Offshoring of routine tasks and (de)industrialisation: Threat or opportunity—And for whom?

Robert-Nicoud, Frédéric

OFFSHORING OF ROUTINE TASKS AND (DE)INDUSTRIALISATION: THREAT OR OPPORTUNITY–AND FOR WHOM?[♣,*]

Frédéric Robert-Nicoud
LSE and CEPR[†]

To be published in the ***Journal of Urban Economics***

First draft: December 2000. This version: 8 March 2007

Abstract. Offshoring, or overseas sourcing of routine tasks, generates efficiency gains that benefit consumers and workers with skills similar to those whose very jobs are threatened by offshoring. Essentially, the interaction between offshoring, footloose capital and agglomeration economies locks the comparative advantage of advanced nations in complex or strategic functions while labour services in 'routine' tasks, the coordination of which is easily codified, are provided by low-wage developing nations through the fibre optic cable. In this framework, the partial-equilibrium view that offshoring is necessarily detrimental to workers in advanced nations is misguided because the implicit counterfactual—that keeping the off-shored jobs would have no macroeconomic impact on the economy—is not warranted. In addition, inasmuch as routine tasks create few positive feedbacks, trade in tasks can be an impediment to income convergence, unlike trade in goods. In short, this paper qualifies the views that offshoring hurts workers in the North and accelerates income convergence between the North and the South.

JEL F02, F12, L22, R11. **Keywords**: Offshoring; wage inequality; communication costs.

♣ The title of this paper (and the exposition of much of its content) borrows from Grossman and Rossi-Hansberg's (2006) insightful terminology. Unfortunately, the content of this footnote does not appear in the published version of the paper – my mistake. (This version also includes the material of the Online Appendix.)

* This paper is a much-revised version of chapter 4 of my 2002 PhD thesis and has previously circulated under other avatars and different titles (e.g. CEPR discussion paper no. 5617). I thank Gilles Duranton for prodding me to turn this piece of work into a paper and for his tireless encouragements; I am indebted to Richard Baldwin for simulating discussions on this issue while working on a related project and to Jacques Thisse for making detailed comments and suggestions at several stages of the paper. An anonymous referee, Kristian Behrens, Rod Falvey, Steve Redding, Nicolas Schmitt, Tony Venables and Gerald Willman also provided highly valuable feedback. Finally, suggestions by Guillaume Daudin, Peter Neary, Gianmarco Ottaviano, Yasushiro Sato, and other participants at the 2000 LSE trade mini-conference, the 2005 CEPR workshop on economic geography, the 2005 Kiel summer workshop in trade and location, the 2006 conference on geography and economic history at CORE, and at seminars held at Milan State University and at the University of Cordoba also contributed to improve this paper. All errors and omissions are of course mine.

† LSE, Department of Geography and Environment, Houghton Street, London WC2A 2AE, United Kingdom. http://personal.lse.ac.uk/robertni/. Email: F.L.Robert-Nicoud@lse.ac.uk

1 INTRODUCTION

This paper links two facets of ‘globalisation’—the re-location of the manufacturing sector and the offshoring of routine tasks to emerging countries—to the reduction of spatial frictions along two distinct dimensions, namely, to the flow of goods and to the flow of information. Specifically, this paper studies the positive and normative effects of ‘offshoring’ routine tasks and its interaction with falling trade costs when trade in goods is characterized by imperfect competition and agglomeration economies. In this framework, the efficiency gains that result from such offshoring benefit workers from developed nations, despite the *de facto* competition from workers in low wage countries.[1] As it turns out, offshoring triggers a specialisation by function rather than by sector (routine tasks in East Asia, complex tasks in Japan, say) and generates efficiency gains. This kind of specialisation *relaxes the pressure to move the entire manufacturing production chain to low wage countries*. This has an important policy implication for OECD countries: prohibiting offshoring so as to ‘save domestic jobs’ might backfire because the side effect of such a policy is to forego the aforementioned efficiency gains. As a result, the whole bulk of tasks might be relocated.

Globalisation can be thought of as the ‘unbundling of things’ (Baldwin 2006). To oversimplify, over the time period 1870-1914 and since 1960, trade costs for goods fell rapidly (in 1990, ocean and air freight costs were worth only 46% and 24%, respectively, of what they were in 1940). Indeed, steam ships, steam trains and air cargo dramatically relaxed the need to produce goods close to the final demand; this pattern is linked to the de-industrialisation of developed countries relative to emerging countries like China. More recently, this reduction of trade costs was dwarfed by the reduction in communication costs—that is, the cost of trading information and ideas (in 1990, the cost of transatlantic phone calls and satellite charges were only a fraction of their 1940 levels—8% and 1%, respectively). Falling communication costs fostered the second unbundling: some tasks—usually referred to as ‘routine tasks’—can easily be codified and transmitted via fibre optic cables or satellites and require few face-to-face interactions; this enables the fragmentation of the production process, which includes offshoring when happening across international borders. As a result, we should expect that ever fewer routine tasks are being conducted in high-wage countries. Consistent with this view, Autor, Levy and Murnane (2003), who measure the composition of the US labour force over the period 1960-2000, report that the mean share of routine tasks in the distribution of all tasks has been decreasing since 1980 at least. To summarise, the fall in the cost of moving costs relaxes the need to cluster production near people whereas the fall in the cost of moving ‘ideas’ relaxes the need to cluster production altogether (Baldwin 2006).

Importantly, the effects of the two types of unbundling on the distribution of income can be quite different. Falling trade costs in goods allows countries to exploit their comparative advantage by sector, affecting the terms of trade with well-known Stolper-Samuelson results on the real returns of factors. Consistent with this view, real wages of rich countries’ unskilled workers have been falling since the 1970s. By contrast, the welfare effects of the second unbundling are ambiguous. Indeed, jobs being threatened to be off-shored abroad resist the simple skilled-versus-unskilled dichotomy (Scheve and Slaughter 2001). As Baldwin (2006) puts it, “[routine] tasks such as computer programming and account management used to be de facto non-traded and this meant that the rewards to workers performing these tasks were not linked to the global market – they were set in local markets. This meant that the North-South wage gap in these tasks could greatly exceed the

[1] As a suggestive example, consider the United States and Japan. In both cases, the widespread offshoring of unskilled manufacturing jobs that started in the mid-1980s was not accompanied by a general decline in manufacturing employment until the late 1990s (Debande 2006).

North-South productivity gap (p.5)." In this context, recent technological breakthroughs in communication technologies give rise to arbitrage opportunities.

In the model I develop in this paper offshoring reduces costs in a way that is equivalent to (labour augmenting) technological progress in the sector offshoring tasks; the general equilibrium outcome is stark: jobs shifted overseas do not translate into jobs lost at home and thus workers in the country importing the fruit of offshored tasks might end up being better off. The most commonly cited reference in the offshoring/fragmentation literature is Jones and Kierzkowski (1990), who emphasized that fragmentation/offshoring can be thought of as technological progress and thus should be expected to have complex and ambiguous effects on wages, prices, production and trade; most of this literature uses a frictionless Walrasian framework.[2] By contrast, the current paper and Fujita and Thisse (2006) use a monopolistic competition framework with positive trade and communication costs.

The 2-coutry, 2-sector trade model I develop in this paper works as follows. Under the initial parameter configuration (trade costs are large and communication costs are prohibitive) North has a comparative advantage in manufacturing goods; as a result of the pecuniary externalities in this sector and of the resulting competition for the geographically immobile factor (labour), North is a high-wage country whereas South is a low-wage country specialised in the production of agriculture (modelled as a perfectly competitive, constant returns to scale sector).[3] Starting from this initial configuration, a fall in trade costs alone endogenously shifts the comparative advantage in manufacturing more evenly towards South: North de-industrialises as in Krugman and Venables (1995). This is because some manufacturing firms find it profitable to forego the pecuniary externalities and the favourable market access of North to benefit from South's lower wages. If instead *communication costs* fall, then, starting from the same initial configuration, fragmentation/offshoring becomes feasible. In this situation, it is economic for manufacturing firms to conduct *routine* tasks in South so as to benefit from low wages and to keep the *complex* tasks in the North so as to benefit from agglomeration economies. Then, as both trade and communication costs fall over time, the pattern of comparative advantage shifts in a more complex way. The central result in this paper is that North retains the core activities in Manufacturing *because offshoring becomes possible*. In other words, the offshoring of routine tasks and the specialisation in complex tasks are the two sides of the same phenomenon.

The rest of the paper is organised as follows. The next section introduces the model. Section 3 solves for the equilibrium whereas Section 4 discusses the equilibrium properties. Section 5 establishes who are the winners and the losers of 'globalisation'. Section 6 wraps up the results and suggests some policy implications of the model. Finally, Section 7 compares the results to important papers in the literature. Some intermediary results have been relegated to a Guide to Calculation in an online appendix.[4]

---

[2] See Baldwin and Robert-Nicoud (2006) for a synthesis and a more exhaustive survey of this literature.

