\Delta_2} \right)$$

with expenditures equal to

(7) $$E_1 = \mu \frac{L^w w_1 + T^w r_1 + \pi}{2} + \alpha(\sigma-1)n\pi_1, \quad E_2 = \mu \frac{L^w w_1 + T^w r_1 + \pi}{2} + \alpha(\sigma-1)(1-n)\pi_2$$

and where the Δ's are recursively defined as

(8)
$$\Delta_1 = n\Delta_1^{\alpha} w_1^{(1-\sigma)(1-\alpha)} + \phi(1-n)\Delta_2^{\alpha} w_2^{(1-\sigma)(1-\alpha)}$$
$$\Delta_2 = \phi n\Delta_1^{\alpha} w_1^{(1-\sigma)(1-\alpha)} + (1-n)\Delta_2^{\alpha} w_2^{(1-\sigma)(1-\alpha)}; \quad \phi \equiv \tau^{1-\sigma}$$

with ϕ as a useful combination of parameters that captures the 'freeness' of international trade (ϕ=0 when trade in manufactures is prohibitively expensive and ϕ=1 when it is free).

Even if these expressions might look somewhat complicated, they are easy to interpret. Note first that operating profits are higher in country 1 relative to country 2 if market access is better in 1 than in 2, if production costs are relatively low, or both. Production costs include wages w and the price of intermediates $\Delta^{1/(1-\sigma)}$; in this two-country world, market access in 1 is larger than in 2, ceteris paribus, if expenditure in 1 (E_1) is large relative to E_2 (this is because transportation costs deflate sales abroad by a factor ϕ<1). Note then that expenditure in any region is increasing in the mass of firms that locate their core activities (or 'plants') there as well as in their profitability. Finally, Δ_1 is increasing in n and ϕ, that is, the price index in region 1 is negatively related to the number of plants in 1 and to trade freeness.

Full-employment conditions

Now, assume that nominal wages are at least as high in region 1 than in region 2; this will be the case if n≥s=½ (this is without loss of generality given the underlying symmetry between the two regions). Finally, define m as the proportion of workers country 1's firms in 1 hire abroad to convey routine tasks. Loosely speaking, m can be referred to as the proportion of firms that get 'multinational'. At the instantaneous equilibrium, m is exogenous.

Capital is fully employed so $N=K^w=1$. Land is inelastically supplied to and fully employed in sector A, thus labour demand in the traditional sector in each country is increasing in land endowment, $T^w/2$. To get an expression for labour demand in the M-sector, we apply Sheppard's lemma on (3) and use the relationship between sales and operating profits in (5). A mass $L^w/2$ of labour is inelastically supplied in each country, thus these considerations alongside (2) enable us to write the full-employment condition for labour as:

(9)
$$\frac{L^w}{2} w_1 = (1-m)n(1-\alpha)(\sigma-1)\pi_1 + \frac{T^w}{2}\frac{\theta}{(1-\theta)} w_1^{-\theta/1-\theta}$$

for country 1 and as

(10) $$\frac{L^w}{2}w_2 = mn(1-\alpha)(\sigma-1)\pi_1 + (1-n)(1-\alpha)(\sigma-1)\pi_2 + \frac{T^w}{2}\frac{\theta}{(1-\theta)}w_2^{-\theta/1-\theta}$$

for country 2. The left hand side terms in these two expressions are the total wage bills. The rightmost term on the right hand side represent the wage bill in sector A; note that it is decreasing in w because the elasticity of labour demand is lower than –1. Reading from right to left, the next term captures the wage bill of domestic (manufacturing) firms; the wage bill is increasing in the value of sales (more workers need be hired to expand production), which are themselves proportional to operating profits. Finally, the leftmost term of the right hand side in expression (10) represents the wage bill paid by multinational firms to foreign workers.

Given π_1 and π_2, these expressions reveal that w_2 increases in m (that is, wages in the South increase with the proportion of routine tasks that are off-shored there) and that w_1 decreases in m (that is, wages in the North go down when multinational's demand for routine work in the South goes up).

Expressions (6)-(10) fully depict the instantaneous equilibrium of $\{\pi_1,\pi_2,w_1,w_2,E_1,E_2,\Delta_1,\Delta_2\}$.

Long-run equilibrium

In the long run, capital moves in search of highest returns and firms hire workers where wages (adjusted for communication costs) are lowest. Given that nominal wages in the North are no lower than wages in the South, the no-arbitrage condition in (4) is the following[11]:

(11) $$w_1 \le \varepsilon w_2, \quad m \ge 0, \quad (w_1 - \varepsilon w_2)m = 0$$

Again following standard practice, I assume that entrepreneurs myopically move plants (or core activities) whenever π_1 and π_2 differ, and that the adjustments follow the following, ad-hoc, law of motion:

(12) $$\dot{n} = \gamma n(1-n)(\pi_1 - \pi_2) = \gamma n(\pi_1 - \pi), \qquad 0 < \gamma < \infty$$

where γ is a parameter that captures the speed of adjustment to differences in profit opportunities (the second equality follows from the definition of π). Accordingly, a long-run equilibrium (or steady state) is defined as an instantaneous equilibrium for which (11) and (13 hold:

(13) $$0 \le n \le 1, \quad \max\{\pi_1, \pi_2\} = \pi, \quad n(1-n)(\pi_1 - \pi_2) = 0$$

Namely, active firms make no pure profits in a long run equilibrium.

The dynamics of the model is simpler if one is willing to assume, as I implicitly did, that employment adjusts faster than plant location (I even made the extreme assumption that the former adjusts in no time). Given that I focus the analysis on the core-periphery equilibrium (see below), this assumption is immaterial. The description of the basic model is now complete; as it turns out, its properties in the special case m=0 are very similar to the model developed by Krugman and Venables (1995) and synthesized in Fujita et al. (1999, chapter 14). The next section describes these properties.

5. EQUILIBRIUM PROPERTIES

In this paper, for the sake of keeping the paper within reasonable length, I focus the rest of the analysis on the agglomerating equilibrium (also known as the "core-periphery equilibrium"), whereby all firms locate in country 1, n=1.[12] There are two justifications for choosing to do this. First of all, as it turns out, all economic intuition can be fleshed out from this equilibrium. Second, this is the most interesting equilibrium, not least because this is the one that exhibits the largest spatial disparities and best capture the "north-south divide". In order to get a single implicit equation to characterize the sustain point, I make a further simplifying assumption: take $\theta=½$. Relaxing this assumption does not bring any further insight; also, allowing θ to vary in (0,1) affects the result quantitatively in an intuitive way.[13]

The sustain point

Conceptually, there are three cases to consider: first, communication costs can be prohibitive in the sense that (11) is not binding; in this case, m=0 and the model is a standard NEG model with the usual properties; in particular, the equilibrium is unaffected by the value of ε whenever $\varepsilon>\varepsilon_0$, where ε_0 is defined as the (nominal) wage gap at the core-periphery outcome when m=0:

$$\textbf{(14)} \qquad \varepsilon_0 \equiv \left.\frac{w_1}{w_2}\right|_{n=1} = \frac{1+\psi}{1-\psi} > 1, \quad \text{where} \quad \psi \equiv \frac{\mu(1-\alpha)(\sigma-1)}{(1-\alpha)(\sigma-1)+1-\mu} < 1$$

($\varepsilon_0>1$ because manufacturing employment is larger in the core than in the periphery.) Alternatively, communication costs ε can be low enough to affect the stability of the core-periphery equilibrium; as we will see, an improvement in the communication technology ($d\varepsilon<0$) makes the agglomeration sustainable over a wider range of parameter values—in particular, for lower values of trade freeness, ϕ. In addition, within the subset of parameters for which the core-periphery equilibrium is sustainable, real factor rewards are a function of ε.

In this paper, I concentrate the analysis on the interior outcome, that is, $\varepsilon<\varepsilon_0$. Interestingly, ε_0 is increasing in μ and σ and decreasing in α. That is to say, firms in the north will hire workers in the south even when the losses due to poor communication technology are large when the fraction of income spent on manufacturing goods is large (because it exerts a large pressure on labour resources, resulting in a large wage gap), when the labour cost share $1-\alpha$ is large (for the same reason) and when goods are close substitutes (in this case, unexploited scale economies are low thus firms operate at a large scale).

Interior case: $1 \leq \varepsilon \leq \varepsilon_0$

When communication costs are prohibitive, all the expressions below hold with ε being replaced by ε_0. When communication costs are low enough, some firms in 1 will hire workers in 2 at equilibrium implying that producing in and exporting from region 1 is cheaper than if off-shoring was not feasible. In other words, the dispersion force of producing in the high wage country is weakened by the possibility of going multinational. This has a dramatic implication on the dynamics of the system, and in particular on the sustainability of the core-periphery pattern.

Set n=1, solve for the shadow value of π_2 using (6)-(11) and benchmark it against $\pi_1=\pi$ in (6):

(15)
$$\left.\frac{\pi_2}{\pi_1}\right|_{n=1} = \varepsilon^{(\sigma-1)(1-\alpha)}\phi^{\alpha}\left(s_E\phi + \frac{1-s_E}{\phi}\right)$$

where

(16)
$$s_E \equiv \left.\frac{E_1}{E^w}\right|_{n=1,m>0} = \frac{1}{2}\left(1+\alpha\beta+(1-\alpha)\beta\mu\frac{\varepsilon-1}{\varepsilon+1}\right)$$

that is, s_E is defined as E_1/E^w for n=1 and $\varepsilon<\varepsilon_0$. By inspection, the share of expenditure from the core s_E is always larger than one half and it is increasing in ε, that is, $s_E(\varepsilon)>½$ and $\partial s_E/\partial\varepsilon>0$ if $\varepsilon \in (1,\varepsilon_0)$. Intuitively, when communication costs fall ever more workers in 2 are brought into M and ever more workers in 1 leave that sector. As a result, nominal factors rewards in each region converge and thus, at the limit $\varepsilon\rightarrow 1$, *nominal* incomes are equalized. Nevertheless, all firms are clustered in 1 and so all intermediates are sold and bought there, hence expenditure in 1 is always larger than expenditure in 2. In other words, even though incomes converge the production patterns do not. Put in yet another way, regarding *final* goods, the core remains industrialised and the periphery is specialised in traditional goods. This implies that real factor rewards will keep diverging as communication costs fall.

