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ICT, ACCESS TO SERVICES AND WAGE INEQUALITY

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Abstract:

This paper discusses how information and communication technology (ICT) affects the quality and reach of consumer services. These services need to be provided locally, but consist of several components, some of which can be digitised and transmitted over long distances. A general equilibrium model is developed and numerical simulations in a stylised two-factor, two-region, centre-periphery setting are presented. Trade in intermediate services improves the quality of consumer services enormously in the periphery, but may reduce the quality at the centre. Trade in intermediate services also has a dramatic impact on skilled workers' wages in the periphery, both relative to unskilled workers in their own region and relative to skilled workers at the centre and leads to a more equal distribution of income both between the centre and the periphery and within the periphery.

JEL codes: D23, F12, F13, R12, R13.

Keywords: Trade in services, transaction costs, income distribution, ICT

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INTRODUCTION

Does diffusion of information and communication technology (ICT) eliminate the relevance of distance? Or does the communication revolution lead to increased centralisation? And are we witnessing a growing digital gap that leads to increased income disparities both within and across countries? These questions have given rise to a lively debate among scholars as well as policy makers and the general public. The low cost of storing and transmitting huge amounts of information allows people to access information, search for suppliers/customers, enter into contracts and exchange services without much regard for distance, goes the argument. However, the information economy is also characterised by rapid technological change, a high rate of innovation and frequent introduction of new goods and services that are customised and often have short product cycles. In this environment of complexity, some essential information cannot be digitised but is entrenched in relationships and communicated through direct interaction (Leamer and Storper, 2001).

This paper explores the impact of the use of ICT in information-intensive consumer services such as health, education, financial services or entertainment. Health and education are important for social and economic development, account for a relatively large share of national expenditure and employ a relatively large share of a community's skilled workforce, while access to such services is important for where people choose to live. Entertainment is already a global industry and the most popular performances and performers are known worldwide, largely thanks to ICT. Audio and video appear to be reasonably good substitutes for live performances while locally provided entertainment can be combined with entertainment provided from a distance for example in sports-cafés, internet-cafés etc. Tele-banking and e-banking have rendered personal visits to the bank unnecessary for most transactions and provided customers in suburban and rural areas with a wide range of financial services.

The question analysed in this paper is whether and to what extent we will see similar developments in social services such as health and education. How will for example access to information on the Internet and interactive learning programs affect a) the quality of education; b) the role of the local teacher/lecturer; c) the demand for her services; d) her relative income? These questions are closely related and are therefore analysed in a general equilibrium framework where consumer services are provided locally but ICT allows the local provider to source intermediate inputs from suppliers outside the region.

Distance learning has existed for more than a century using correspondence by mail, adding TV from the 1950s and the Internet from the 1990s. In the past distance learning constituted a relatively small market for adult learning. However, according to the OECD (2001) more than a third of the member countries' population between the age of 25 and 60 participated in adult education and training in 1998. Furthermore, demand for adult training is growing rapidly as the labour market becomes more flexible and technological progress creates the need for frequent skills upgrading and updating. Universities, regional colleges, large companies and a number of specialised suppliers have entered this market in recent years (OECD, 2003). In tertiary education e-learning, distance learning and traditional learning are increasingly mixed to provide more flexible course packages (OECD, 2001). In Norway small schools and schools in rural areas have fewer students per computer than large schools and schools in urban areas at all levels of education (Quale, 2000). This may indicate that ICT is used to compensate for less variety in the choice of courses, excursions etc. in smaller communities in addition to teaching computer skills.

In the health sector, local doctors and nurses make use of distant laboratories for analysing tests and hospitals outsource routine tasks such as the typing of patient journals to lower-cost regions or countries. Finland and Norway have adopted a national telemedicine policy and are investing heavily in infrastructure and training of personnel (WHO, 2002). There are also joint Nordic projects in the northern counties of Finland, Norway and Sweden. Monitoring patients at home, providing health information on digital text-TV, supporting the parents of children with various chronic diseases, securing electronic links between patients and their practitioners, mental health related online discussion groups and many more applications have been developed and introduced (Norwegian Center for Telemedicine, 2003). Finland, Norway and Sweden are all sparsely populated, particularly in the northern counties and the telemedicine projects aim at providing quality services to these remote areas.