[3] The manufacturing sector displays pecuniary externalities because there are input-output linkages among manufacturing firms, increasing returns to scale at the firm level and imperfect competition. Thus, it is modelled as in 'New Economic Geography' (NEG) models in the wake of Venables (1996). The importance of trade in intermediates has been documented by Yi (2003).

[4] This appendix can be downloaded from http://personal.lse.ac.uk/robertni/ or is available from the author upon request. Alternatively, see the CEPR discussion paper No. 5617 version of the paper for more details.

2 A THEORETICAL FRAMEWORK

The theoretical framework this section develops has two building blocks; the first block is 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 'complex' tasks. In a sense, all comparative advantage is endogenous and stems from agglomeration forces that take the form of pecuniary externalities (Fujita, Krugman and Venables 1999; Baldwin et al. 2003).[5]

2.1 Notation and basic structure of the model

Consider a world economy made of two regions or hemispheres (i.e., two sets of identical countries), j=1,2 (North and South, respectively), identically endowed with the following primary factors: capital K (the return of which is denoted by π_j), labour L (denote its return by w_j) and land T (denote its return by r_j). The world is endowed with K^w units of capital, L^w units of labour and T^w units of land; all these stocks are normalised to unity. The spatial distribution of all primary factors is uniform, that is, region 1 is endowed with an exogenous share s=½ of owners of capital, labour and land.[6] 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; in such a case, profits are repatriated and spent in the owner's location. Region j's total factor income is thus equal to $(w_j+r_j+\pi)/2$, where π is the world average return on capital.

Consumption

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

$$\textbf{(1)} \qquad V_j = \frac{\text{income}_j}{\text{CPI}_j}; \quad \text{CPI}_j \equiv p_A^{1-\mu} G_j^{\mu}, \quad G_j \equiv \left[\int_0^N p_j(i)^{1-\sigma} di \right]^{1/(1-\sigma)}; \quad 0 < \mu < 1, \quad \sigma > 1$$

where income_j and CPI_j respectively denote the nominal income of a typical individual residing in j and the consumer price index prevailing in j. The CPI has two elements: p_A denotes the consumer price of good A and G denotes the price index of the bundle M; $p_j(i)$ is the consumer price of a typical variety. 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 is chosen as the numéraire. Also, good A is freely tradable,

[5] Extending the model to allow for (Ricardian and Hecksher-Ohlin) comparative advantage or embodied factor migration would reinforce the results. Fujita and Thisse (2006) consider Marshallian externalities instead.

[6] I make this assumption to reduce the already quite large dimension of the parameter space. In the central analysis of the model, all firms are clustered in the north; de-facto, the North's market size will be larger than the South's.

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 $r_j^{1-b} w_j^b = p_A \equiv 1$, where 0<$b$<1. Viewing land as a hidden factor, this is equivalent to saying that there are decreasing returns to L in the A-sector and that the Ricardian rent is spent locally (Picard, Thisse and Toulemonde 2004); also, b<1 implies that the M-sector faces an imperfectly elastic labour supply in both regions. In order to get more amenable analytical solutions, I impose b=½, which implies:

(2) $$r_j = 1/w_j\,, \quad j = 1,2$$

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_j denotes output, $\tilde{w}_j$ is the unit labour cost (which might be different from w_j; see below), 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 first that (3) is not homothetic: the fixed component is intensive in capital (e.g. R&D, marketing, HQ services) whereas the variable component is intensive in labour and intermediates. By choice of units, I normalise a_{KM} to unity, namely, each firm needs one unit of K to operate. Next, 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).

Trade in the manufacturing sector between the two regions is impeded by iceberg transportation costs à-la Samuelson. Specifically, τ>1 units of good M need be shipped from region 1 for one unit of this good to reach region.

Offshoring and communication costs

In the model the possibility of off shoring/fragmentation comes in two ways. Trade in intermediates (Yi 2003) arises naturally in this NT/NEG models with vertical linkages.[7] Given the terminology of the model about what is a 'firm', this kind of offshoring is occurring at arm's length. In addition, firms can hire workers abroad to complete routine tasks: conceptually, this 'trade in tasks' takes place within the boundaries of the firm (thus a multinational corporation).

The offshoring of routine tasks involves intangibles and 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. In addition, offshoring also involves managerial costs (the extra time needed to codify information to distant workers, especially if they operate in different time zones) and more intangible costs like cultural barriers and the misunderstandings that can also result from using different languages (Leamer and Storper 2001, Fujita and Thisse 2006). I group all these costs under the same umbrella, which I refer to as 'communication costs', though only a fraction of these costs can be affected by technological progress in ICT (information and communication technologies) infrastructures.

[7] Even if all firms locate in a single hemisphere (North), in the model offshoring takes place among Northern countries.

Specifically, I assume that communication costs take the iceberg form; these costs are parameterised by ε>1. That is, a fraction 1-1/ε 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, effectively one unit of labour hired in j=1 costs w_1 to the firm whose manager is established in 1, but one unit of L hired in country 2 costs her εw_2. Thus, arbitraging between workers in the two hemispheres yields the following expression for $\tilde{w}_j$ in (3):

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

As a result, technological progress in ICT (a reduction in ε) increases the scope for arbitrage.

3 EQUILIBRIUM

Following a 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 short run equilibrium. In step two, the spatial allocation of firms is also endogenous and the so-called long run equilibrium emerges when the returns of the mobile factor—here, capital—are equalised worldwide.

3.1 Short run equilibrium

Define n (resp. N-n) as the mass of manufacturing firms that establish their 'complex activities' (headquarters or assembly plants) in region 1 (resp. region 2). In the short run equilibrium, the spatial allocation of firms (n,N-n) is given and firms maximise profits, consumers maximise utility and all markets clear. The endogenous variables to determine are expenditures on manufactures (denoted by E_j), price indices G_j, wages w_j, operating profits π_j (j=1,2) and the fraction of offshored manufacturing jobs (denoted by m).[8] Recall that (2) already fully characterises the equilibrium conditions pertaining to sector A, so let us turn to the M-sector.

Anticipating a little, in the central case under study in this paper, all firms cluster their sophisticated tasks in North (n=N) whereas South specialises in routine tasks and A (typically, this pattern is a long run equilibrium for a strictly positive measure of the parameter set, as we will see). For further reference, refer to this pattern as the 'agglomerating' case. It turns out that the equilibrium expressions are much simpler in this case and all economic intuition can be fleshed out from this equilibrium; I relegate the general case $n\in[0,\mathrm{N}]$ to the Guide to Calculations in the online appendix.

Operating profits in the M-sector

Using (1) and (3), on each market each producer faces a demand of the form $d_{ji} = B_i p_{ji}^{-\sigma}$, where p_{ji} is the producer price charged by the typical firm located in j on market i, d_{ji} is the quantity demanded to this firm (the quantity produced and the quantity demanded are linked by $x_j = d_{jj} + \tau d_{ji}, i \neq j$) and B_i is a function of the market sizes and of the price index of region i (to get an analytical expression for B_i, use Roy's identity and Sheppard's lemma; see Guide to Calculations for details). As in any model of monopolistic competition, each firm recognises that its actions have a negligible aggregate impact and thus it treats B_i as a parameter: there are no strategic interactions.

[8] That is, m is the proportion of workers country 1's firms hire abroad to convey routine tasks. Alternatively, m can be referred to as the proportion of tasks that are shifted overseas by the *multinational* firm.

As usual with Dixit-Stiglitz monopolistic competition, each firm charges a unique producer price for both markets; using (3), this mill price is $p_j(1-1/\sigma)=a_{LM}\tilde{w}_j^{1-\alpha}G_j^{\alpha}$. As a result, p_j is larger than marginal cost and firms active in the M-sector earn positive operating profits. To operate, these firms also need to hire one unit of capital; specifically, would-be entrepreneurs bid for units of K competitively; as a result, the capital rental rate π_j is equal to the operating profit. Finally, we can chose units of M such that a_{LM} = 1-1/σ. Together, these considerations yield:

(5) $$\pi_j=\frac{p_j x_j}{\sigma} \quad \text{and} \quad p_j=\tilde{w}_j^{1-\alpha}G_j^{\alpha}, \quad j=1,2.$$

Note that the first expression above implies that aggregate operating profits are just equal to a fraction (1/σ) of world sales of manufacturing goods, which we denote as $E^w \equiv E_1+E_2$.