Turning to the stability of the agglomerated equilibrium when communication costs are non-prohibitive, the core-periphery outcome is said to be sustainable if the expression in (15) is lower than unity (conversely, if f(.) below takes a positive value), which is the case if $\phi \in \Phi^S \equiv [\phi_S, \phi^S]$, where ϕ_S and ϕ^S are the roots of $f(\phi)=0$:

(17) $$f(\phi,\varepsilon) \equiv \varepsilon^{(1-\sigma)(1-\alpha)}\phi^{1-\alpha} - s_E\phi^2 - (1-s_E)$$

Standard algebra shows that the ‘polynomial’ above is negative and increasing at $\phi=0$, negative and decreasing at $\phi=1$, and concave everywhere. Hence, f(.) admits a unique maximum. If agglomeration forces are strong enough (i.e. if μ is large and σ is low), the two roots of (17), namely ϕ_S and ϕ^S, belong strictly to the (0,1) interval (in which case $\partial f/\partial\phi>0$ at ϕ_S and $\partial f/\partial\phi<0$ at ϕ^S). Unless otherwise specified, I assume that agglomeration forces are strong enough so that this maximum is positive and the roots of $f(.,\varepsilon)$ are in (0,1).

Discussion: Agglomeration and dispersion forces

An intuitive way to understand the long run equilibrium configurations in this model relies on describing the agglomeration and dispersion forces at work, both working through pecuniary externalities. There are two of each. Figure 2 plots the magnitude of agglomeration (AA-curve) and dispersion forces (DD-curve) as a function of trade freeness and evaluated at the core-periphery outcome (n=1). Both AA and DD are decreasing in trade freeness because location becomes irrelevant when transportation costs are nil ($\phi=1$). In the case depicted, agglomeration forces outweigh dispersion forces for intermediate values of ϕ ; if agglomeration forces were too weak, the maximum of $f(.,\varepsilon)$ would be negative (in such a case the curves AA and DD in Figure 2 do not intercept).

Start with the agglomeration forces. The first source of pecuniary externalities in this model arises because firms buy each other's output as intermediate inputs. Due to transportation costs ($\phi<1$), other firms benefit from a firm’s decision to locate nearby—the more so, the larger is the share of intermediates in production costs (graphically, AA rotates clockwise as a result of $d\alpha>0$). The first effect of a larger α is to increase intermediate demand for local manufacturing output; this effect manifests itself in (17) as an increase in s_E (and of f(.) in turn because $\partial f(.)/\partial s_E>0$); also, from (16), it is clear that the north's share of expenditure, already larger than ½ at the agglomerated equilibrium, is increasing in α. The second effect of getting an additional firm locating in a given region on other local firms is to lower their marginal cost of production; again, this effect is bigger, the larger the share of intermediates. This effect manifests itself directly in (17) as a reduction of the exponent of $\varepsilon^{1-\sigma}\phi$ (since this term is lower than unity, it increases when the exponent falls). Thus, all things equal, stronger vertical linkages reinforce this agglomeration force: $\partial f(.)/\partial\alpha>0$.

Figure 2: Dispersion and agglomeration forces at the core-periphery equilibrium

Turn now to the dispersion forces using the same thought experiment. The first negative pecuniary externality is usually referred to as the market crowding effect in the literature. It arises because when making their location choice firms do not take into the negative effect on the domestic firms' local market share (and thus on their operating profits), nor do they care about the positive effect on market shares and profits for firms in the other location. In (6), the market shares of the typical firm based in region 1 are equal to $w_1^{(1-\sigma)(1-\alpha)}/\Delta_1^{1-\alpha}$ on the domestic market and $\phi w_1^{(1-\sigma)(1-\alpha)}\Delta_1^{\alpha}/\Delta_2$ on the export market. By inspection of (8), the former is increasing in n and that the later is decreasing in n. This is a dispersion force because it gives an incentive to locate away from the core. In (17), the market crowding effect is captured by the ϕ^2 that pre-multiplies s_E; it weakens as ϕ increases, thus DD in Figure 2 is downward sloping. The other dispersion force of the model stems from the decreasing returns to labour in agriculture; to repeat, these decreasing returns imply that the labour supply curve to M is strictly increasing. Thus, when the share of firms in 1, n, increases this increases labour costs in 1 and reduces labour costs in 2, ceteris paribus. From (6), it is readily verified that an increase in w_1 (resp. a reduction in w_2) results in a fall of both domestic and export market shares of firms located in the north and, in turn, in a fall in π_1 (resp. an increase in π_2). This dispersion force is analogous to a 'congestion cost' in an urban setting because it works through the use of an inelastic supplied non-tradable factor. This congestion cost appears in (17) as ε, which at equilibrium is the wage gap $w_1/w_2>1$; since it comes with a negative exponent, it is clear that improvements in communication technologies ($d\varepsilon<0$) make the core-periphery outcome sustainable over a wider range of parameters, that is, $\partial f(.)/\partial\varepsilon<0$. Crucially, this dispersion force is unaffected by the value of ϕ (it is due to decreasing returns to labour in the agricultural sector and to the fixed supply of land), thus the DD curve in Figure 2 lies strictly above the horizontal axis.

As it turns out, the DD-curve is steeper than the AA curve for low values of ϕ (Baldwin et al. 2003) and, provided the congestion costs are not too high, these curves intersect twice. As a result, agglomeration forces dominate dispersion forces when trade barriers take intermediate values. To summarise this discussion, we can write:

> Result 1. Let $0<\theta<1$. Then two cases might arise. (i) either n=1 implies $\pi_1<\pi_2$ for all admissible values of ϕ and thus full agglomeration of the manufacturing sector is never part of a long run equilibrium (this case arises if θ is low enough, that is, if the elasticity of the labour supply to the manufacturing sector is low); (ii) or there exist a ϕ^S and a ϕ_S (which are referred to as the sustain points) such that $0<\phi_S<\phi^S<1$ and, for all ϕ in $\Phi^S\equiv[\phi_S,\phi^S]$, n=1 is part of a long run equilibrium in the sense that $\pi_1\geq\pi_2$.

In the remainder of the paper, unless otherwise specified I assume that parameter values are such that case (ii) applies, that is, a core-periphery pattern emerges at equilibrium.[14]

The role of communication technologies

To consider the effect of offshore outsourcing, turn first to Figure 3, which plots the profit gap at the instantaneous equilibrium against the proportion of firms operating in 1. In the case depicted by the plain curve, ε is prohibitive (so firms hire workers on the domestic labour market only, viz. m=0) and transportation costs are such that the core-periphery equilibrium is unsustainable, i.e. $\phi\notin\Phi^S$ because π_1-π_2<0 at n=1, whilst the dispersed configuration is stable, viz. $d(\pi_1-\pi_2)/dn<0$ at n=½ (Puga, 1999). The horizontal axis measures the proportion of firms established in region 1, n. The vertical axis measures the difference in operating profits between firms operating in 1 and firms operating in 2.

Figure 3. Hiring workers abroad.

Consider now what happens when communication costs are moderate ($1<\varepsilon<\varepsilon_0$), as in the case depicted by the dotted curve. As we know, employment in the manufacturing sector in region 1 increases when the proportion of firms established in 1 increases. This implies that wages in 1 increase (and wage in 2 decrease) as n increases; this opens a wage gap when n>½. The no-arbitrage condition kicks in for an n large enough (by the symmetry of the model $w_1\simeq w_2$ when $n\simeq$ ½). In the figure, this happens from point A onwards. Their ability to hire cheap labour increases the profitability of firms in 1 and hence the curve π_1-π_2 rotates anti-clockwise around point A. In the situation depicted, the core-periphery outcome n=1 becomes sustainable. In addition, m increases as n increases, ceteris paribus (this can be shown formally). To sum-up, we can write:

> Result 2. The ability of firms established in region 1 to hire workers from region 2 has three effects. First, the number of workers being hired abroad is increasing in the unevenness of the spatial allocation of firms (namely, m is increasing in n). Second, this decreases the production costs in 1 relative to 2, which raises the relative profitability in 1. Finally, as a corollary of the preceding effect, a core-periphery pattern that was unsustainable when communication costs were prohibitive might become sustainable when communication costs are moderate.

To understand this corollary in depth, consider the effects of lower communication costs on domestic and foreign employment in the manufacturing sector when communication costs are non-prohibitive to start with, that is, when $\varepsilon \leq \varepsilon_0$. As we have seen already, this reduces the equilibrium wage gap because $\varepsilon = w_1/w_2$ at equilibrium. The effect on employment is the dual of this effect on wages: controlling for the spatial distribution of firms (n=1), manufacturing employment expands in the south and contracts in the north (i.e. dm>0). This relaxes the congestion cost, that is, manufacturing firms established in the north now face an effective labour supply curve that is more elastic and their wage costs fall as a result. Graphically, the effect of an improvement in communication technology is to shift the DD-curve down in Figure 2, as indicated by the arrows. Clearly, this expands the bounds of Φ^S (mathematically, $\partial\phi_S/\partial\varepsilon>0$ and $\partial\phi^S/\partial\varepsilon<0$ whenever $0<\phi_S,\phi^S<1$), that is, *the core-periphery pattern is sustainable for a wider range of parameters*. In other words, this makes an uneven north-south development more likely. To sum up, we can write:

> Result 3. When communication costs decrease, the core-periphery equilibrium is sustainable over a wider range of trade costs.