An additional recent example of how ICT can enhance health services and reduce the relevance of distance is quoted from the WHO (2003): "On 17 March 2003, WHO called upon 11 laboratories in 9 countries to join a collaborative multi-center research project on SARS diagnosis. This network takes advantage of modern communication technologies (e-mail; secure web-site) to share outcomes of investigation of clinical samples from SARS cases in real time. Daily assessment of research results supports immediate refinement of investigative strategies and permits instant validation of laboratory findings."

The rest of the paper is organised as follows: Section two briefly discusses related previous research. Section 3 develops the model in a closed economy and analyses its properties. The model is extended to a two-region setting with exogenously declining (iceberg) transport costs in section 4, where I also present numerical simulations. I take as given that there are communication networks in place in the same way as trade models take as given that adequate transport infrastructure exists. Section 5 summarises and concludes.

RELATIONS TO PREVIOUS RESEARCH

There is a growing body of research on the relationship between transaction costs, trade and location of firms.[1] A major finding in this literature is that economic activities in which vertical linkages between firms are important tend to cluster. Furthermore, when transport costs are significant and labour immobile between regions, a centre-periphery pattern is formed where the centre pay the highest wages even when the regions have the same factor endowments. The model developed in this paper adds more realism to the standard geography model by accommodating two factors of production, a non-traded consumer services sector and a fixed cost of entering a distant market. I show that in this setting differentiated services will agglomerate in one region only if the regions are asymmetric. In addition the introduction of two categories of labour allows me to analyse income distribution *within* economies as well as between economies.

A relatively early analysis of trade in business services over the Internet is a study by Harris (1998). He applied a small open economy setting where prices are exogenously given in the world market and where digitised information is a perfect substitute to directly communicated information. He shows that the skills premium increases with skilled labour supply and that the location of business services firms is indeterminate. The general equilibrium model developed here in contrast, allows prices to adjust to changing demand and trade costs. Then the skills premium declines with relative skilled labour supply and the industrial structure in each region is determined, although the model has multiple solutions.

Several studies have found that sunk costs of entering export markets are significant (Roberts and Tybout, 1997; Bernard and Bradford Jensen, 2001). Entering a distant services market through arms-length trade involves fixed costs that cover software, translation, organisational changes and skills upgrading.[2] The cost of software for distance learning for example can be between $16 000 and $150 000 dollars per year (Anderson, 2003). Venables (1994) provided an analytical framework for analysing the impact of such fixed costs, introducing them in a Dixit-Stiglitz type model with symmetric countries and one production factor. He shows that trade liberalisation, modelled as a decline in variable iceberg trade costs increases the proportion of trading firms and reduces the total population of active firms. The latter effect is due to the fixed cost of exporting, which increases the break-even scale of exporting firms. The model developed here extends Venables' framework in order to assess income distribution and welfare implications in asymmetric markets.

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[1] See for example Fujita, Krugman and Venables (1999) for a comprehensive study of these issues.

[2] See Bresnahan et. al. (2002) for a discussion of organisational restructuring following introduction of ICT.

To summarise, the main contribution of this paper is to provide a realistic framework for analysing how ICT affects reach and quality of essential services, income distribution and welfare in small communities. It shows that agglomeration does not arise spontaneously if countries initially have the same factor endowments, and it spells out the trade-off between universal services and variety of services. Finally, as opposed to most models of trade where scale matters, it is the small trading partner that gains the most from trade, while welfare in the large trading partner may be reduced compared to autarky.