Next, impose the condition of full employment of capital $N=K^w=1$ and 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 short run equilibrium.
In the agglomerating case n=1, all firms are identical and located in North, so each of them ought to earn the average profit. Using symbols:

(6) $$\pi=\pi_1=\frac{E^w}{\sigma}; \quad E_1=\mu\frac{w_1+w_1^{-1}+\pi}{2}+\frac{\alpha(\sigma-1)}{\sigma}E^w, \quad E_2=\mu\frac{w_2+w_2^{-1}+\pi}{2}.$$

These expressions are readily interpreted. First, since all firms are clustered in region 1, E_2 is a fraction μ of factor income only; note that we have made use of (2). Second, E_1 is the sum of local final demand for manufacturing goods, which is a fraction μ of local income, and of local intermediate demand, which is a fraction α(σ-1)/σ of world sales (see Guide to Calculations for details).

Full-employment conditions

We have already imposed $N=K^w=1$. Also, land is inelastically supplied to—and fully employed in—sector A. To close the model, we need the full-employment conditions for L_1 and L_2.

Anticipating slightly the equilibrium outcome for wages, it must be that whenever most manufacturing firms locate their core tasks in North (i.e. when $n \geq ½$) then $w_1 \geq w_2$ holds because demand for labour is larger in region 1 than in region 2.[9] In particular, under our working assumption n=1, this inequality holds strictly.

To get an expression for labour demand in the M-sector, apply Sheppard's lemma on (3) and use the relationship between sales and operating profits, e.g. $p_j d_{jj}=B_j p_j^{1-\sigma}$. A mass $L^w/2$ = ½ of labour is inelastically supplied in each country, thus these considerations alongside (2) enable us to write the full-employment condition for labour (in value) as:

(7) $$\frac{w_1}{2}=(1-m)(1-\alpha)(\sigma-1)\pi+\frac{1/w_1}{2}; \quad \frac{w_2}{2}=m(1-\alpha)(\sigma-1)\pi+\frac{1/w_2}{2}$$

---

[9] The reader can confirm that this intuition is correct by imposing n=1 and m=0 in the full employment condition (7) below.

Expressions (A.7) and (A.8) in the Guide to Calculations generalise these expressions for any *b* in the unit interval and for any $n \geq ½$. The left hand side terms in these two expressions are the total wage bills. The first term in the right hand side of each of these expressions captures the wage bill paid by region 1's (manufacturing) firms to their workers in j=1,2; the wage bill is increasing in the value of sales (more workers need to be hired to expand production), which are themselves proportional to operating profits. The rightmost terms of each in expression in (7) represents the wage bill in sector A; note that it is decreasing in *w* because the elasticity of labour demand is lower than –1 by (2). Given π, these expressions reveal that w_2 is increasing in *m* and that w_1 is decreasing in *m* (that is, South's wage rate rises and North's wage rate falls as multinationals' demand for routine work in South goes up).

By the same token, given that nominal wages in North are no lower than wages in South, the no-arbitrage condition in (4) simplifies to:

(8) $$w_1 \leq \varepsilon w_2, \quad m \geq 0, \quad (w_1 - \varepsilon w_2)m = 0$$

For the sake of completeness, note that $G_1=w_1$ and $G_2=\tau w_1$.[10] These, together with expressions (6)-(8) and (A.5) fully depict the short run equilibrium value of $\{\pi_1,\pi_2,w_1,w_2,E_1,E_2,G_1,G_2,m\}$.

3.2 Long-run equilibrium

In the long run, capital moves in search of highest returns. Accordingly, a long-run equilibrium is defined as a short run equilibrium for which the following additional condition holds:

(9) $$0 \leq n \leq 1, \quad \max\{\pi_1,\pi_2\} = \pi, \quad n(1-n)(\pi_1 - \pi_2) = 0$$

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

To assess the stability of the equilibrium, I follow standard practice in assuming that entrepreneurs move core activities (HQ and assembly) myopically whenever π_1 and π_2 differ, and that the adjustments follow the following, ad-hoc, law of motion: $\dot{n} = n(1-n)(\pi_1 - \pi_2) = n(\pi_1 - \pi)$, where the second equality follows from the definition of π.[11] The description of the basic model is now complete. The next section describes these properties.

4 EQUILIBRIUM PROPERTIES

Under our working assumption n=1, the central question of this paper can be reformulated as follows: When is the agglomerating pattern a stable equilibrium? How do the properties of this equilibrium change when communication costs fall and foreign sourcing increases?

Conceptually, there are two cases to consider: first, communication costs can be prohibitive in the sense that (8) is not binding; in this case, m=0 and the model is a standard NEG model with the

---

[10] To see this, note that when n=1, firms in 1 do not import any intermediates, so from (1) and (5) we obtain $G_1=w_1$. Similar calculations lead to the expression for G_2. (A.5) provides an expression for π_2.

[11] 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 instantaneously). Formally, manufacturing employment follows the ad-hoc law of motion $\dot{m} = \gamma m(1-m)(w_2 - w_1)$ with $\gamma \to \infty$. Given that I focus the analysis on the agglomerating equilibrium (i.e. n=1), this assumption is immaterial.

usual properties.[12] In particular, the equilibrium is unaffected by the value of ε whenever $\varepsilon>\varepsilon_0$, where:

(10) $$\varepsilon_0 \equiv \left.\frac{w_1}{w_2}\right|_{n=1,m=0} = \frac{1+\psi}{1-\psi} > 1, \quad \text{where} \quad \psi \equiv \frac{\mu(1-\alpha)(\sigma-1)}{(1-\alpha)(\sigma-1)+1-\mu} < 1$$

That is, ε_0 is defined as the (nominal) wage ratio at the agglomerating outcome when the no-arbitrage condition in (8) is not binding. (To get this expression for ε_0, impose m=0 and solve the system given by (6)-(7) for the nominal wages.) This confirms that nominal wages are higher in the agglomeration region ($\varepsilon_0>1$). Alternatively, communication costs ε can be low enough so that $m>0$, namely, manufacturing firms established in region 1 might offshore tasks to region 2 (this happens if $\varepsilon<\varepsilon_0$). In this paper, I concentrate the analysis on the interior outcome, that is, $\varepsilon<\varepsilon_0$.[13]

4.1 The 'sustainable' interval

Here, we want to assess the stability of the agglomerating equilibrium, or, in the NEG jargon, we want to know the conditions under which conditions the agglomerating pattern is 'sustainable'. When n=1, (9) holds if, and only if $\pi_2\leq\pi_1$. In words: the agglomerating equilibrium is stable if, and only if, no firm has any incentive to relocate its core activities to region 2.

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

To assess whether the shadow operating profit π_2 is not larger than π_1, we need to get an expression for x_2 and d_2, namely, the demand the firm contemplating a deviation from n=1 would be facing. The easiest way to proceed is to apply Roy's identity on (1) and Sheppard's lemma on (3); see Guide to Calculations for details. Substituting n=1 into the general expression for π_1 and π_2 in (A.5), using (8) and tacking the ratio of the two yields:

(11) $$q \equiv \left.\frac{\pi_2}{\pi_1}\right|_{n=1} = \left(\frac{w_2}{w_1}\right)^{(1-\sigma)(1-\alpha)} \frac{\Delta_2^\alpha}{\Delta_1^\alpha}\left(\frac{s_E\phi}{\Delta_1} + \frac{1-s_E}{\Delta_2}\right) = \frac{\phi^\alpha}{\theta^{1-\alpha}}\left(s_E\phi + \frac{1-s_E}{\phi}\right)$$

where $\phi\equiv\tau^{1-\sigma}$ and $\theta\equiv\varepsilon^{1-\sigma}$ are two useful collections of parameters that can respectively be interpreted as the level of trade freeness (phi-ness) and of communication freeness,[14] and s_E is defined as region 1's expenditure share when n=1 and $\varepsilon<\varepsilon_0$:

(12) $$s_E(\varepsilon) \equiv \left.\frac{E_1}{E^w}\right|_{n=1} = \frac{1}{2}\left[1+\alpha\beta+(1-\alpha)\beta\mu\frac{\varepsilon-1}{\varepsilon+1}\right], \quad s_E(\varepsilon)\in(\frac{1}{2},1)\ \forall\varepsilon, \quad \frac{\partial s_E}{\partial\varepsilon}>0$$

---

[12] In this case, its properties are very similar to the model developed by Krugman and Venables (1995) and synthesized in Fujita et al. (1999, chapter 14)

[13] Interestingly, ε_0 is increasing in σ, μ and 1-α (decreasing in α). That is to say, firms in the north are more likely to offshore some tasks when at least one of the following conditions holds: when varieties are close substitutes (in this case, unexploited scale economies are low thus firms operate at a large scale, exerting higher pressure on wages); when the fraction of income spent on manufacturing goods is large (because a larger manufacturing sector exerts a larger pressure on labour resources, resulting in a large wage gap); when the wage bill represents a large fraction of variable costs (for the same reason).