To get an intuition for this result, note that an improvement in communication technology allows firms to outsource some labour-intensive tasks, which relaxes the trade-off between taking advantage of the agglomeration economies that result from backward and forward linkages in the north and of the low wages in the south; now, manufacturing firms can have it both ways. However, this is not the end of the story: there is also a general equilibrium effect. Indeed, as m increases for given n, expenditure in region 1 may decrease relative to expenditure in region 2 (it decreases if the fall in relative wages outweighs the rise in the relative reward to the fixed factor, land). There are two reasons to believe that this general equilibrium, income effect might not overcome the direct equilibrium cost-effect. On the one hand, the cost effect operates for all firms within the industry; the general equilibrium effect on factor returns is small if the sector is small in respect to the rest of the economy, that is, if the share of factors affected by off-shoring is small with respect to the rest of the economy. Within the current model, of course, the whole of the economy is affected by this effect. However, and this brings us to the other reason, numerical simulations suggest that the direct effect dominates the possibly countervailing general equilibrium effect *for all economically meaningful parameter value*.[15] As a consequence, I ignore this general equilibrium effect from now on.[16]

Figure 4. The 'Loudspeaker' diagram

Turn to Figure 4 for an illustration of the equilibrium. This figure plots 'trade freeness' ϕ against 'communication freeness' $\varepsilon^{1-\sigma}$, both defined on the unit interval. When one moves from the South-Westernmost part of the diagram towards its North-Eastern corner both trade and communications costs fall, that is, both trade freeness and communication freeness rise. The diagram shows that the range of parameters for which agglomeration is sustainable, Φ^S, is non-decreasing in communication free-ness. In particular, its lower bound is decreasing in $\varepsilon^{1-\sigma}$ and its upper bound is increasing in $\varepsilon^{1-\sigma}$ and, at the limit $\varepsilon=1$, it encompasses $\phi=1$. By contrast, when communication costs are prohibitive –which happens when $\varepsilon^{1-\sigma}<\varepsilon_0^{1-\sigma}$– then the no-arbitrage condition (11) is not binding and as a result Φ^S is constant.[17]

Discussion: 'History of the world, Part II'

It is useful to contrast Result 3 to Krugman and Venables' (1995) "History of the world, Part II" result (the somewhat provocative terminology they use in the working paper version of their QJE paper). The idea is as follows. At the beginning of the industrial age, assume that transportation costs of all sorts are high enough so that ϕ is above ϕ_S; as a result, only the Northern hemisphere is industrialised (say country 1 in the model) and the rest of the world produces only traditional goods ('country 2' specialises in agriculture and in the extraction of natural resources). Since all manufacturing firms are in 1, both nominal wages and real wages are higher in 1 than in 2 as per (7) and (8). Indeed, n=1 implies that the demand for workers is larger in the core than in the periphery, hence $w_1>w_2$. Also, since consumers in 1 don't have to pay transportation costs on manufactured products, they face a lower consumer price index, which is defined as CPI$\equiv 1/\Delta^{\mu/(\sigma-1)}$ by (1) and (3). Formally, we can write

$$\textbf{(18)} \qquad \omega_1 > \omega_2; \quad \omega_j \equiv w_j G_j^{-\mu} = w_j \Delta_j^{\mu/(\sigma-1)}$$

When ϕ increases, this raises demand for manufactured products from country 2 (ϕE_2 increases), ceteris paribus. This in turn increases labour demand in the industrialised part of the world, and hence both nominal and real wages diverge further, by the same mechanism. This is the history of the nineteenth and (most of) twentieth centuries, or 'history of the world, Part I'. When ϕ increases yet further, wages diverge even further. When ϕ crosses the cut-off ϕ^S dispersion forces dominate and n=1 is no-longer part of an equilibrium; rather, some firms re-locate to low wage countries, willing to incur the cost of imported intermediates to save on labour costs. Thus the very same process that caused wage divergence in the first phase of 'globalisation' brings wage convergence in a later phase; this is the process that Krugman and Venables refer to as the 'history of the world, Part II'. The core argument of the current paper is that the possibility of outsourcing changes the prospect for this convergence in both wages and production patterns dramatically, as we have seen.

'History of the world, part II bis'?

In the recent past, trade barriers and communication costs have fallen dramatically – since the end of WWII, recall that the cumulative number of transatlantic and transpacific voice paths fell by a factor 30, while the air freight costs fell by a factor six 'only' (see section 2 of the paper). How do each of these trends differ qualitatively in terms of their effect on spatial distribution of economic activity?

Turn again to Figure 4. The story Krugman and Venables are telling involves moving up from a point such as point S on the figure ('S' for 'symmetry'). Thus, as trade becomes freer and freer, the world economy travels through three phases: dispersion (with some manufacturing activity everywhere, i.e. n=½), agglomeration (point A) (the phase we are currently experiencing, with the North and South diverging, i.e. $n \simeq 1$), and re-dispersion and thus convergence of production patterns and incomes, both real and nominal (point S'). In the current framework, what is driving the convergence result is the presence of decreasing returns to labour in the traditional sector. In an urban framework, congestion costs would have the same effect. However, if we allow for a simultaneous reduction of trade and communication barriers, with the possibility of foreign off-shoring, then the globalisation process might look like more moving from point A towards the

North-East (point A'). In words, the possibility of off-shoring reduces the magnitude of the convergence process –and might even prevent it altogether. In this case, the Northern hemisphere retains capital-intensive processes with large value added, while routine tasks are outsourced to the Southern hemisphere. Remember that in this framework, the two countries are deliberately symmetrical ex-ante. Thus, nominal rewards do converge as one moves towards the northeast of the figure. Nevertheless, real incomes diverge because the South has to import all manufactured products. In the current framework, low communication costs play the role of increasing the elasticity of labour supply to the manufacturing sector, thus relaxing the re-dispersion force. In an urban setting, the possibility of relegating some back office tasks to sub-urban areas or to the countryside reinforces the agglomeration forces that support economic activity inside the city at the CBD.

6. Welfare

Spatial economic integration can have large distributional impacts on factor rewards. In trade theory, this point was famously made in the early forties by Stolper and Samuelson (1941). Their celebrated theorem characterises the redistributive effects of relative tradable goods prices, that is, it establishes a form of class struggle. Indeed, some authors have argued that the post-WWII globalisation wave has taken the form of a zero sum game between skilled and unskilled workers in all OECD countries (Baldwin and Martin 1999, Wood 1998). On the other hand, an equally hot debate is raging as to whether 'globalisation' and trade integration in particular hinder or stimulate income divergence across regions of the globe (Ben David and Kimhi, 2004). In this section I look at how falling trade costs *and* falling communication costs affect factor rewards and income inequalities.

It is worth recalling that in the model the two regions are ex-ante identical. However, the prevalence of agglomeration economies and, possibly, of foreign outsourcing implies that these regions might diverge at equilibrium. In the previous section, I focused on the agglomerated equilibrium of the model. However, another equilibrium is possible, the symmetric equilibrium whereby $n=s=½$ and $m=0$, and for some parameter values both equilibria coexist. To provide an exhaustive analysis of the welfare properties of the model, I also characterize how factor rewards evolve at the symmetric equilibrium. The appendix describes the properties of this equilibrium; however, it is easy to show that the symmetric equilibrium is unstable for intermediate values of ϕ and is unaffected by the value of ε. To understand the former result, note that the agglomeration and dispersion forces that interact to make the agglomerated equilibrium stable or not are the same as those that are making the symmetric equilibrium stable or not; only their magnitude changes. As to the latter, note that factor owners earn the same rewards, independent of their location ($w_1=w_2$, etc.). Since there is no wage gap, there is no off-shoring at the symmetric equilibrium (m=0).

More formally, note first that by the symmetry of the model the symmetric equilibrium always exists. In addition, there exist two values of ϕ, call them ϕ_B and ϕ^B, such that the symmetric equilibrium is unstable for any ϕ outside the range $\Phi^B\equiv[\phi_B, \phi^B]$. The appendix establishes that $\Phi^B\subset\Phi^S$. Graphically, this shows up as a 'double tomahawk diagram' in Figure 5, which plots the possible equilibria of the model against trade freeness ; stable equilibria are drawn in continuous lines, whereas unstable equilibria appear as dotted lines. This figure establishes (a) that full dispersion (n=½) is the unique stable equilibrium for extreme values of trade freeness, (b) that agglomeration (n=1) is the unique stable equilibrium for intermediate values of ϕ, and (c) that three stable equilibria coexist when $\phi\in\Phi^S\backslash\Phi^B$. [18]

Figure 5: The 'Double Tomahawk' diagram

In the model, labour markets get more integrated as communication technologies improve. This has no impact on factor rewards (nominal or real) at the symmetric equilibrium but it does affect wages and other rewards at the agglomerated equilibrium. In addition, it might shift the world economy equilibrium to another one, thus dramatically affecting factor rewards. Similarly, reductions in transportation costs result in integrating goods markets. This has no impact on nominal factor rewards at the symmetric equilibrium but alters the stability properties of the model and thus factor rewards in turn. In the remainder of the section, I consider how the factor rewards evolve at the symmetric equilibrium first, then at the agglomerated equilibrium and then when equilibria switch.

Evolution of nominal and real rewards at the symmetric equilibrium

Assume $\phi\notin\Phi^B$ and n=½ . Denote the values of the nominal factor rewards and all other endogenous variables at the symmetric equilibrium with the naught subscript; to solve for these, substitute n=½ and m=0 into (6)-(10) to get:

(19) $$w_0=\sqrt{\varepsilon_0 T^W / L^W}, \qquad \pi_0=\frac{1}{\varepsilon_0 w_0}\frac{T^w(\varepsilon_0-1)}{(\sigma-1)(1-\alpha)}, \qquad \Delta_0=\left(\frac{1+\phi}{2}\right)^{1/(1-\alpha)} w_0^{1-\sigma}$$

and $r_0=1/w_0$ by (2) and θ=½ (ε_0 is a collection of parameters defined in (14)). Since nominal rewards are unaffected by the level of transportation or communication costs ϕ and ε, as (19) reveals, Δ_0 is a sufficient metric to assess welfare effects of $d\phi>0$ or $d\varepsilon<0$ (see (1)). Indeed, as in (18), the consumer price index is a decreasing function of Δ, viz. $CPI_0=\Delta_0^{-\mu/(\sigma-1)}$. It is immediate by inspection that everybody's welfare is increasing in trade freeness and unaffected by communication costs *along the symmetric equilibrium.*

Evolution of nominal and real rewards under agglomeration

Assume $\phi\in\Phi^S$ and n=1. Then solving for nominal rewards using (6)-(10), we get:

(20) $$\forall\varepsilon\leq\varepsilon_0: \quad w_1(\varepsilon)=w_0\sqrt{\varepsilon}, \quad w_2(\varepsilon)=w_0\frac{1}{\sqrt{\varepsilon}}, \quad \pi(\varepsilon)=\pi_0\frac{(1+\varepsilon)}{2\sqrt{\varepsilon}}$$

and $r_j(\varepsilon)=1/w_j(\varepsilon)$, j=1,2 (when communication costs are prohibitive ($\varepsilon>\varepsilon_0$), then ε_0 replaces ε in the expressions above). The extend of outsourcing is given by

(21) $$m(\varepsilon)=\begin{cases}\dfrac{\varepsilon_0-\varepsilon}{(1+\varepsilon)(\varepsilon_0-1)}, & \varepsilon\leq\varepsilon_0\\ 0 & \text{otherwise}\end{cases}$$

Inspection of expressions (20) and (21) reveal the following results. First, transportation costs have no impact on the nominal rewards; this artefact of the model is essentially driven by the Cobb-Douglas preferences and variable costs. Second, when communication costs de-segment labour markets, labour demand in the core country—the North—shifts in and w_1 falls as a result: $\partial w_1/\partial\varepsilon>0$. The opposite happens in the periphery—the South—namely, $\partial w_2/\partial\varepsilon<0$. When manufacturing employment in the north decreases, more people work in the traditional sector and the nominal returns to that sector's specific factor increases, thus $\partial r_1/\partial\varepsilon<0$ (conversely, $\partial r_2/\partial\varepsilon>0$).Third, π is *increasing* in communication costs. This counterintuitive result is due to a general equilibrium effect. Individually, all firms gain from lower communication costs if other firms keep their behaviour unchanged. Finally, the scope for outsourcing increases as communication costs fall, i.e. $\partial m/\partial\varepsilon\leq 0$.

To evaluate the effect of ε and ϕ on real incomes, we need to get an expression for Δ_1 and Δ_2 (see (1)) From (8) and (11), we have

(22) $$\forall\varepsilon\leq\varepsilon_0: \quad \Delta_1(\varepsilon)=(w_0\sqrt{\varepsilon})^{1-\sigma}, \quad \Delta_2(\varepsilon)=\phi(w_0\sqrt{\varepsilon})^{1-\sigma}$$

and $\Delta_j=\Delta_j(\varepsilon_0)$ if $\varepsilon>\varepsilon_0$, j=1,2.

Using (20) and (22), it is verified by inspection that residents in the South benefit from greater trade freeness trivially, because an increase in ϕ increases Δ_2 and has no effect on their nominal incomes. Conversely, residents in the North are unaffected by transportation costs—they do pay any trade costs on imports and equilibrium nominal incomes are invariant in ϕ. However, they are affected by communication costs in two ways.

Consider what happens to workers' incomes in the North. On the one hand, their nominal income is increasing in ε as per (20). However, they benefit from lower manufacturing prices when communication costs fall because the cost saving of off-shoring is passed onto consumers. Of course, the former effect affects the whole of their income, the latter one affects only a fraction μ of their expenditure and hence the overall effect is negative. By contrast, Southern workers' gain from improvement in communications is twofold: they benefit from both higher nominal wages *and* lower consumer good prices. To see these formally, denote workers' real wage as ω_j (which is equal to V_j evaluated at w_j); we thus get:

(23) $$\frac{\partial \ln \omega_1}{\partial \ln \phi} = 0, \quad \frac{\partial \ln \omega_1}{\partial \ln \varepsilon} = \frac{1-\mu}{2} > 0; \qquad \frac{\partial \ln \omega_2}{\partial \ln \phi} = \frac{\mu}{\sigma - 1} > 0, \quad \frac{\partial \ln \omega_2}{\partial \ln \varepsilon} = -\frac{1+\mu}{2} < 0$$

Interestingly, the real incomes of capital owners in both countries increases as communication costs fall. Specifically, the elasticity of their real income, $\pi/\Delta_j^{\mu/(\sigma-1)}$, with respect to ε is equal to $\varepsilon/(1+\varepsilon)-(1+\mu)/2$, which is always negative.[19]

To summarise the results from the former two subsections, we can write:

> Result 4. Given any spatial equilibrium: (a) an improvement in communication technology (a reduction in ε) has no effect at the symmetric equilibrium; (b) an increase in trade freeness ϕ makes nobody worse off and at least half of the population better off; (c) at the agglomeration equilibrium, an improvement in communication technology hurts workers in the core whereas workers in the periphery are better-off; the opposite is true for land owners; capital owners everywhere benefit from a lower ε.

Equilibrium switch

To fix ideas, let me focus attention on workers' real incomes, in each region, and imagine the following thought experiment: assume that the economy is at a point like point A in Figure 5, that is, given ε, ϕ is just equal to the upper bound of Φ^S: if trade freeness increases beyond this point, there is catastrophic relocation of half of the manufacturing sector to the south (point S'). In this case, using (20) and (22) it is clear that workers in the north face a contraction of their nominal wage and workers in the south benefit from an expansion of theirs. However, the effect of such a catastrophic relocation on the CPIs is ambiguous. To see this formally, let me write the difference (in logs) between real wages evaluated at the core-periphery equilibrium and at the symmetric one, for given ϕ and ε, namely:

(24)

$$\begin{aligned}\ln\omega_1-\ln\omega_0&=\frac{1-\mu}{2}\ln\varepsilon+\frac{\mu}{(\sigma-1)(1-\alpha)}\ln(\frac{2}{1+\phi})>0\\ \ln\omega_2-\ln\omega_0&=-\frac{1+\mu}{2}\ln\varepsilon+\frac{\mu}{(\sigma-1)(1-\alpha)}\ln(\frac{2}{1+\phi})+\frac{\mu}{\sigma-1}\ln\phi\end{aligned}$$

This expression is crucial: it shows the net gain (possibly negative) that a switch from the dispersed equilibrium to the core-periphery outcome entails for workers in the north and the south, respectively. Several aspects of (24) deserve emphasis. First, workers in the North are necessarily better-off under the core-periphery outcome than under the dispersed equilibrium; in other words, the gain in their nominal wage is larger than the loss that could result from a larger CPI (the CPI can be larger in the core than at the dispersed equilibrium because labour costs are higher; this is captured by the term $-\frac{\mu}{2}\ln\varepsilon$ in the right hand side of the first expression in (24)). Second, workers in the South are not necessarily worse off in the periphery than at the dispersed equilibrium. For sure, they are hurt by lower nominal wages (which is captured by the term –ln(ε)/2 in the right hand side of the second expression in (24)) and by being located remotely (which entails facing a larger CPI and is captured by the last term in the expression above). However, agglomeration economies may entail lower production prices (because of the input-output linkages) and, to the extent that transportation costs are not too large, consumer prices can as a result be lower in the periphery also; this is captured by the second term in the second expression in (24).[20]

Third, and most importantly, an increase in ε does not necessarily benefit workers in the south at the expense of workers in the north, as Result 4 would have us to think (recall that this result holds *keeping the spatial equilibrium constant*). Starting from point A in Figure 5, a marginal increase in ϕ would result in a catastrophic reallocation of half of the firms from the north to the south (point S), which would hurt northerners and have an ambiguous effect on southerners, as per (24). If communication costs decrease alongside transportation costs, then the world economy remains at the agglomerated equilibrium and this clearly benefits workers in the north. In other words, improvement in communication technologies and the resulting off-shoring of production help maintain core activities in the north and, as a result, benefit workers in the north *despite the fact that they face more competition from workers in the south*.

Figure 6. Trade liberalisation and welfare

Turn to Figure 6 for an illustration of this point. Trade freeness appears on the horizontal axis and workers' welfare is measured along the vertical axis. Consider what happens when trade and transportation costs fall over time, that is, what happens on ω_1 and ω_2 as one moves from left to right. Two scenarios are considered: under the first one, which is drawn with plain lines, communication costs are prohibitive; define the relevant upper bound for the sustain interval as $\phi_0^S \equiv \phi^S(\varepsilon_0)$. Thus, when ϕ increases, all workers are better off (at least in a weak sense) as long as the spatial equilibrium does not change, as per (19) and (23); when the economy switches from the symmetric to the agglomerated equilibrium (e.g. moving from point S to point A in either Figure 4, Figure 5, or Figure 6), there is a discrete jump in real wages; workers in 1 gain at the expense of workers in 2. The opposite happens when the economy shifts back to a symmetric configuration (point S') .

As an alternative scenario, consider now what happens when communication costs fall below ε_0; graphically, the effects of such an improvement in the economic environment is shown with the block arrows on Figure 6. Now, the relevant lines are the dashed ones. The first effect of a reduction in ε is to increase the sustain point to ϕ_1^S, that is, the agglomerated equilibrium is sustainable over a wider parameter range: ϕ^S shifts out (Result 3). Next, as an illustration of Result 4, ω_1 falls and ω_2 shifts up in the range $[\phi_B, \phi^S]$.

The key insight from the model is what happens to ω_1 and ω_2 when ϕ is between ϕ_0^S and ϕ_1^S and communication costs are not prohibitive ($\varepsilon<\varepsilon_0$). In this case, as is clear on the graph, the lessons from the previous scenario are turned on their head: workers in the North benefit, workers in the South loose, unless trade costs are large enough. That is to say, looking at the patterns of incomes at a given spatial pattern potentially provides a very misleading picture. Claiming that the off-shoring hurts manufacturing workers in the north is meaningless *unless the counterfactual is properly specified and is part of a stable spatial equilibrium.*

7. Conclusion

This paper takes a new look at the issue of overseas sourcing of services. In a non-neoclassical framework in which comparative advantage is endogenous to agglomeration economies and factor mobility, the fragmentation of production made possible by the new communication technologies and low transportation costs allow global firms (multinational corporations or individual firms active in global networks) to simultaneously reap the benefit of agglomeration economies prevailing in OECD countries and of low wages prevailing in countries with an ever better educated labour force like India. Thus, the reduction of employment in some routine tasks in rich countries in a general equilibrium helps sustain and reinforces employment in the core competencies in such countries. A policy implication of this theory, from the perspective of developed countries, is the following. By making it more difficult for global firms to cut employment in routine tasks and, more generally, of unskilled jobs including manufacturing jobs might have the adverse effect of making it unprofitable for global firms to locate even their core tasks in countries like Spain and France (see for instance the recent outcry regarding the restructuring of Hewlett Packard). A growing body of research seems to be consistent with this theoretical prediction: Amiti and Wei's (2006) results suggest that the increase in service outsourcing in the US in the past decade is partly responsible for the growth of productivity; even more in line with the theory, Barba-Navaratti et al. (2006) suggest that firms that decide to offshore some of its value chain abroad become more productive; since they control for the self-selection effect, this result can be interpreted as indicating causality. Thus, policies to prevent off-shoring (and employment loss) might backfire because the essential choice facing some industries is off-shore or cease to exist, in a perfect parallel to the policies meant to prevent decentralization (that is, the loss of manufacturing employment in cities), also a failure (Cheshire 1995).