THE MODEL - AUTARKY

The economy has three sectors, labelled X,Y and Z. The X-sector produces complex consumer services and its technology is assemblage of differentiated intermediate service inputs. These inputs are produced by the Z-sector, which consists of *n* firms each producing one service using skilled labour only. I apply the standard Dixit-Stiglitz framework where there is a fixed cost involved in setting up each differentiated service. The Y-sector represents an aggregation of perfectly competitive industries producing goods and services employing both unskilled and skilled workers. The number of unskilled and skilled workers in the economy is given exogenously. Equations (1)-(3) describe the technology in the three sectors:

$$Y = L^{\alpha} S_y^{1-\alpha} \tag{1}$$

$$X = \left[\sum_{i=1}^{n} z_i^{\rho} \right]^{1/\rho} \tag{2}$$

$$z_i = f + \frac{1}{b} s_i \tag{3}$$

Equation (1) is a standard Cobb-Douglas constant returns to scale production function where L represents unskilled and S skilled labour. Equation (2) represents the familiar Dixit-Stiglitz framework where production increases both with the quantity of each input, *z*, and the number of inputs, *n*. The elasticity of substitution between any pair of intermediate services is given by $\varepsilon \equiv 1/(1-\rho)$ and is assumed to be larger than unity. Each firm in the Z-sector produces its service subject to an increasing returns technology given by equation (3) where *f* is a fixed cost in terms of skilled labour. As usual in Dixit-

Stiglitz models, only one firm produces each input and each firm produces only one product. The number n thus represents both the number of firms in the Z-sector and the number of differentiated services being supplied to the X-sector. I apply the standard mark-up price rule:

$$q = \frac{bv}{\rho} \tag{4}$$

where v is the unit cost of skilled labour. I further assume that there is free entry of firms into the Z-sector. Firms will in that case enter until the profit of the last firm entering is zero. The non-zero profit condition is the same for all firms due to symmetry and reads $q = fv/z + bv$. Inserting this in (4) yields the unique size of the service producing firm:

$$z = \frac{f}{b}\frac{\rho}{(1-\rho)} \tag{5}$$

The X-sector is competitive, implying marginal cost pricing:

$$P_x = qn^{(\rho-1)/\rho} = \frac{bv}{\rho}n^{(\rho-1)/\rho} \text{ where } \quad \frac{\delta P_x}{\delta n} < 0; \frac{\delta^2 P_x}{\delta n^2} > 0 \tag{6}$$

Consumers have identical preferences described by a Cobb-Douglas utility function, which implies that consumers spend a fixed share of their income on each good:

$$U = Y^{\sigma} X^{(1-\sigma)} \tag{7}$$

Market equilibrium in the X-sector can now be determined by the following demand and supply conditions:

$$P_x X = (1-\sigma)(wL + vS) \text{ and } X = n^{1/\rho}\frac{f\rho}{b(1-\rho)} \tag{8}$$

We finally turn to the labour market in order to close the model. Employment of skilled labour in the Z- and Y-sectors, and the skilled labour market equilibrium are given by:

$$S_z = n(f + bz) = \frac{nf}{1-\rho} \tag{9}$$

$$S_y = \frac{(1-\alpha)P_y Y}{v} = \frac{(1-\alpha)\sigma(wL + vS)}{v} \tag{10}$$

$$S_y + S_z = S \tag{11}$$

Inserting (9) and (10) in (11), using (8) yields the allocation of skilled workers between sectors Y and Z:

$$S_y = \frac{(1-\alpha)\sigma}{1-\alpha\sigma} S; \quad S_z = \frac{(1-\sigma)}{1-\alpha\sigma} S \tag{12}$$

Allocation of skilled labour depends on the technology in the Y-sector and consumer preferences. The more skills intensive the Y-sector and the higher the income share consumers spend on Y-products, the less skilled workers are employed in the Z-sector. The number of services produced in the economy is determined by (9) and (12):

$$n = \frac{(1-\rho)}{f} \frac{(1-\sigma)}{(1-\alpha\sigma)} S \tag{13}$$

The number of Z-sector firms is larger the larger the stock of skilled workers, the smaller the fixed cost of producing services and the smaller the elasticity of substitution between producer services in the assembly industry. The intuition behind the latter point is that when producer services can be easily substituted, there is little to gain from having additional varieties. The linkage between the elasticity of substitution in the X-sector and the number of firms in the Z-sector is an externality between the two sectors. However, since ρ also appears in the mark-up rate on the marginal cost of z, the externality is internalised by the market and it is therefore termed a pecuniary externality.