[14] ϕ (resp. θ) ranges from zero when trade (resp. communication) is prohibitive ($\tau=\infty$ and $\varepsilon=\infty$) to unity when trade (resp. communication) is perfectly free (τ=1 and ε=1). Both θ and ϕ are decreasing in σ: intuitively, when varieties become closer substitutes, the dampening effect of e.g. τ on trade volumes rises.

In this case, the fraction of manufacturing jobs being off-shored is given by

$$\textbf{(13)}\qquad m(\varepsilon)\big|_{n=1} = \frac{\varepsilon_0 - \varepsilon}{(1+\varepsilon)(\varepsilon_0 - 1)}, \qquad m(\varepsilon)\big|_{n=1} \in [0, \frac{1}{2})\ \forall \varepsilon, \quad \frac{\partial m}{\partial \varepsilon} < 0$$

In (11), the term $\phi^{\alpha}/\theta^{(1-\alpha)}$ captures the net loss linked to production costs that results from moving core production from North to South; this net loss is positive if the term in question is smaller than unity. Firms weigh the access to relatively cheap intermediates in North—the 'supplier access', as parameterised by $\phi^{\alpha}=(G_2/G_1)^{\alpha(1-\sigma)}$ – against the access to relatively cheap labour in South—as parameterised by $\theta^{(1-\alpha)}=(w_1/w_2)^{(1-\alpha)(1-\sigma)}$. As comparative statics reveal, the loss of moving production from the core (North) to the periphery (South) is high if trade costs are high, if communication costs are low and/or if the share of labour in variable costs is low.

Firms face a second trade-off that involves the so-called 'market access' and 'market crowding' effects; in symbols, this is the term $(\phi s_E+(1-s_E)/\phi)$ in (11). This term captures the net loss in market access that results from moving the core production from the core location (North) to the periphery (South). Again, this net loss is positive if the term in question is smaller than unity. When n=1, each firm in 1 is a 'small fish in a big bowl': it has a good access to the large market (North's) but it has a small market share (in the NEG jargon, the market is 'crowded' in the core). By contrast, the firm contemplating relocation to region 2 would have a poorer access to the large market, as captured by the term ϕs_E, but a good access to the small market, where competition is weak, as captured by the term $(1-s_E)/\phi$. Since s_E>½, the loss of moving to the periphery is larger, the larger the income gap between the two regions (the larger is s_E) and the freer is trade (the larger is ϕ).

Discussion: Agglomeration and dispersion forces

Taken together, the superior market and supplier access in the North vanishes as trade costs fall because locations become less segmented; likewise, when ϕ increases, competition becomes global and both markets become more evenly crowded. These can be seen by $\phi^{\alpha}\to 1$ and $\phi s_E+(1-s_E)/\phi\to 1$ in (11), respectively. By contrast, for given n, relative labour costs are unaffected by ϕ. As is well known in the NEG literature (Fujita et al. 1999, Baldwin et al. 2003), agglomeration forces (market and supplier access) dominate dispersion forces for intermediate values of ϕ. In particular, market crowding considerations are the dominating force when ϕ is low (firms locate evenly to try avoid competition on the goods market) whereas labour costs are the dominating dispersion force when ϕ is close to unity (firms locate evenly to try avoid competition for the primary factor). Since we have $1/\theta^{1-\alpha}>1$ at the limit $\phi\to 1$, $\pi_2>\pi_1$ at the agglomerating equilibrium, which violates (9): by continuity then, n=1 cannot be part of a long run equilibrium when $\phi \approx 1$.

More generally, define $\Phi^S(\theta) \equiv \{\phi : \pi_1(\phi,\theta) \geq \pi_2(\phi,\theta) \wedge n = 1\}$ as the range of values of ϕ, expressed as a function of θ, such that, when n=1, no firm currently in North has any incentive to relocate its complex operations to South; this will be the case if, and only if, the expression in (11) is lower than unity. In other words, the agglomerating outcome is *sustainable* if, and only if, ϕ is in Φ^S:

$$\textbf{(14)}\qquad \Phi^S(\theta) = \{\phi : f(\phi,\theta) \geq 0\}, \quad f(\phi,\theta) \equiv (\theta\phi)^{1-\alpha} - s_E\phi^2 - (1-s_E)$$

where s_E is the collection of parameters provided by (12). Standard algebra shows that *f*(.) is negative and increasing at ϕ=0, negative and decreasing at ϕ=1, and concave everywhere. Hence, *f*(.) admits a unique maximum. If agglomeration forces are strong enough (i.e. if μ is large, σ is low and ε is low), the two roots of (14), which we denote by ϕ_S and ϕ^S, belong 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 I mention it explicitly, I assume that parameters of the model take values such that this condition holds from now on. Note that an equivalent definition of Φ^S in this case is $\Phi^S\equiv[\phi_S,\phi^S]$. To summarise this discussion, we have shown[15]:

> *Result 1. 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 other words, the agglomerating equilibrium exists for intermediate values of trade freeness. The paper is mostly interested in the effects of communication costs on Φ^S, so we turn to this next.

4.2 The role of communication technologies

The effect of offshore sourcing of routine tasks on the sustainability of the agglomerating pattern is twofold: on the one hand, the possibility of hiring cheap labour abroad directly reduces the production costs of the firms in the North, which increases the 'sustainability' of the agglomerating equilibrium—from (11), we have $\partial q/\partial\theta<0$ (given s_E). On the other hand, this will have a feedback (or general equilibrium) effect on wages and thus a on each region's market size—from (11) and (12), we have $\partial q/\partial s_E<0$ (given θ) and $\partial s_E/\partial\varepsilon>0$, thus $\partial q/\partial\varepsilon<0$ (given θ).

Consider the direct effect first: from (14) an increase in an increase in communication freeness θ alone increases the measure of the set of parameters of the model such that $f>0$ holds, that is, *this expands the set of other parameters that are consistent with an uneven North-South development*. Figure 1 plots ln(q) on the vertical axis and the mass of firms established in region 1 (n) on the horizontal one. It illustrates the case in which θ increases sufficiently to make an agglomerating pattern sustainable (point S), starting with initial conditions such that it was not (point U).

Figure 1. Offshoring

However, this analysis would be incomplete if we did not consider the feedback effect due to the spatial reallocation of income which results from the change in occupation of workers in both regions. In symbols, we obtain $\partial s_E/\partial\varepsilon>0$ if $\varepsilon\in(1,\varepsilon_0)$ and $s_E(\varepsilon)>½$ for all ε by (12), that is, an increase in foreign sourcing in manufacturing triggers GDP convergence. There are at least two reasons to believe that the income-driven general equilibrium-effect might not overcome the direct cost-saving effect. First, the magnitude of the cost effect is first-order large: it operates for all firms within the industry; the general equilibrium effect on factor returns is small if the sector is small with respect to the rest of the economy (e.g. if μ is small). In addition, numerical simulations suggest that the direct effect dominates the possibly countervailing general equilibrium effect *for all economically meaningful parameter values* (namely, for all $\{\alpha,\mu\}\in[0,1]^2$ and for all $\sigma>1$).[16] As a consequence, we can ignore this general equilibrium effect and write:[17]

---

[15] This agglomerating equilibrium might not be unique, however; see e.g. Fujita et al. (1999) and Robert-Nicoud (2005) for details.

[16] 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.

[17] 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). The potential advantage of choosing the alternative modelling strategy is that it would be straightforward to provide an analytical proof to Result 2: indeed, mathematically assuming quasi-linear preferences would have the same effect as having $\mu=0$ in (14), thus s_E would be

Result 2. When communication costs decrease, the agglomerating equilibrium is sustainable over a wider range of trade costs.

Figure 2. Sustainability of the agglomerating equilibrium

An graphical illustration of this result is provided by the top quadrant of Figure 2. This figure plots trade freeness ϕ against communication freeness θ. The diagram shows that the lower bound of the sustained interval Φ^S is decreasing in θ and that its upper bound is increasing in θ. By contrast, when communication costs are prohibitive –which happens when $\theta<\theta_0$– then the no-arbitrage condition (8) is not binding and as a result Φ^S is constant. The bottom quadrant plots (13) in the (m,θ)-space; it illustrates that the fraction of manufacturing jobs being off-shored is the cause of the expanding sustain interval.

5 WELFARE

This section considers the normative implications of the ideas developed henceforth. We are particularly interested in the well-being of workers, so the metric we will be using to assess the welfare effects is their real wage, which using the closed form solution for (1) can be written as:

(15) $$\omega_j \equiv \frac{w_j}{\text{CPI}_j} = w_j \Delta_j^{\mu/(\sigma-1)}$$

In this section, we want to convey two conceptually very different welfare analyses. The first one is standard: it involves a comparative statics exercise on the closed form solution for ω_j, *given* the spatial equilibrium configuration (as in Fujita and Thisse 2006). The second exercise is less standard and involves comparing welfare levels at different equilibria (as in Charlot et al. 2006).