It is my contention that further work, especially empirical work now that micro-level data base become ever more available, will cast more light on this issue and, if these results diffuse outside the ivory tower, they might bring more sense to the related public debate.

References

Amiti, M. and S.J. Wei (2005). Service offshoring, productivity and employment: Evidence from the US. CEPR discussion paper 5475.

Amiti and Wei (2005). 'Fear of outsourcing: Is it justified?' Economic Policy (April), 308-48.

Antrás, P. (2005). 'Incomplete Contracts and the Product Cycle.' American Economic Review (forthcoming).

Baldwin, R. (2001). 'The Core-Periphery model with forward looking expectations.' Regional Science and Urban Economics 31, 21-49.

Baldwin, R., R. Forslid, P. Martin, G. Ottaviano, and F. Robert-Nicoud (2003). Public Policy and Spatial Economics (Princeton University Press, Princeton NJ).

Baldwin, R. and P. Martin (1999). 'Two waves of globalisation: Superficial similarities, fundamental differences.' In H. Siebert (ed.) Globalisation and Labour (Tubingen: J.C.B. Mohr for Kiel Institute of World Economics).

Barba-Navaretti, G. and D. Castellani (2004). 'Investment abroad and performance at home: Evidence from Italian multinationals.' CEPR discussion paper 4284.

Barba-Navaretti, G., D. Castellani and A.C. Disdier (2006). 'How Does Investing in Cheap Labour Countries Affect Performance at Home? France and Italy.' Centro Studi Luca d'Agliano, mimeo.

Barba-Navaretti, G. and A. Venables et al. (2004). Multinational Firms in the World Economy (Princeton University Press, Princeton NJ).

Behrens, K. (2004). 'Agglomeration without trade: How non-traded goods shape the space-economy.' Journal of Urban Economics 55, 68–92.

Ben-David, D. and A. Kimhi (2004). 'Trade and the Rate of Income Convergence.' Journal of International Trade and Economic Development 13(4), 419-41.

Cairncross, F. (1997). The Death of Distance (Harvard Business School Press, Cambridge MA).

Cheshire, P. (1995). 'A new phase of urban development in Western Europe? The evidence for the 1980s.' Urban Studies 32(7), 1045-63.

Chun Zhu, S. and D. Trefler (2005). 'Trade and Inequality in Developing Countries: A General Equilibrium Analysis.' Journal of International Economics, 21-48.

Coe, D. and E. Helpman (1995). 'International R&D spillovers.' European Economic Review 39(5), 859-87.

Deardoff, A. (2001). 'Fragmentation in simple trade models.' North American Journal of Economics and Finance 12, 121-37.

Disdier, A. and K. Head (2004). 'The Puzzling Persistence of the Distance Effect on Bilateral Trade.' Mimeograph, UBC.

Dixit, A. and J. Stiglitz (1977). 'Monopolistic competition and the optimum product diversity.' American Economic Review 67, 297-308.

Duranton, G. and D. Puga (2005). 'From sectoral to functional urban specialisation.' Journal of Urban Economics, 57(2), 343-370.

Duranton, G. and D. Puga (2004). 'Microfoundations of urban agglomeration economies.' In J.V. Henderson and J.F. Thisse (eds), Handbook of Regional and Urban Economics (vol. 4) (North Holland).

Duranton, G. and M. Storper (2005). ' Rising Trade Costs? Agglomeration and Trade with Endogenous Transaction Costs.' CEPR discussion paper 4933.

Ethier, W. (1982) 'National and International Returns to Scale in the Modern Theory of International Trade.' American Economic Review 73, 389-405.

Feenstra, R. and G. Hanson (1996). 'Globalization, outsourcing, and wage inequality.' American Economic Review P&P, 86(2), 240-5.

Flam, H. and E. Helpman (1987). 'Industrial policy under monopolistic competition.' Journal of International Economics 22, 79-102.

Fujita M., P. Krugman and A. Venables (1999). The Spatial Economy (MIT Press, Cambridge MA).

Fujita, M. and J. Thisse (2002). Economics of Agglomeration. (Cambridge University Press, Cambridge).

Fujita, M. and J. Thisse (2003). 'Globalization and the evolution of the supply chain: Who gains and who looses?' CEPR discussion paper 4152.

Gaspar, J. and E. Glaeser, E. (1998). 'Information technologies and the future of cities.' Journal of Urban Economics 43(1), 136-46.

Harrigan, J. and A. Venables (2006). 'Timeliness and agglomeration.' Journal of Urban Economics 59(2), 300-16.

Harris, R. (1995). 'Trade and communication costs.' Canadian Journal of Economics 28: 46-75.

Helpman (1998). 'The size of regions.' In D. Pines, E. Sadka and I. Zilcha (eds.) Topics in Public Economics (Cambridge University Press, Cambridge).

Hesley, R. and W. Strange (2004). 'Agglomeration, opportunism and the organisation of production.' Mimeo, UBC and U. Toronto.

Jones, R. and H. Kierzkowski (1990). 'The role of services in production and international trade: A theoretical framework.' In R. Jones and A. Krueger (eds.) The Political Economy of International Trade (Basil Blackwell, Oxford).

Jones, R. and H. Kierzkowski (2001). 'A framework for fragmentation.' In W. Arndt and H. Kierzkowski (eds) Fragmentation (Oxford University Press, Oxford).

Keller W. (2002). "Trade and the transmission of technology," Journal of Economic Growth 7, 5-24.

Krugman, P. (1996). Pop Internationalism.

Krugman, P. (1991). 'Increasing returns and economic geography.' Journal of Political Economy 99, 483-99.

Krugman, P. and A. Venables (1995). 'Globalization and the inequality of nations.' Quarterly Journal of Economics 110 (4): 857-80.

McLaren, J. (2000). 'Globalization and vertical structure.' American Economic Review 90(5), 1239-54.

Milanovic, B. (2003). 'The two faces of globalisation: Against globalisation as we know it.' World Development 31(4): 667-683.

Mokyr, J. (2002). The Gifts of Athena. Historical Origins of the Knowledge Economy (Princeton NJ: Princeton University Press).

Mossay, P. (2006). 'The core-periphery model: A note on the existence and uniqueness of short-run equilibrium.' Journal of Urban Economics, in press.

Murata, Y. and J.F. Thisse (2005). 'A Simple Model of Economic Geography à la Helpman-Tabuchi.' Journal of Urban Economics 58(1), 137-55.

Neary, P. (2001). 'On hypes and hyperbolas: Introducing the new economic geography.' Journal of Economic Literature 39:536-61.

Ottaviano, G. and F. Robert-Nicoud (2006). ' The 'genome' of NEG models with vertical linkages: A positive and normative synthesis'. Journal of Economic Geography 6(2).

Ottaviano, G.I.P., T. Tabuchi and J.-F. Thisse (2002) Agglomeration and Trade Revisited, International Economic Review 43, 409-36.

Pflüger, M. (2004). ‘A simple, analytically solvable, Chamberlian agglomeration model.’ Regional Science and Urban Economic 34(5), 565-73.

Puga, D. and A. Venables (1996). ‘The spread of industry: Spatial agglomeration in economic development.’ Journal of the Japanese and International Economies 10(4), 440-64.

Robert-Nicoud, F. (2002). New economic geography: Multiple equilibria, welfare, and political economy. PhD dissertation, London School of Economics.

Robert-Nicoud, F. (2005). ' The structure of simple New economic geography models (Or, on identical twins).' Journal of Economic Geography, 5(2), 201-234.

Samuelson, P. (1952). 'The transfer problem and transport costs: The terms of trade when impediments are absent.' Economic Journal 62, 278-304

Samuelson, P. (2004). ‘Where Ricardo and Mill Rebut and Confirm Arguments of Mainstream Economists Supporting Globalization.’ Journal of Economic Perspectives, 18 (3), 135-46.

Scheve, K. and M. Slaughter (2001). Globalization and the Perception of American Workers (Washington, SC: Institute for International Economics).

Slaughter, M. (2000). 'Multinational Corporations, Outsourcing, and American Wage Divergence.' Journal of International Economics, 449-472.

Stolper, W. and P. Samuelson (1941). 'Protection and real wages.' Review of Economic Studies 21, 1-20.

Tabuchi, T. (1998). 'Urban agglomeration and dispersion: A synthesis of Alonso and Krugman.' Journal of Urban Economics, 44, 333-51.

Toulemonde, E. (2006). ‘Acquisition of skills, labour subsidies and agglomeration of firms.’ Journal of Urban Economics, in Press.

Venables, Anthony J. (1996). 'Equilibrium location of vertically linked industries.' International Economic Review 37, 341-59.

Wilson, M. (1995). 'The office farther back: Business services, productivity, and the offshore back office.' In P. Harker (ed.) The Service Productivity and Quality Challenge (Kluwer, Boston).

Wood, A. (1998). 'Globalisation and the rise in labour market inequalities.' Economic Journal 108, 1463-82.