The skills premium, defined as the income earned by skilled workers over and above that of unskilled workers, can be found by using (10) and (12).

$$\frac{v}{w} = \frac{(1-\alpha\sigma)}{\alpha\sigma}\frac{L}{S} \tag{14}$$

We notice that the skills premium declines with the relative endowment of skilled labour, but it does not depend on the size of the total labour force as long as the ratio L/S is constant. In order to assess the relation between market size and real income, I deflate the wage rates by the price index $P = \left(P_x/\sigma\right)^{\sigma}\left(P_y/(1-\sigma)\right)^{1-\sigma}$ where P_y is the marginal cost in the Y-sector given by $P_y = \left(w/\alpha\right)^{\alpha}\left(v/(1-\alpha)\right)^{1-\alpha}$ and P_x is given by (6). Setting unskilled labour as the numeraire (w = 1), using (13) and (14) and collecting parameters, the price index reads:

$$P = \Psi\left(\frac{L}{S}\right)^{1-\alpha\sigma} S^{(\rho-1)(1-\sigma)/\rho} \tag{15}$$

where Ψ is a positive constant. We notice that the price index declines with a proportionate increase in L and S. This is because an increase in the absolute number of skilled workers increases the number of differentiated intermediate services (equation 13) and thus lowers the price of X (equation 6). Consequently real wages increase while the skills premium remains constant. A proportionate increase in the stock of skilled and unskilled labour can be interpreted as the integration of two regions with the same relative factor endowments. If the two regions differ in size, the smaller region will experience a larger increase in the variety of intermediate services assembled in the X-sector, P_x will decline more in the smaller region and real wages will catch up with the larger region. Full integration of the services markets is, however, not technologically feasible, and I therefore analyse the impact of partial integration in the next section.

THE TWO-REGION CASE

In this section I explore the welfare and income distribution effects of trade between two regions labelled Big and Small, which can be interpreted as a rural and an urban region within a country, a small and a large country or a rich and a poor country. In all cases the market size is defined by the size of the labour force.[3] Y-sector goods are freely traded between the two regions. I make the usual assumption that labour is perfectly mobile within a region, but cannot move between regions. As discussed in the introduction, consumer services most often are produced and consumed at the same time and in the same space, and the X-sector is therefore modelled as non-tradable. The two regions have the same production technology in the Y and Z-sectors described by equations (1) and (3) respectively. Z-sector services can be digitised and transmitted between the two regions subject to an iceberg transport cost, $t > 1$, reflecting the loss of information when digitised. In order to enter the other region's market, the Z-sector service firm needs to incur a fixed trade cost denoted g that comes on top of the fixed costs f of setting up a firm. Some service providers may choose to export, while others may choose to service the local market only. I denote the share of Z-sector firms that makes the investment g and exports, θ, where $0 \leq \theta \leq 1$. The share is endogenously determined in the model. The X-sector now assembles both local and imported differentiated services. All variables related to Small are denoted with an asterisk. Equation (3) applies to the service providers that service the local market only, while the service exporters' production function reads:

$$z_i = f + g + \frac{1}{b} s_i \tag{16}$$

There is free entry in both markets, such that the non-profit condition for the exporting firm reads $q = (f + g)v/z + bv$ and the unique size of the exporting service firm becomes:

$$z = \frac{(f + g)}{b} \frac{\rho}{(1 - \rho)} \tag{17}$$

Obviously, the exporting firm is larger than the firm producing for the local market only. There are now two possible types of producer service firms in each market; firms servicing the home market only, and exporting firms servicing both regions. The market clearing condition for each type of firm reads:

[3] In poor countries the labour force may be interpreted as those working in the formal sector, or efficient labour.

$$\frac{q^{-\varepsilon}}{P_x^{1-\varepsilon}}E = \frac{f\rho}{b(1-\rho)} \tag{18a}$$

$$\frac{q^{-\varepsilon}}{P_x^{1-\varepsilon}}E + \frac{q^{-\varepsilon}\tau}{P_x^{*(1-\varepsilon)}}E^* = \frac{(f+g)\rho}{b(1-\rho)} \tag{18b}$$

$$\frac{q^{*-\varepsilon}}{P_x^{*1-\varepsilon}}E^* = \frac{f\rho}{b(1-\rho)} \tag{18c}$$

$$\frac{q^{*-\varepsilon}}{P_x^{*1-\varepsilon}}E^* + \frac{q^{*-\varepsilon}\tau}{P_x^{(1-\varepsilon)}}E = \frac{(f+g)\rho}{b(1-\rho)} \tag{18d}$$