5.1 Comparative statics: marginal effect of θ and ϕ

Let us start by considering how the welfare of each group of factor owners evolves when trade or communication freeness increases (a shortcut for 'globalisation') for a given spatial configuration. At the agglomerating equilibrium (n=1), the following properties hold (the formal proof follows):

Result 3. At the agglomerating equilibrium, the following hold: (a) an increase in trade freeness ϕ (a reduction of τ) does not affect North's residents and makes South's residents better off; (b) an increase in communication freeness θ (a reduction of ε) hurts workers in North whereas workers in South are better-off; the opposite is true for land owners; (c) all capital owners are better off following an increase in θ (a reduction of ε).

To see this formally, solve the model for w_j and G_j, then plug the resulting expressions into (15) and obtain:

(16) $$\omega_1(\varepsilon)\big|_{n=1,\,\varepsilon\le\varepsilon_0} = (w_0\sqrt{\varepsilon})^{1-\mu}, \quad \omega_2(\tau,\varepsilon)\big|_{n=1,\,\varepsilon\le\varepsilon_0} = \frac{1}{\tau^{\mu}} w_0^{1-\mu}\left(\frac{1}{\sqrt{\varepsilon}}\right)^{1+\mu}; \quad w_0 \equiv \sqrt{\varepsilon_0}$$

where the economic interpretation of w_0 (a collection of parameters) is to be defined shortly. Parts (a) and (b) of the proposition can be verified by inspection in the workers' case; as to capital

---

constant; as a result, it is readily verified that $\partial f/\partial\varepsilon<0$ (or $\partial f/\partial\theta>0$) holds for all parameter values.

owners, note that their nominal return is invariant in ϕ by (6) and (7). Part (*c*) says that capital owners are better off when θ increases; this looks intuitive insofar as offshoring ought to reduce production costs. This intuition, however, is misleading because it turns out that the *nominal* return to capital π is decreasing in θ (increasing in ε), thus, so capital owners benefit from a higher θ only because it reduces the CPI.[18] This counterintuitive result holds because even though it is individually rational for all firms to offshore routine tasks when possible, a lower ε benefits all firms in the same way so no single firm gests a wedge at equilibrium. Actually, the aforementioned general equilibrium effect pulls in the opposite direction and reduces profits. This completes the proof.

Figure 3. Communication freeness and welfare

An illustration of the effect of θ on ω_1 and ω_2 at the agglomerating equilibrium (n=1) can be found in the top panel of Figure 3 (the bottom panel of this figure reproduces the top panel of Figure 2): $\omega_1(\theta)$ is (weakly) decreasing and $\omega_2(\theta)$ is (weakly) increasing, as assessed in Result 3.

5.2 Equilibrium switch and welfare

The central claim of this paper is that the stance that offshoring is necessarily welfare worsening for workers in the North is only partially correct because the implicit counterfactual—that keeping the off-shored jobs would have no macroeconomic impact on the economy—is not warranted. The agglomerating equilibrium might become unstable as the result of an increase in ϕ and/or θ. Thus, when parameters of the model are such that ϕ does not belong to Φ^S, the economy will find itself at the symmetric spatial long run equilibrium, whereby n=½ and m=0; since the two regions are ex-ante identical, the symmetric equilibrium always exists and it turns out that it is stable when the agglomerating equilibrium is not.[19] This other spatial equilibrium provides the correct counterfactual. Denote with the subscript 'naught' the values of the nominal factor rewards and all other endogenous variables pertaining at the symmetric equilibrium; the closed form solution of these can be found in (A.9). Also, by symmetry of the model, $w_1=w_2$ always holds and as an implication (8) is not binding, thus factor rewards do not depend on ε. Finally, an increase in ϕ makes everybody better off because lower trade costs result in cheaper intermediates and final goods (and thus a lower CPI).[20] In short, the welfare properties of Result 3 (*a*) hold at the symmetric equilibrium, too.

We now make three thought experiments with the help of Figure 3. Turn to the bottom panel and assume that (ϕ,θ) is such that the economy stands at point X in the figure: this parameter configuration is consistent with a agglomerating equilibrium; mathematically, $\phi_X\in\Phi^S(\theta_X)$. Consider first the effects of an increase in θ alone from point X to point Y (an improvement in ICT): the economy remains at the agglomerating equilibrium. As to the welfare effects, turn to the top panel of Figure 3, where the loci labelled ω_1 and $\omega_2(\phi_X)$ plot (16) as a function of θ whereas the locus ω_0

---

[18] Nevertheless, the elasticity of the *real* income of capital owners with respect to ε is equal to $\varepsilon/(1+\varepsilon)-(1+\mu)/2$, which is negative on $(1,\varepsilon_0)$; see (A.12). To prove this claim 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 (10). However, $\mu>\psi$, as is immediate from the definition of ψ. Thus the necessary condition is violated and the elasticity is negative.

[19] For some parameter values both equilibria are stable. In the CEPR discussion paper no. 5617, I establish that the set of values of ϕ such that the symmetric equilibrium is unstable, denoted by Φ^B, is such that $\Phi^B\subset\Phi^S$ holds. Also, no asymmetric interior equilibrium is ever stable in the current framework; see Guide to Calculations for details.

[20] Specifically, real incomes at the symmetric equilibrium are proportional to $(1+\phi)^{\mu/(1-\alpha)}$; see Guide to Calculations.

plots workers' real wages (15) at the symmetric equilibrium (n=½); see (A.9) for a closed form solution. Clearly, such ICT-driven globalisation directly benefits South's workers at the expense of North's.

Consider next the positive effect of an increase in ϕ alone (a reduction in trade frictions) from point X to point Z, which is to 'destroy' the agglomerating equilibrium and to trigger a perfect convergence between North and South. The normative implications of this are clear: workers in the North loose whereas workers in the South may gain or loose (Z in the top panel corresponds to ω_0 evaluated at (θ_X,ϕ_Z), which lies strictly below points X_1 and X_2 but above the line $\omega_0(\phi_X)$). To verify these claims formally, use (A.9), (15) and (16) to write the difference (in logs) between real wages evaluated at the agglomerating equilibrium and at the symmetric one (for given ϕ and θ), namely:

(17)

$$\ln\omega_1 - \ln\omega_0 = \frac{1}{\sigma-1}\left[\frac{1-\mu}{2}\ln(\frac{1}{\theta}) + \frac{\mu}{1-\alpha}\ln(\frac{2}{1+\phi})\right] > 0,$$

$$\ln\omega_2 - \ln\omega_0 = \frac{1}{\sigma-1}\left[-\frac{1+\mu}{2}\ln(\frac{1}{\theta}) - \mu\ln(\frac{1}{\phi}) + \frac{\mu}{1-\alpha}\ln(\frac{2}{1+\phi})\right]$$

Several aspects of (17) deserve emphasis. First, workers in North are necessarily better-off under the agglomerating outcome than under the dispersed equilibrium; by contrast, South's workers are hurt by lower nominal wages (which is captured by the first term in the square bracket in the second expression in (17)) and by being located remotely (which entails facing a larger CPI and is captured by the second term). On the other hand, agglomeration economies may entail lower producer prices (thanks to input-output linkages; this is captured by the last term) and, to the extent that transportation costs are not too large, consumer prices can as a result also be lower in the periphery than at the dispersed equilibrium.[21]

Turn last to the third thought experiment. Realistically, globalisation is driven by the simultaneous increase of both ϕ and θ (see Introduction). Specifically, consider a move such as from X to W on Figure 3; in this case, the economy remains agglomerated. Workers in the North are worse off (W_1, not shown, is confounded with Y_1), but not as worse off as in Z. Taken in isolation, offshoring hurts these workers and trade integration has no effect on them (ω_1 does not depend on ϕ); but together *trade in final goods with offshoring* improve their lot. We can see these contrasted effects in the first terms in each bracketed expression in (17): since θ>1, offshoring benefits workers in the North but hurts workers in the South insofar as it helps maintaining manufacturing activities in the North. An *increase* in θ, however, benefits the latter and hurts the former because it increases demand for labour in the South and lowers it in the North. In other words, we have established:

> *Result 4. Improvements in communication technologies and the resulting offshoring of routine tasks help maintain core activities in North and, as a result, benefit workers in North despite the fact that they face more competition for jobs from workers in South.*

The reason for this result is that the offshoring of routine tasks creates efficiency gains for the manufacturing sector in the North, which *exclusively* benefits workers and consumers at the expense of capital (remember that capital owners' nominal reward falls).