FIGURES

Figure 1. Transportation versus Communication Costs, 1940-1990

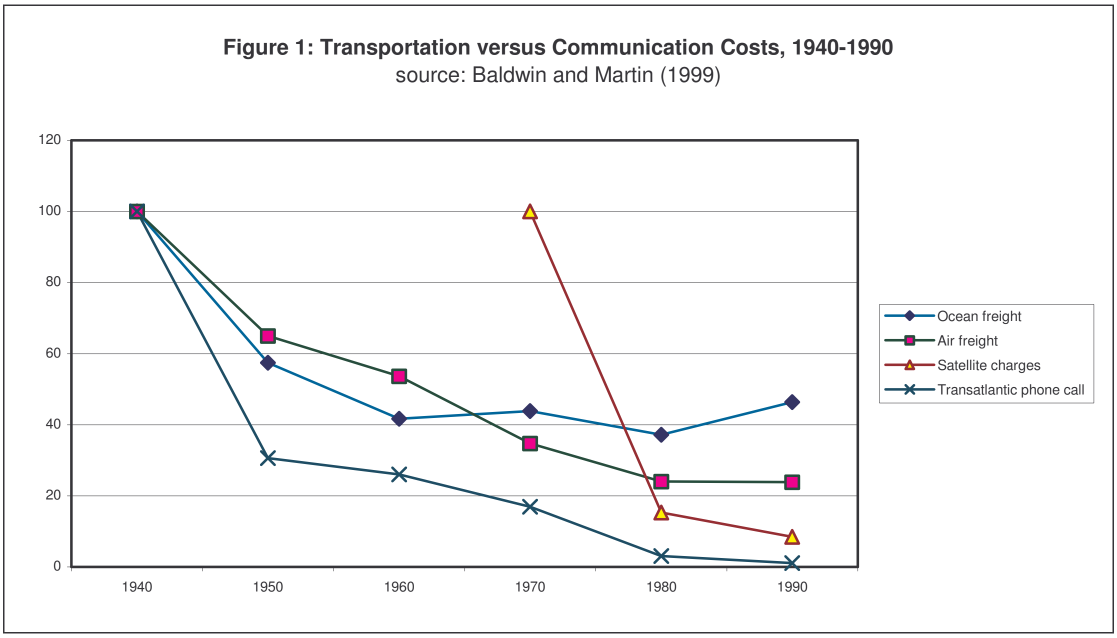


Figure 2: Dispersion and agglomeration forces at the core-periphery equilibrium

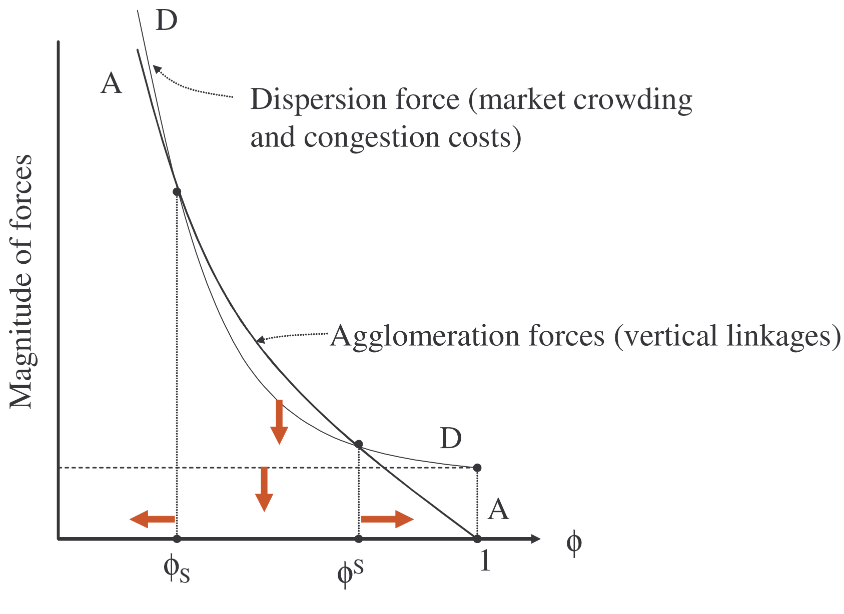


Figure 3. Hiring workers abroad.

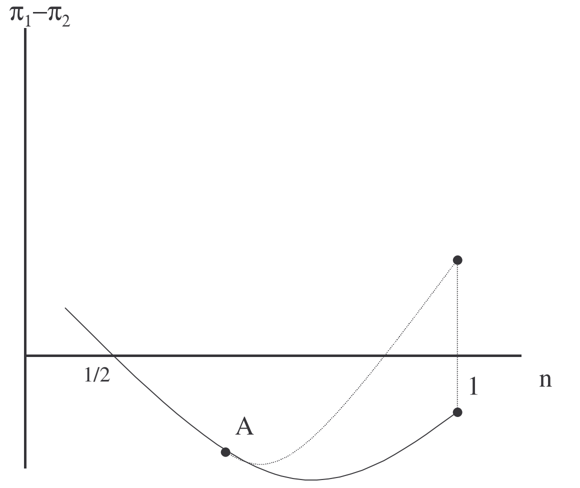


Figure 4. The 'Loudspeaker' diagram

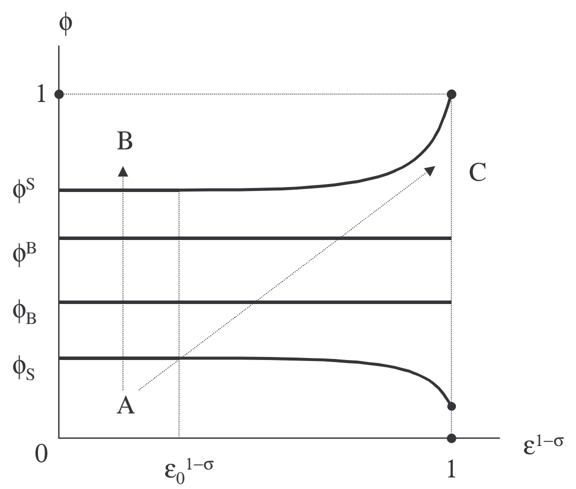


Figure 5: The 'Double Tomahawk' diagram

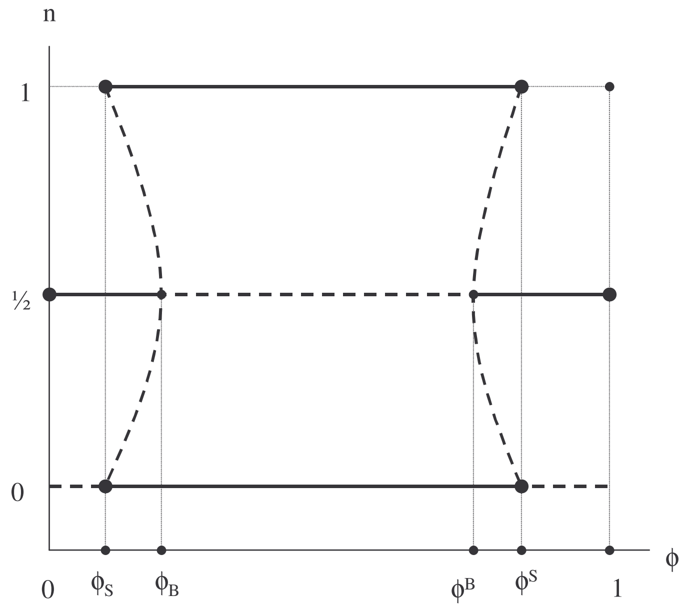


Figure 6. Trade liberalisation and welfare

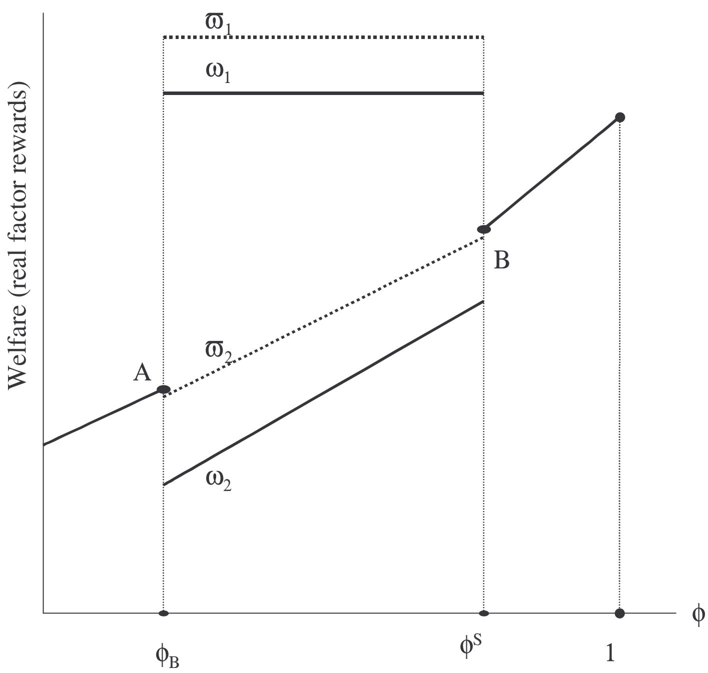
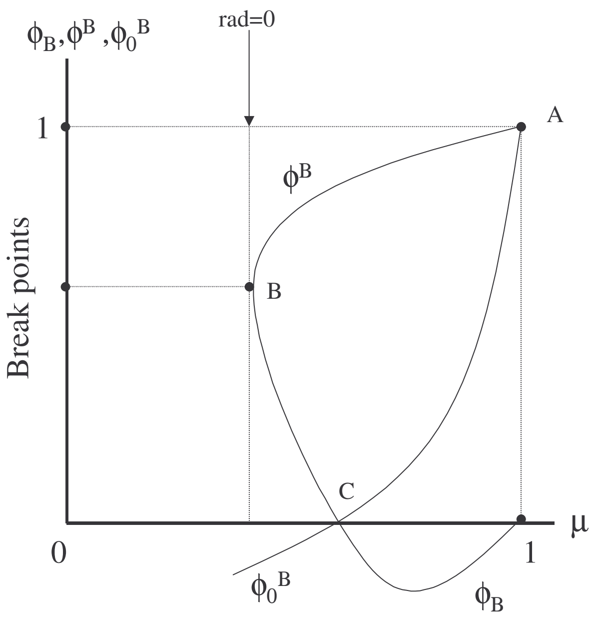