The left-hand side of the equations represents demand facing each firm where E represents the X-sector's expenditure on intermediates. The cost index of the X-sector is given by $P_x = \left[nq^{1-\varepsilon} + \theta^* n^* \tau q^{*1-\varepsilon}\right]^{1/(1-\varepsilon)}$ and $P_x^* = \left[\theta n \tau q^{1-\varepsilon} + n^* q^{*1-\varepsilon}\right]^{1/(1-\varepsilon)}$. I define $\tau = t^{1-\varepsilon}; 0 < \tau < 1$, which makes it more convenient to make graphical presentations for the full range of transport costs from unity to infinity. Note that all relevant information is maintained during transport when $\tau = 1$, while no relevant information is maintained during transport when $\tau = 0$. The price of a service sold to the other region is multiplied by τ, in order to account for losses during digitisation and transmission. From (18) we see that an increase in expenditure or an increase in the cost index shift the demand curve to the right. Furthermore, since a change in q affects the cost indices, a movement *along* the demand curve will eventually also shift it. The right-hand side of the equations represents the vertical break-even supply curve of each company and is further to the right the larger is the fixed costs ($f + g$).

Inspection of the four market clearing conditions reveals that all of them can be satisfied simultaneously only when $\tau = g / f$. This is a case that could only occur by coincidence, and I therefore disregard the possibility that all four types of firms can coexist in the two regions[4]. We are then left with five possibilities:

1) $\theta^* = 1$ and $\theta = 1$; all firms in both regions export;
2) $\theta^* = 1$ and $0 \leq \theta \leq 1$; all firms in Small export while some firms in Big export;
3) $\theta^* = 0$ and $0 \leq \theta \leq 1$; no firms in Small export while some firms in Big export;

[4] There is, however, a possibility that $\tau = \tau(g)$, a possibility I leave for future research.

4) $0 \le \theta^* \le 1$ and $\theta = 1$; some firms in Small export while all firms in Big export;

5) $0 \le \theta^* \le 1$ and $\theta = 0$; some firms in Small export while no firm in Big export.

When the difference in market size of Big and Small is large, it turns out that case 4 where all firms in Big export is only economically feasible for a narrow range of τ at low levels of g. The distant market is simply too small for all firms in Big to recover the fixed cost of entering when they compete with local firms that have not incurred this cost. Firms in Big will have incentives to break out of autarky at a lower transport cost than firms in Small if Big is only slightly more abundant in skills (see equation 27 below). Case 5 is therefore unlikely to occur. We are then left with case 1, 2 and 3, which I explore in more detail. Y-sector goods are freely traded and fetch the same price in both regions, which yields the equilibrium condition:

$$\left(\frac{w}{\alpha}\right)^{\alpha}\left(\frac{v}{1-\alpha}\right)^{1-\alpha} = \left(\frac{w^*}{\alpha}\right)^{\alpha}\left(\frac{v^*}{1-\alpha}\right)^{1-\alpha} \text{ or } \left(\frac{w}{w^*}\right)^{\alpha} = \left(\frac{v^*}{v}\right)^{1-\alpha} \tag{19}$$

Equation (19) also tells us that relative wages of skilled and unskilled workers move in the opposite direction. Employment of skilled labour in the producer service sector in Big reads:

$$S_z = (1-\theta)\frac{nf}{1-\rho} + \theta\frac{n(f+g)}{1-\rho} = \frac{n(f+\theta g)}{1-\rho} \tag{20}$$

and equivalently for Small. The equilibrium condition in the skilled labour market is then found using (20), (10) and the first order conditions for profit maximisation in the final goods sector $L = \alpha P_y Y / w$:

$$\frac{n}{n^*} = \frac{\left(\alpha v S - (1-\alpha) w L\right)}{\left(\alpha v^* S^* - (1-\alpha) w^* L^*\right)} \frac{(f+\theta^* g) v^*}{(f+\theta g) v} \tag{21}$$