---

[21] Specifically, residents in the periphery face lower price index than in the symmetric equilibrium (for a given θ) if $2\phi^{1-\alpha} > (1+\phi)$ (this in turn requires α>½ and ϕ to be large enough).

6 SUMMARY AND POLICY IMPLICATIONS

This paper addresses the issue of overseas sourcing of services from a non-neoclassical angle. In a framework in which comparative advantage is endogenous to agglomeration economies and factor mobility, the fragmentation of production made possible by fibre optic cables 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; in other words, the efficiency benefits generated by offshoring are shared with workers worldwide (in the model, it turns out that *all* of these benefits accrue to workers and consumers). 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, policymakers in countries like Spain and France (to take a couple of recent examples) make their economies unattractive for global firms to locate there even their core tasks. 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 United States in the past decade is partly responsible for the outstanding growth of US productivity; at the micro level, Barba-Navaratti et al. (2006) suggest that firms that offshore some of their value chain abroad become more productive; since they go some way towards controlling for the self-selection effect, this result can with caution be interpreted as indicating causality. Thus, policies to prevent offshoring and the loss of domestic employment might backfire, very much like policies meant to prevent the loss of manufacturing employment in cities mostly failed (Cheshire 1995); indeed, the essential choice facing some industries is 'offshore or die'.

7 CONCLUDING REMARKS

In this final section, I discuss how the theoretical results of the previous section are related to theoretical work developed earlier on as well as to contemporaneous work developed independently, and why it generates distinct results.

I have already mentioned how the current paper relates to the work of Krugman and Venables (1995). In their paper, there is no offshoring and the authors establish that incomes and production patterns converge when trade costs (for goods) are either low or large; using Figure 2, this is akin to a vertical movement (bottom-up) over time across the sustain interval. Their main result is that the industrialisation of the Northern hemisphere in the course of the nineteenth century *had to* be accompanied by a de-industrialisation of the South (especially China and India) because agglomeration forces set up a self-enforcing mechanism that was virtuous for the North and detrimental to the South. However, at a later stage (the late twentieth century in their narrative) the very same process of falling trade costs triggers a re-location of manufactures towards Taiwan, South Korea, Singapore or Honk Kong, which were low-wage countries at the time.

By contrast, the presumption of this paper is that routine tasks generate fewer agglomeration economies. Therefore, the offshoring of routine tasks undermines the potential for growth take off in the recipient countries. Indeed, in the model of this paper, offshoring actually reinforces the agglomeration forces and weakens the dispersion forces. As a result, routine tasks only are being off-shored to developing countries, while the rich ones retain the 'high value added' jobs. This way, the fibre optic cable triggers a ‘functional specialisation’ of countries.[22] This specialisation by function rather than by sector *relaxes the pressure to move the entire manufacturing production chain to low wage countries*. This slows down the convergence of production patterns, though speeds up the convergence in *nominal* incomes.

Next, like this paper, Fujita and Thisse’s (2006) (F&T hereafter) adopt a modelling strategy that combines the issue of ‘fragmentation’ and the reduction in communication costs in an imperfectly competitive setting. Their approach and the one in this paper are complementary on several accounts; I mention three of them here. First, one emphasis in F&T is on the skilled v. unskilled wage gap; by contrast, I start with the premise that the ‘offshorability’ of tasks is orthogonal to the skill content of the task and thus I model only one type of labour.[23] Another noticeable difference between the two papers is that the (unskilled) wage gap between the North and the South is fixed in F&T (*North* has an exogenous absolute advantage in the *traditional* sector); here, it varies in a subtle way as a result of changes in trade and communication costs. The third important difference between this paper and F&T involves the location of final production. Specifically, they study the offshoring of tangible tasks, namely, they model the economic implications of the spatial unbundling of the whole production unit (in South or North) and the HQ (in North). By contrast, my model applies to the unbundling of intangible tasks.[24] Thus, Fujita and Thisse’s model captures best the offshoring of manufacturing processes to ‘manufacturing dragons’ like China, whereas my model fits the patterns of offshoring to ‘IT dragons’ like India. In the online appendix, I analyse F&T’s case in the framework developed in the current paper; as it turns out, both the normative and positive implications of offshoring whole manufacturing processes (instead of trade in tasks) are similar but lower in magnitude than those of my main model.

REFERENCES

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

Autor, D., Levy, F. and R. Murnane (2003). ‘The skill content of recent technological change: An empirical exploration.’ Quarterly Journal of Economics, November, 1279-1333.

Baldwin, R. (2006). ‘Globalisation: The great unbundling(s).’ Finnish Prime Minister’s Office. hei.unige.ch/~baldwin/PapersBooks/

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 F. Robert-Nicoud (2006). “Offshoring: General equilibrium effects on wages, production and trade.” Paper presented at the Hitotsubashi COE/RES Conference on International Trade and FDI, Tokyo, Japan (http://www.econ.hit-u.ac.jp/~coe-res/fdi2006/).

[22] The terminology is borrowed from Duranton and Puga (2005) who study the functional specialisation of cities. See also Defever (2006) on FDI.

[23] The reader who thinks that this assumption is too extreme might consider the following examples applying to the health sector. Routine processing of patient data (e.g. computing the bill) as well as day-to-day patient personal care are two tasks that are relatively unskilled-intensive. By contrast, a neurologist’s surgical intervention and the interpretation of medical imagines are two tasks that require a high degree of expertise. Yet, helping a patient with her basic body hygiene and opening her skull cannot be done remotely but producing her bill and interpreting the scanner images of her brain can. In this example, the offshorability of skills is related to the nature of the task only, not to its skill content. On this, see also Grossman and Rossi-Hansberg (2006), Baldwin (2006) and Baldwin and Robert-Nicoud (2006).

[24] In both papers, the ‘strategic’ tasks—management, R&D, marketing, finance—are conveyed in the North.

Barba-Navaretti, G., D. Castellani and A.C. Disdiers (2006). 'How does investing in cheap labour countries affect performance at home? France and Italy.' CEPR discussion paper 5765.

Charlot, S., C. Gaigné, F. Robert-Nicoud and J.-F. Thisse (2006). 'Agglomeration and welfare: The core-periphery model in the light of Bentham, Kaldor, and Rawls.' Journal of Public Economics, 90(1), 325-347.

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

Debande, Olivier (2006). "De-industrialisation," Volume 11, N°1, European Investment Bank Papers. www.eib.org/attachments/general/events/02_Debande.pdf

Defever, F. (2006). 'Functional fragmentation and the location of multinational firms in the enlarged Europe.' Regional Science and Urban Economics 36(5), 658-77.

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

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

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 (2006). 'Globalization and the evolution of the supply chain: Who gains and who looses?' International Economic Review, forthcoming.

Grossman, G. and E. Rossi-Hansberg (2006). "Trading Tasks: A Simple Theory of Offshoring." Mimeographed, www.princeton.edu/~grossman/offshoring.pdf

Jones, Ronald W. and Henryk Kierzkowski (1990): "The Role of Services in Production and International Trade: A Theoretical Framework", in Ronald Jones and Anne Krueger, eds., The Political Economy of International Trade, Basil Blackwell, Oxford.

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

Leamer, E. and M. Storper (2001). 'The economic geography of the internet age.' Journal of International Business Studies 32: 641-66.

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).

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

Picard, P.M., J.F. Thisse. and E. Toulemonde (2004), 'Economic Geography and the Role of Profits', Journal of Urban Economics 56, 144-167.

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

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

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

Yi, K.M. (2003). "Can vertical specialization explain the growth of world trade?" Journal of Political Economy, 111(1), 52-102.