Figure 7. Break points



Parameter values: $\alpha=\mu$, $\sigma=5.31$, $\theta=.3$

APPENDIX–GUIDE TO CALCULATIONS

A.1. Break point and asymmetric equilibria

In this appendix I characterize some aspects of long run equilibria such that n≥½. Start with the symmetric equilibrium n=½. This is always part of a long run equilibrium given the symmetry of the model. Observe that nominal wages are equal at the symmetric equilibrium, independently of the magnitude of the trade and communication costs: hence n=½ implies m=0, all ϕ and ε. By continuity, it must be that there are no external workers in the neighbourhood of the symmetric equilibrium. Therefore the break point –derived and motivated below– is unaffected by ε as long as ε is strictly larger than unity. Note however that the no-arbitrage condition might be binding at interior, asymmetric equilibria. Such equilibria are always unstable in this model.[21]

Now take n to be 'significantly' larger than ½ so that the no arbitrage condition in (11) is binding. It should be obvious that the existence of communication costs implies that most workers who are employed by firms located in 1 are themselves in 1, namely the proportion of 'multinationals' in 1 is smaller than ½ at any long run equilibrium, viz. m∈ [0,½). To see this, take the difference of (9) and (10) and manipulate the terms to get:

(25)
$$\begin{aligned}
0 &< \frac{\Lambda}{2}\frac{\theta}{(1-\theta)} w_2^{-\theta/1-\theta}\left(1-\varepsilon^{-\theta/1-\theta}\right)+\frac{L}{2}w_2(\varepsilon-1) \\
&= (1-\alpha)(\sigma-1)[(1-2m)n\pi_1-(1-n)\pi_2] \\
&= (1-\alpha)(\sigma-1)[2n(1-m)-1]\pi_1+(1-\alpha)(\sigma-1)(1-n)(\pi_1-\pi_2) \\
&= (1-\alpha)(\sigma-1)2n[(1-\frac{1}{2n})-m]\pi
\end{aligned}$$

where the inequality stems from the parameter restrictions –in particular $\varepsilon>1$. The first equality follows directly from (9) and (10). The second equality is just a rearrangement of the previous line. The final equality stems from (13) and the definition of π; also, in any long run equilibrium n>0 implies $\pi_1=\pi$; in turn this implies m<1-1/(2n). Since n>½ by assumption, it follows that m<½, as was to be shown.

To get further intuition for this result, assume that all entrepreneurs are in 1 and that half of them hire workers in 1 and the other half hire workers in 2, viz. m=½. As they are all located in the same region, each firm equilibrium size is identical, and hence all entrepreneurs hire the same number (mass) of workers. At equilibrium, they must all pay the same gross wage ($w_1=\varepsilon w_2$). Therefore nominal wages in 2 are lower than in 1. On the other hand, the labour force employed in sector A in each region is the same by the assumption n=1 and m=½. Because there are decreasing returns in labour in this sector, nominal wages must be the same in both regions ($w_1=w_2$), a contradiction if $\varepsilon>1$. In short, we have:

> Result 5. In the symmetric equilibrium (n=½) costs in both regions are identical, so m=0. In any long-run equilibrium such than n>½ the proportion of workers joining the manufacturing sector is larger in 1, viz. n(1-m)>mn+1-n. This in turn implies that less than half of the firms in 1 hire workers from 2, viz. m<½.

The analysis here complements section 5. The 'dispersed equilibrium' is said to be unstable if $d\pi_1/dn>0$ at n=½. (By the symmetry of the model, $d\pi_2/dn=-d\pi_1/dn$ at h=½.) In words, the dispersed equilibrium is unstable if moving one unit of K from 1 to 2 increases the capital reward in 1 relatively to 2 (remember that capital reward equals operating profit by free-entry). In such a case, agglomeration forces dominate and, by the law of motion, n increases further. That is, the initial shock is not self-correcting. Accordingly, any long run interior equilibrium n' such that $\pi_1=\pi_2$ is said to be unstable if $d(\pi_1-\pi_2)/dn>0$ at n=n'.

We then differentiate the system around the symmetric equilibrium, following Puga (1999); we also use the symmetry properties of the model and write $dw_0=dw_1=-dw_2$, $d\pi_0=d\pi1=-d\pi2$, etc. This way we get a system in $d\ln\Delta_0$, dw_0, and $d\pi_0$, dE_0:

(26)
$$\begin{bmatrix} 1-\alpha\beta Z & 2\beta[\alpha(\sigma-1)-\mu Z] & Z-\alpha \\ 0 & (\sigma-1)(1-\alpha)Z & 1-\alpha Z \\ -\beta & \beta+(1-\alpha\beta-\mu)\theta/(\mu(1-\theta)) & 0 \end{bmatrix} \begin{bmatrix} d\pi_0 \\ dw_0 \\ d\Delta_0/\Delta_0 \end{bmatrix} = 2\begin{bmatrix} \alpha\beta Z \\ Z \\ \beta \end{bmatrix} dn$$

where $Z\equiv(1-\phi)/(1+\phi)$ and $\beta\equiv 1-1/\sigma$ as before, and dn is treated as exogenous. By Cramer's rule, it is easy to get a solution for $d\pi_0/dn$; the break points ϕ_B and $\phi^B<1$ are the zeroes of the resulting second order polynomial in ϕ. In the limiting case $\theta=1$, ϕ_B is similar to the break points in Ottaviano and Robert-Nicoud (2006) or in chapter 14 (section 14.2) of Fujita et al. (1999).

With the addition of decreasing returns in A, both ϕ_B and ϕ^B are smaller than unity –when they are real. The reason is, again, that these decreasing returns act as a dispersion force that does not depend on ϕ, so it must be that $d\pi_0/dn<0$ at n=½ (namely, the symmetric equilibrium is stable) when

ϕ is arbitrarily close to 1. The general solution to (26) is not particularly enlightening, even in the special cases $\alpha=\mu$ or $\theta=\frac{1}{2}$.

However, there are a couple of useful facts that some standard (if tedious) algebra reveals. At the limit $\alpha=1$ (agglomeration forces as measured by strength of vertical linkages are maximal) we have $\phi_B=0$ and $\phi^B=1$, for all $\{\sigma,\mu,\theta\}\in[0,1]^3$; this implies that the symmetric equilibrium is never stable. By contrast, $\alpha=0$ implies that the symmetric equilibrium is always stable (the model essentially collapses to the trade model due to Flam and Helpman, 1987).

Note an important caveat here: a necessary condition for ϕ_B and ϕ^B to be sufficient statistics for our problem is that the denominator of $d\pi_0/dn$ is different from zero. It turns out, however, that the polynomial that constitutes the denominator generically admits two zeroes. One is always negative and, as such, does not make any economic sense, hence we disregard it entirely. The largest one is sometimes positive (but not always) and smaller than 1, so it matters. Define it as ϕ_0^B. With some effort, we can check that $\alpha=1$ implies $\phi_0^B=0$. However, it can be shown that the following is true:

$$\textbf{(27)} \qquad \phi_0^B=0 \Leftrightarrow \min\{\max\{0,\phi_B\},\phi^B\}=0$$

in the simplifying case $\mu=\alpha$ Fujita et al. (1999) and others assume. In words, this expression means that $\phi_0^B=0$ if and only if the smallest between ϕ_B and ϕ^B is nil, provided it belongs to the meaningful range [0,1], are the same. This fact is useful for the graphical analysis we are now conducting.

Figure 7 plots ϕ_0^B, ϕ_B and ϕ^B as a function of α, for some $\mu=\alpha$, $\sigma=5.31$, and $\theta=.3$. The first locus, ϕ_0^B, is the curve that links (0,-1) and point A. The second and third loci, ϕ_B and ϕ^B, link point B to point C and A, respectively. At point B the radical of the solution to ϕ_B and ϕ^B is negative, which implies $\phi_B=\phi^B$. Also, ϕ_0^B and ϕ_B cross on the horizontal axis for some α in (0,1). All these properties follow from the observations made in the previous paragraph.

The configuration plot in this figure is typical: for low values of α (when agglomeration forces are weak), no real root exists (the radical is negative) and the symmetric equilibrium is always stable. On the other hand, when μ is sufficiently large (i.e. the radical is positive), the symmetric equilibrium is unstable for all combinations of μ and ϕ in the convex set ABC.

Figure 7. Break points

When agglomeration forces as measured by σ are so weak that $\phi_B<0\ \forall\alpha$, ϕ_B rotates anti-clockwise; it is increasing in μ on the relevant range, but negative for low values of α.

It can be shown that when σ is low enough (agglomeration forces strong enough) the convex set of the combinations (α,ϕ) such that $\phi\in[\phi_B,\phi^B]$ expands; in particular, the value of α such that the radical is nil is lower. Further simulations show that the analysis for general values of θ is qualitatively identical (in particular, this set expands when θ increases because this corresponds to lower dispersion forces). Therefore, I am confident the analysis conveyed is exhaustive.[22]

Clearly, if the new dispersion force is not too strong, the curves AA and DD in Figure 2 cross twice. For low values of ϕ, the market crowding force is strong enough for the AA curve to lie below the DD curve; the core-periphery outcome is not sustainable. For values of ϕ larger than ϕ_S, the vertical linkages are stronger than the market crowding force. But when ϕ is high enough (larger than ϕ^S on the figure), the strength of the vertical linkages is weaker than the strength of both dispersion forces taken together. Hence, a core-periphery structure is sustainable only for intermediate values of ϕ. Summing-up:

> Result 6. Decreasing returns in agriculture introduce a dispersion force that is independent of ϕ. As a result $n=½$ is the unique stable long run equilibrium of the model when ϕ is sufficiently close to unity.

To put it simply, in any configuration in which $n\neq½$ the presence of decreasing returns in labour in A implies $w_1\neq w_2$. When ϕ is arbitrarily close to 1, this implies that production costs cannot be different in 1 and 2. This in turn implies that $n\neq½$ cannot be part of a stable long-run equilibrium.

This brings us to the conditions under which $n=½$ is part of a stable long run equilibrium.