Equation (21) shows that the relative number of Z-sector firms is negatively related to the relative shares of exporting firms, which follows from the fact that exporting firms are larger. Balance in the market for goods produced by the Y-sector can be expressed as follows: $P_y(Y+Y^*)=\sigma(wL+vS+w^*L^*+v^*S^*)$ which, reorganising and using the first-order condition mentioned above, can be expressed as:

$$\frac{1-\alpha\sigma}{\alpha\sigma}=\frac{vS+v^*S^*}{wL+w^*L^*} \quad \text{or} \quad \frac{v^*}{w^*}=\frac{(1-\alpha\sigma)}{\alpha\sigma}\frac{L^*}{S^*}\frac{\left(w/w^*+1\right)}{\left(v/v^*+1\right)} \tag{22}$$

The skills premium now not only depends on local factor endowments but also on endowments relative to the trading partner, which is reflected in relative wages. In order to solve the equation system, I first define relative wages and the relative number of services in the two regions as follows: $n/n^*\equiv\tilde{n};\ v/v^*\equiv\tilde{v};\ w/w^*\equiv\tilde{w};\ L/L^*\equiv\tilde{L};\ S/S^*\equiv\tilde{S}$. Using these definitions equations (19), (21) and (22) can be written as:

$$\tilde{w}=\tilde{v}^{(\alpha-1)/\alpha} \tag{23}$$

$$\tilde{n}\tilde{v}=\frac{(f+\theta^*g)}{(f+\theta g)}\frac{\left[(1-\alpha\sigma)\left(\tilde{w}\tilde{L}+1\right)\tilde{v}\tilde{S}-(1-\alpha)\sigma\left(\tilde{v}\tilde{S}+1\right)\tilde{w}\tilde{L}\right]}{\left[(1-\alpha\sigma)\left(\tilde{w}\tilde{L}+1\right)-(1-\alpha)\sigma\left(\tilde{v}\tilde{S}+1\right)\right]} \tag{24}$$

In the following I consider each of the three feasible cases.

ALL FIRMS IN BOTH REGIONS EXPORT

When all firms in both regions export, equilibrium in the intermediate services markets requires that (18b) and (18d) are satisfied simultaneously, which yields:

$$\left(\frac{v}{v^*}\right)^{-\varepsilon}=\frac{\tau E/E^*+\left(P_x/P_x^*\right)^{1-\varepsilon}}{E/E^*+\tau\left(P_x/P_x^*\right)^{1-\varepsilon}} \quad \text{or expressed in terms of the endogenous variables:}$$

$$\frac{\left(1-\tilde{v}^{-\varepsilon}\tau\right)}{\left(\tilde{n}\tilde{v}^{1-\varepsilon}\tau+1\right)}\frac{\left(\tilde{n}\tilde{v}^{1-\varepsilon}+\tau\right)}{\left(\tilde{v}^{-\varepsilon}-\tau\right)}=\frac{\alpha\sigma\left(\tilde{v}\tilde{S}+1\right)\tilde{w}\tilde{L}+(1-\alpha\sigma)\left(\tilde{w}\tilde{L}+1\right)\tilde{v}\tilde{S}}{\alpha\sigma\left(\tilde{v}\tilde{S}+1\right)+(1-\alpha\sigma)\left(\tilde{w}\tilde{L}+1\right)} \tag{25}$$

The market equilibrium is given by (23), (24), (25) setting $\theta = \theta^* = 1$. It can immediately be observed from (25) and (23) that if $\tau = 1$ (no information is lost during trade), factor prices are equalised, no matter what the relative endowments are. Furthermore in the symmetric case where $\widetilde{S} = \widetilde{L} = 1$, the solution to the model is $\widetilde{n} = \widetilde{v} = \widetilde{w} = 1$ for all $\tau \in (0,1)$. This is in contrasts to often cited models of trade in intermediate differentiated products subject to transport costs, where a core-periphery structure forms spontaneously when transport costs have reached a critical level (e.g. Krugman and Venables, 1995). In a setting with non-traded consumer services and two factors of production – a setting I would argue is more realistic than the Krugman-Venables model - agglomeration of intermediate services in one market will only occur if the markets are asymmetric.