FIGURES

Figure 1. Offshoring

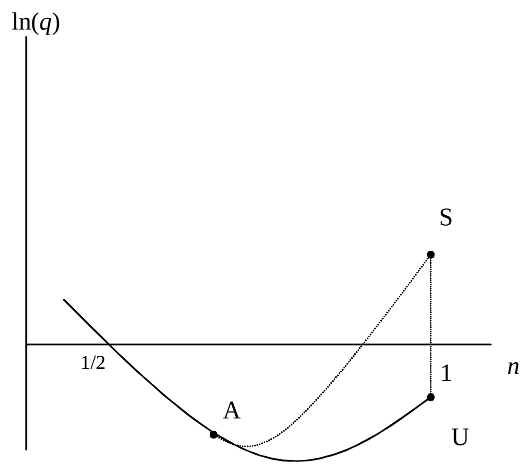


Figure 2. Sustainability of the agglomerating equilibrium

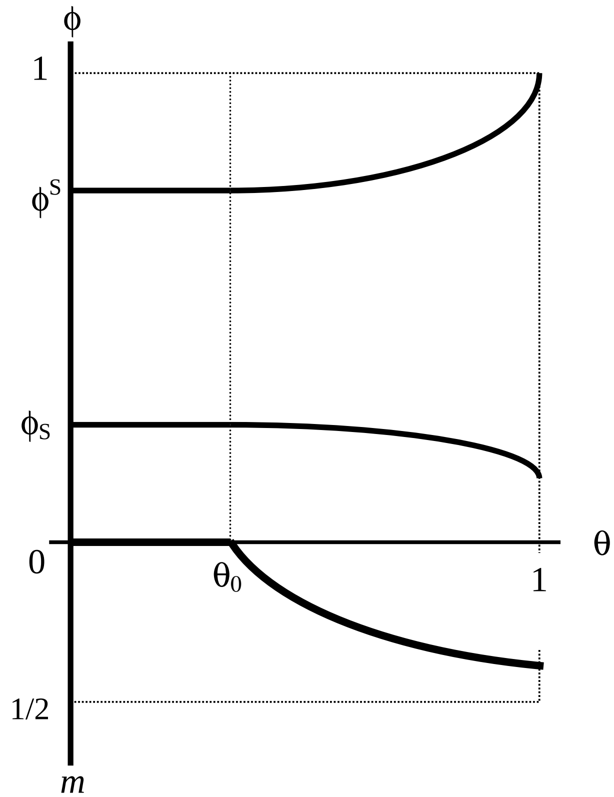
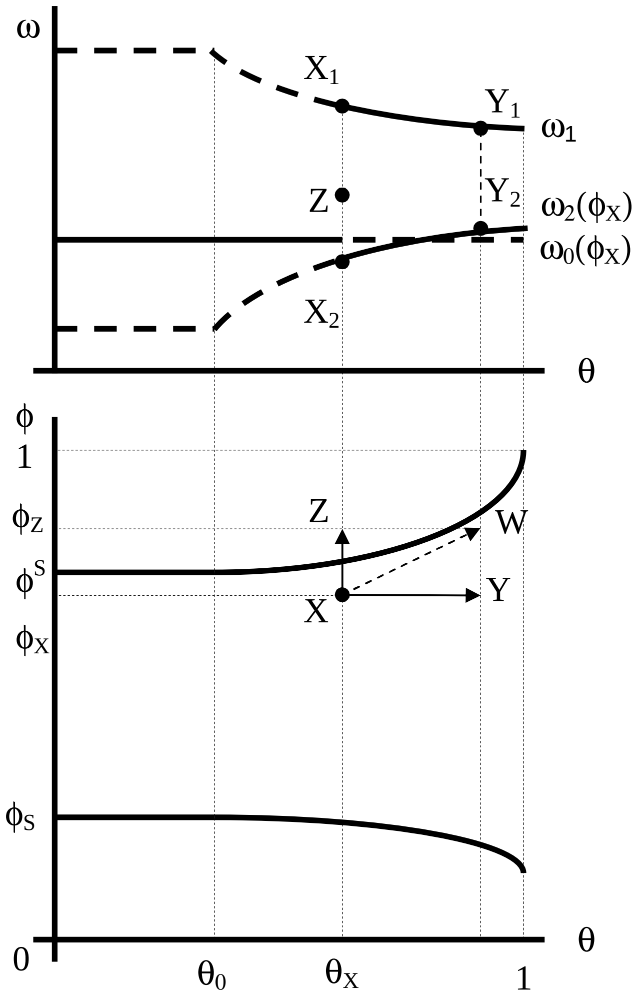


Figure 3. Communication freeness and welfare.



ONLINE APPENDIX AND GUIDE TO CALCULATIONS—NOT FOR PUBLICATION (WILL BE POSTED ON THE WEB)

A.1. Short run equilibrium: Guide to Calculations

This section first provides a guide to get expressions (6) and (7) in the text. Here, I *do not* impose n=1, thus the expressions are more general than in the text. From (5), rewrite p_j as $w_j^{1-\alpha}\Delta_j^{\alpha(1-\sigma)}$. To get an expression for the final demand for a local variety (i.e. from j to j), apply Roy's identity on (1), which yields

(A.1) $$\mu\frac{V_j}{G_j}\cdot\frac{G_j}{(1-\sigma)\Delta_j}\cdot(1-\sigma)p_j^{-\sigma}=\mu\frac{\text{income}_j}{\Delta_j}p_j^{-\sigma}=\mu\frac{\text{income}_j}{\Delta_j}w_j^{-\sigma(1-\alpha)}\Delta_j^{-\sigma\alpha/(1-\sigma)}$$

where income_j is the sum of all factor income, namely, $w_1L^w/2+r_1T^w/2+\pi K^w/2=(w_1+r_1+\pi)/2$ and $\Delta_j\equiv G_j^{1-\sigma}$. To get an expression for the intermediated demand for a local variety (say in j=1), apply Sheppard's lemma on (3) and use the fact that $\tilde{w}_j^{1-\alpha}G_j^{\alpha}=p_j$ to get

(A.2) $$n\cdot\alpha a_{LM}\frac{x_1p_1}{G_1}\cdot\frac{G_1}{(1-\sigma)\Delta_1}\cdot(1-\sigma)p_1^{-\sigma}=n\cdot\alpha(1-\frac{1}{\sigma})\cdot\frac{\sigma\pi_1}{\Delta_1}w_j^{-\sigma(1-\alpha)}\Delta_j^{-\sigma\alpha/(1-\sigma)}$$

where the second expression stems from our choice of units for M's output and from (5). The value of local sales in region is then equal to the unit price of the typical variety produced in j=1 (namely, p_1) times the sum of the terms in the right hand sides of (A.1) and (A.2):

(A.3) $$\text{total sales}_1=\mu\frac{w_j+r_j+\pi}{2}\cdot\frac{1}{\Delta_j}\cdot w_j^{(1-\sigma)(1-\alpha)}\Delta_j^{\alpha}+n\alpha(\sigma-1)\pi_1\cdot\frac{1}{\Delta_1}\cdot w_j^{(1-\sigma)(1-\alpha)}\Delta_j^{\alpha}$$

Now, defining E_1 as total expenditure on manufacturing goods in region 1 (from both consumers and firms' expenditure on intermediates), then in the general case $n\in[0,1]$, E_1 and E_2 are equal to

(A.4) $$E_1=\mu\frac{w_1+r_1+\pi}{2}+\alpha(\sigma-1)n\pi_1,\quad E_2=\mu\frac{w_2+r_2+\pi}{2}+\alpha(\sigma-1)(1-n)\pi_2$$

and operating profits are equal to

(A.5) $$\pi_1=\frac{1}{\sigma}w_1^{(1-\sigma)(1-\alpha)}\Delta_1^{\alpha}\left(\frac{E_1}{\Delta_1}+\phi\frac{E_2}{\Delta_2}\right),\quad \pi_2=\frac{1}{\sigma}w_2^{(1-\sigma)(1-\alpha)}\Delta_2^{\alpha}\left(\phi\frac{E_1}{\Delta_1}+\frac{E_2}{\Delta_2}\right)$$

Substituting n=1 yields (6), (11) and (12) in the text. Finally, in this general case, there does not exist a simple closed form solution for the Δ's; rather, they are implicitly and recursively defined as:

(A.6) $$\Delta_1=n\Delta_1^{\alpha}w_1^{(1-\sigma)(1-\alpha)}+\phi(1-n)\Delta_2^{\alpha}w_2^{(1-\sigma)(1-\alpha)},\quad \Delta_2=\phi n\Delta_1^{\alpha}w_1^{(1-\sigma)(1-\alpha)}+(1-n)\Delta_2^{\alpha}w_2^{(1-\sigma)(1-\alpha)}$$

Note that at the limit n=1, these expressions do simplify to $\Delta_1=w_1^{(1-\sigma)}$ and $\Delta_2=\phi w_1^{(1-\sigma)}$.

Next, consider the full employment conditions for labour (7), which hold for b =½ and n=1. More generally, for $b\in(0,1)$ and $n\in[0,1]$, the conditions of full employment of labour (in value) are:

(A.7) $$\frac{w_1}{2}=(1-m)n(1-\alpha)(\sigma-1)\pi_1+\frac{b}{(1-b)}\frac{w_1^b}{2}$$

for region 1 and

$$\textbf{(A.8)} \qquad \frac{w_2}{2} = mn(1-\alpha)(\sigma-1)\pi_1 + (1-n)(1-\alpha)(\sigma-1)\pi_2 + \frac{b}{(1-b)}\frac{w_2^b}{2}$$

for region 2. The right hand side term in the expression above from illustrates that worker in 2 are split between those employed by region 1's multinationals, those employed by local firms and those employed in the traditional sector, respectively.