A.2. **Ranking the break and sustain points**

As is well known, the ordering of the break and sustain points was crucial for the dynamics of the model; see Baldwin (2001), Fujita et al. (1999), Fujita and Thisse (2002) and Neary (2001). In the simple case $\theta=1$ there are a unique break point and a unique sustain point in the interval [0,1]. Robert-Nicoud (2005) shows formally that the sustain point comes before the break point; this has two implications. First, no interior, asymmetric equilibrium is ever stable. Second, there is hyseresis in location. The same holds true here: at least when $\alpha=\mu$ (the case Krugman and Venables (1995), among others, assume) simulations show that the sustain interval $[\phi_S,\phi^S]$ encompasses the break interval $[\phi_B,\phi^B]$, hence $\phi_S<\phi_B<\phi^B<\phi^S$, as shown in Figure 4 and Figure 5.[23]

Figure 5 plots n against ϕ. As usual, the stable, long-run equilibria of the system are depicted in plain lines whereas the unstable ones are depicted in doted schedules. There is room for hysteresis in this model in the sense that if the system finds itself at n=1 when ϕ is, say, larger than ϕ_B, then this remains a stable long run equilibrium if ϕ decreases to some value in (ϕ_S,ϕ_B). Conversely, if the system finds itself at n=½ and ϕ is lower than ϕ_S, then this remains a stable long run equilibrium if ϕ increases to the same value in (ϕ_S,ϕ_B). Hence history matters.

NOTES

---

[1] Academic economists are less sanguine; Amiti and Wei (2005), for example, note that service outsourcing from developed countries to developing ones is increasing fast, but still low. In this *Economic Policy* paper, the authors contrast statistical features with newspaper articles and headlines. The gap could hardly be wider: the fact that 'insourcing' into the USA is greater than outsourcing, for instance, goes barely noticed in the press. A notable exception is Samuelson (2004) who argues that outsourcing services to large countries like China and India could harm rich countries by twisting their terms of trade in an unfavourable manner *provided that the former countries reduce the technology gap with the latter.* See also Deardoff (2001).

[2] See e.g. McLaren (2000) and Antràs (2005) in a trade setting and Hesley and Strange (2004) in an urban framework.

[3] This has led some authors to be carried away by the supposed 'death of distance' (Cairncross 1997); however, a reduction in physical barriers to the movement of goods and people does not necessarily imply that location becomes irrelevant; see Disdier and Head (2004), Duranton and Storper (2005), Gaspar and Glaeser (1998), Harrigan and Venables (2006) and Krugman (1991).

[4] For instance, Coe and Helpman (1995) provide empirical evidence that knowledge spillovers are related to trade flows; see Keller (2002) for a critique.

[5] See Duranton and Puga (2005) for a formalisation of this idea in a urban setting

[6] Indeed, Duranton and Puga (2004) argue that various assumptions regarding the foundations of agglomeration economies may have similar positive properties (observational equivalence). However, they generate inefficiencies of different nature and thus how these inefficiencies can be improved upon depends on their nature. They conclude that "while different assumptions regarding individual behaviour and technology may support similar aggregate outcomes, the normative implications of alternative microfoundations can differ substantially". The approach followed in this paper shares this philosophy.

[7] It is also briefly described in Baldwin et al. (2003) and in the appendix of Robert-Nicoud (2005).

[8] Actually, the first draft of this paper considered skilled labour mobility; it is available from the author upon request.

[9] The generalisation to $s \neq ½$ is cumbersome and not worth the few additional insights (Robert-Nicoud, 2002). In a related model, see also Baldwin et al. (2003).

[10] In the limiting case $\theta=1$, it can be shown that the model is isomorphic to Krugman's (1991) seminal core-periphery model (see Robert-Nicoud 2005) and Krugman and Venables's (1995) model with input-output linkages (see Ottaviano and Robert-Nicoud 2006). In the opposite extreme $\theta=0$, the properties of the model are similar to Helpman's (1998) model.

[11] More generally, we should have $\varepsilon w_2 \leq w_1$ and $\varepsilon w_2 \geq w_1$; but these are mutually exclusive because $\varepsilon>1$.

[12] See Robert.Nicoud (2002) for details and for the analysis of other equilibria. This thesis version is available from the author upon request.

[13] Indeed, in the appendix I derive the 'break point' for any θ in the unit interval. Also, Fujita and Thisse (2003) allow θ to vary and convey comparative statics on θ using numerical simulations; quite intuitively, the closer θ is to unity, the lower is the congestion cost and the more sustainable is agglomeration.

[14] This core-periphery equilibrium might not be unique, however; see e.g. Fujita et al. (1999), Mossay (2006) and Robert-Nicoud (2005) for details. When there is no congestion cost, as in Krugman (1991) among others, $\phi^S=1$ and thus n=1 for all ϕ's arbitrarily close to unity. Helpman (1998) and Murata and Thisse (2005) introduce congestion costs in NEG models. As a result, the opposite happens: ϕ_S tends toward a negative value (which does not have any economic meaning) and thus n=1 is part of a long run equilibrium for all ϕ's arbitrarily small. See also Tabuchi (1998).

[15] Of course, the computer runs a finite number of simulations, so one can never take such evidence as a proof. These numerical simulations accompanied my thesis chapter and are available upon request.

[16] A more elegant way to get rid of this general equilibrium effect would be to assume away income effects by specifying preferences with a quasi-linear utility function as in Pflüger (2004) and Ottaviano and al. (2002). I have chosen not to pursue along those lines because in practice the two models generate the same predictions; that is, these predictions seem to be robust to this general equilibrium effect, which I see as a desirable property of the model. The potential advantage of choosing the other way is that it would be straightforward to provide an analytical proof to Result 2: indeed, mathematically assuming quasi-linear preferences would have the same affect as having $\mu=0$ in (17), thus s_R would be constant; as a result, it is readily verified that $\partial f/\partial \varepsilon<0$ holds for all parameter values, that is, Φ^S expands in both directions when communication technologies improve.

[17] The interval $[\phi_B,\phi^B]$ depicts the 'break interval' whereby the symmetric equilibrium, n=½, is unstable; To keep the paper within acceptable length, I relegate the analysis of the break point to an appendix..

[18] No asymmetric interior equilibrium is ever stable in the current framework. Other functional forms produce stable interior equilibria, as in Fujita et al. (1999, chapter 14).

[19] To see this is easily shown by contradiction. A necessary (and sufficient) condition for this elasticity to be positive is that $\varepsilon>(1+\mu)/(1-\mu)$. Since $\varepsilon\leq\varepsilon_0$, this implies $\varepsilon_0>(1+\mu)/(1-\mu)$, which is equivalent to $\psi>\mu$ by (14). However, $\mu>\psi$, as is immediate from the definition of ψ. Thus the necessary condition is violated and the elasticity is negative.

[20] Specifically, residents in the periphery face lower price index than in the symmetric equilibrium (for a given ε) if $2\phi^{1-\alpha}>1+\phi$ (this in turn requires $\alpha>½$ and ϕ to be large enough); if this is the case, the trade-off they are facing is qualitatively the same as in the north.

[21] This need not be the case if the two countries were not ex-ante identical.

[22] The Maple worksheet BreakAnalysis.mws is available on request.

[23] Details of the calculations can be found on the Maple worksheet vertical_linkages_0523.mws, available upon request. When $\alpha\neq\mu$, the parameter space has many dimensions, hence making sure that the ranking remains unchanged for all parameter combinations is a formidable task. For this reason, I put it aside and *assume* that the combinations of the parameters α, μ, and σ is such that the ranking holds so that this figure is always relevant.

CENTRE FOR ECONOMIC PERFORMANCE
Recent Discussion Papers

733	Alex Bryson Michael White	Unions, Within-Workplace Job Cuts and Job Security Guarantees
732	Francesco Caselli Wilbur John Coleman II	On the Theory of Ethnic Conflict
731	Alex Bryson Richard Freeman	What Voice Do British Workers Want?
730	Giulia Faggio Stephen Nickell	Patterns of Work Across the OECD
729	Saul Lach Mark Schankerman	The Impact of Royalty Sharing Incentives or Technology Licensing in Universities
728	Philippe Aghion Robin Burgess Stephen Redding Fabrizio Zilibotti	The Unequal Effects of Liberalization: Evidence from Dismantling the License Raj in India
727	Richard E. Baldwin Fredéric Robert-Nicoud	Trade and Growth with Heterogeneous Firms
726	Gustavo Crespi Chiara Criscuolo Jonathan Haskel	Productivity, Exporting and the Learning-by-Exporting Hypothesis: Direct Evidence from UK Firms
725	Giovanni Olivei Silvana Tenreyro	The Timing of Monetary Policy Shocks
724	Ghazala Yasmeen Azmat	The Incidence of an Earned Income Tax Credit: Evaluating the Impact on Wages in the UK
723	Sharon Belenzon	Basic Research and Sequential Innovation
722	Daron Acemoglu Philippe Aghion Claire Lelarge John Van Reenen Fabrizio Zillibotti	Technology, Information and the Decentralization of the Firm

721	Sharon Belenzon	Knowledge Flow and Sequential Innovation: Implications for Technology Diffusion, R&D and Market Value
720	Rafael Gomez Konstantinos Tzioumis	What Do Unions Do to CEO Compensation?
719	Ralph Ossa	A Gold Rush Theory of Economic Development
718	Nick Bloom	The Impact of Uncertainty Shocks: Firm Level Estimation and a 9/11 Simulation
717	Holger Breinlich	Trade Liberalization and Industrial Restructuring through Mergers and Acquisitions
716	Nick Bloom John Van Reenen	Measuring and Explaining Management Practices Across Firms and Countries
715	Mirko Draca Stephen Machin John Van Reenen	Minimum Wages and Firm Profitability
714	Matteo Bugamelli Francisco Paternò	Do Workers' Remittances Reduce the Probability of Current Account Reversals?
713	Alex Bryson	Union Free-Riding in Britain and New Zealand
712	Marco Manacorda Carolina Sanchez-Paramo Norbert Schady	Changes in Returns to Education in Latin America: the Role of Demand and Supply of Skills
711	Claudia Olivetti Barbara Petrongolo	Unequal Pay or Unequal Employment? A Cross-Country Analysis of Gender Gaps
710	Hilary Steedman	Apprenticeship in Europe: 'Fading' or Flourishing?
709	Florence Kondylis	Agicultural Returns and Conflict: Quasi-Experimental Evidence from a Policy Intervention Programme in Rwanda

The Centre for Economic Performance Publications Unit
Tel 020 7955 7673 Fax 020 7955 7595 Email info@cep.lse.ac.uk
Web site http://cep.lse.ac.uk