A.2. Welfare analysis at the symmetric equilibrium: Guide to Calculations

At the symmetric equilibrium (n=½), substitute n=½ and m=0 into (5)-(8) to get:

$$\textbf{(A.9)} \qquad \begin{aligned} & w_j(\varepsilon)\big|_{n=1/2} \equiv w_0 = \sqrt{\varepsilon_0}, \qquad \pi(\varepsilon)\big|_{n=1/2} \equiv \pi_0 = \frac{1}{\varepsilon_0 w_0}\frac{\varepsilon_0 - 1}{(\sigma-1)(1-\alpha)}, \\ & \Delta_j(\varepsilon)\big|_{n=1/2} \equiv \Delta_0 = \left(\frac{1+\phi}{2}\right)^{1/(1-\alpha)} w_0^{1-\sigma} \end{aligned}$$

and $r_0=1/w_0$ by (2), where ε_0 is the collection of parameters defined in (10). Since nominal rewards are unaffected by the level of trade freeness ϕ or communication costs ε, as (A.9) reveals, Δ_0 is a sufficient metric to assess welfare effects of $d\phi>0$ or $d\theta>0$. Indeed, as in (15), the consumer price index is a decreasing function of Δ, viz. $CPI_0=\Delta_0^{-\mu/(\sigma-1)}$. It is immediate by inspection that, *along the symmetric equilibrium*, everybody's welfare is increasing in trade freeness but unaffected by communication costs (because no offshoring is going on at this equilibrium).

A.3. Welfare analysis at the agglomerating equilibrium: Guide to Calculations

At the agglomerating equilibrium (n=1), when communication costs are below their prohibitive level ε_0, solving for nominal rewards using (5)-(8) yields:

$$\textbf{(A.10)} \qquad w_1(\varepsilon)\big|_{n=1,\,\varepsilon\le\varepsilon_0} = w_0\sqrt{\varepsilon}, \quad w_2(\varepsilon)\big|_{n=1,\,\varepsilon\le\varepsilon_0} = w_0\frac{1}{\sqrt{\varepsilon}}, \quad \pi(\varepsilon)\big|_{n=1,\,\varepsilon\le\varepsilon_0} = \pi_0\frac{(1+\varepsilon)}{2\sqrt{\varepsilon}}$$

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).

To evaluate the effect of ε and ϕ on real incomes, we need to get an expression for Δ_1 and Δ_2; see (15). From (8) and the expressions in footnote 10, we obtain:

$$\textbf{(A.11)} \qquad \Delta_1(\theta)\big|_{n=1,\,\theta\ge\theta_0} = w_0^{1-\sigma}\sqrt{\theta}, \quad \Delta_2(\theta)\big|_{n=1,\,\theta\ge\theta_0} = \phi w_0^{1-\sigma}\sqrt{\theta}$$

and $\Delta_j=\Delta_j(\theta_0)$ if $\theta<\theta_0$, j=1,2 (recall that $\theta\equiv\varepsilon^{1-\sigma}$ and $\theta_0\equiv\varepsilon_0^{1-\sigma}$). To address the effect of ϕ and ε on real labour incomes, substitute (A.10) and (A.11) into (15) and obtain (16) in the text. From these expressions, it is readily verified that residents in the South benefit from greater trade freeness, because the elasticity of ω_2 with respect to τ is equal to $-\mu$ at the agglomerating equilibrium. Conversely, residents in the North are unaffected by transportation costs—they don't pay any trade costs on imports and equilibrium nominal incomes are invariant in ϕ.

Consider next the effect of an improvement in communication technology on the real incomes of workers in each region. In the North, workers' nominal income falls as ε falls as per (16); this is because lower communication costs in effect reduces the segmentation of the two labour markets, thus making labour supply to the manufacturing sector more elastic. However, these workers also benefit from lower manufacturing prices because the cost saving of offshoring is passed onto consumers. Of course, the former effect affects the whole of their income, while the latter one affects only a fraction μ of their expenditure; hence the overall effect is negative (specifically, at the agglomerating equilibrium the elasticity of ω_1 with respect to ε is equal to $(1-\mu)/2$. By contrast, Southern workers' gain from improvement in communications is twofold: they benefit from both higher nominal wages *and* lower consumer good prices; specifically, (16) reveals that $\partial\ln(\omega_2)/\partial\ln\varepsilon=-(1+\mu)/2$.

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, as we establish in the text.

Using (A.10) and (A.11), we can also get the following expression for the capital owners' real incomes:

(A.12)
$$\left.\frac{\pi(\varepsilon)}{\text{CPI}_1(\varepsilon)}\right|_{n=1,\,\varepsilon\le\varepsilon_0}=\frac{\pi_0}{2w_0^{\mu}}(1+\varepsilon)\varepsilon^{-(1+\mu)/2},\quad \left.\frac{\pi(\varepsilon)}{\text{CPI}_2(\varepsilon)}\right|_{n=1,\,\varepsilon\le\varepsilon_0}=\frac{\pi_0}{2w_0^{\mu}}(1+\varepsilon)\varepsilon^{-(1+\mu)/2}$$

which are decreasing in ε for all ε in $(1,\varepsilon_0)$, as established in the text.

A.4. Symmetric equilibrium and the break point

The 'dispersed equilibrium' is said to be unstable if $d\pi_1/dn>0$ at $n=½$; see the low of motion associated to (9). (By the symmetry of the model, $d\pi_2/dn=-d\pi_1/dn$ at $n=½$.) 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 $n'\ge½$ 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 $dw_0=dw_1=-dw_2$, $d\pi_0=d\pi_1=-d\pi_2$, etc. This way we get a system in $d\ln\Delta_0$, dw_0, $d\pi_0$ and dE_0; using (A.4) to (A.8) and eliminating dE_0, this reads:

(A.13)
$$\begin{bmatrix}1-\alpha a_{LM}Z & 2a_{LM}[\alpha(\sigma-1)-\mu Z] & Z-\alpha\\ 0 & (\sigma-1)(1-\alpha)Z & 1-\alpha Z\\ -a_{LM} & a_{LM}+(1-a_{LM}\alpha-\mu)b/[\mu(1-b)] & 0\end{bmatrix}\begin{bmatrix}d\pi_0\\ dw_0\\ d\Delta_0/\Delta_0\end{bmatrix}=2\begin{bmatrix}a_{LM}\alpha Z\\ Z\\ a_{LM}\end{bmatrix}dn$$

where $Z\equiv(1-\phi)/(1+\phi)$ and dn is treated as exogenous; recall that $a_{LM}=1-1/\sigma$ and $b=½$ in the text (see (2)). 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 (A.13) is not particularly enlightening, even in the special cases $\alpha=\mu$ or b=½. The appendix CEPR discussion paper 5617 version of this paper discusses the properties of the 'Break interval' $\Phi^B\equiv[\phi_B,\phi^B]$ in more details.

A.5. **Ranking the break and sustain points**

As is well known, the ordering of the break and sustain points is crucial for the dynamics of the model. In the simple case b=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.[25]

Figure 4. Multiple equilibria and stability

Figure 4 plots n against ϕ. Conventionally, the stable, long-run equilibria of the system are depicted in plain lines whereas the unstable ones are depicted using dashed 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). In other words, history matters in this model.

A.6. **F&T (Fujita and Thisse 2006)**

In this section of the appendix, I extend the current framework to study Fujita and Thisse's case. Unlike intangible tasks in this paper, in F&T the product of the tasks conveyed offshore is impeded by transportation costs τ when it is shipped back into the parent country for consumption (in my model, it is shipped back by fibre optic cable). To see the implication of their assumption into my model, add trade costs τ to the frictions to offshoring ε; a direct implication of this assumption is to replace θ in (11) and (14) by $\theta\phi$; thus the definition of the sustain interval becomes:

(A.14) $$\Phi^S(\theta,[\cdot])\equiv\{\phi: f(\phi,\theta)\geq 0\},\quad f(\phi,\theta)\equiv\phi^{1-\alpha}(\theta\phi)^{1-\alpha}-s_E\phi^2-(1-s_E)$$

As a result, the costly shipping back of manufactured items should weaken the agglomeration forces; this intuition is confirmed by the term $\phi^{1-\alpha}$ (<1) in front of $(\phi\theta)^{1-\alpha}$ in the expression above; recall that this term is absent in the definition of the sustain interval in my model; see (14). Despite this difference, the qualitative positive properties of the sustain interval are the same. As to the normative ones, the benefits of residing in the core are reduced when the goods manufactured in the off-shored assembly lines have to be imported at the cost τ. Since strictly less than half of the assembly lines are ever being off-shored and production costs are lower in the periphery than in the core (net of trade and communication costs), it must be that the CPI in the North is lower at the agglomerating equilibrium than at the dispersed one. Thus, in this extension of the model, both the normative and positive implications are similar but lower in magnitude than those of the main

[25] Details of the calculations are 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.

model.

Figure 4. Multiple equilibria and stability