In the general asymmetric case the system is uniquely determined, but it is not possible to find an analytic expression. I therefore present stylised numerical solutions to the model. Rural areas typically have a lower ratio of skilled to unskilled labour than urban areas, although the difference may not be very large in rich countries (Glaeser and Maré, 2001). In a North-South trade context, however, the difference in relative endowments of skills is substantial, and comparative advantage for skills intensive services also enters the picture. I first study the scale effect by solving the model when Big and Small have the same relative factor endowments, but Big is ten times larger. Next I study comparative advantage, setting $\widetilde{S} = 20; \widetilde{L} = 10$.[5] The other key exogenous variables of interest are the fixed cost of entering a distant market and the transport costs τ, which may also be interpreted as a digital disadvantage ratio.

In the first case Big has 10 times as many Z-sector firms as Small in autarky (see equation 13). The marginal change in X and P_x from an additional variety of Z is therefore largest in Small (equation 6). When all firms in both regions incur the fixed cost g and start to export, the immediate effect is a shake-out of Z-sector firms such that the remaining firms are able to break even when fixed costs have increased from f to $f + g$. In the numerical example where $\widetilde{S} = 10; \widetilde{L} = 10$, the total number of firms in the two regions combined drops from 96 in autarky to 68 with trade. Big actually lose more than 20 percent of its variety of intermediate services while the number of varieties available increases almost 8-fold in Small compared to autarky. The initial reduction in the total number of firms is obviously larger the larger is g. In addition the larger is g the lower t must be before firms start to export. The partial impact of the change in the number of assembled services is an increase in P_x in Big and a decline in the equivalent price in Small, shifting demand facing each firm to the right in Big and to the left in Small.

[5] The model is simulated in GAMS software. Parameter values in all simulations are the following: α = 0.7, ρ = 0.75, σ = 0.6, f = 1, g = 0.4. The qualitative results are robust to changes in the parameter values.

What happens when transport costs decline further can be seen by differentiating the left-hand side of (18b) and (18d) with respect to τ. This yields:

$$\frac{\delta z}{\delta\tau} = -q^{-\varepsilon} n^{*} q^{*(1-\varepsilon)}\left[\frac{E}{P_x^{2(1-\varepsilon)}} - \frac{E^{*}}{P_x^{*2(1-\varepsilon)2}}\right], \quad \frac{\delta z^{*}}{\delta\tau} = q^{*-\varepsilon} n q^{(1-\varepsilon)}\left[\frac{E}{P_x^{2(1-\varepsilon)}} - \frac{E^{*}}{P_x^{*2(1-\varepsilon)}}\right] \tag{26}$$

With strongly asymmetric markets we would expect the term in the square brackets to be positive for all levels of τ, and the demand effect (before adjustment in prices and entry/exit of Z-sector firms) is positive in Small and negative in Big. The subsequent adjustments are complex and involve the following elements. i) The shift in demand facing Z-sector firms after a change in τ affects the price q. ii) A change in q affects the cost indices P_x and P_x^* which shifts the demand curve facing each Z-sector firm. iii) A change in P_x and P_x^* affects demand for X and thus E, which shifts demand facing Z-sector firms in the opposite direction as under the previous point. iv) If sufficiently large, shifts in demand facing each Z-sector firms create space for new entrants in the Z-sector, or induce exits from the sector, which in turn affect P_x and P_x^*. The difference in responses to changes in prices between the two regions depends on the level of τ. The smaller is τ, the larger is the difference. At low levels of τ there is a net decline in demand facing each firm in Small and a net increase in demand facing each firm in Big, indicating that the impact of the change in P_x and P_x^* is larger than the impact of the change in expenditure. The shift in demand is sufficiently large to induce new firms to enter in Big, and existing firms to exit in Small. However, when τ reaches a critical level, the relative importance of the two forces is reversed.

Figure 1 depicts the adjustments to changes in τ in the Z-sector, while Fig. 2 depicts the corresponding adjustments in the labour market, both in the case where $\widetilde{S} = 10; \widetilde{L} = 10$. The transport cost parameter τ is given along the horizontal axis, and transport costs decline as we move from the left to the right. Relative number of services produced in each region is depicted on the right-hand vertical axis, while import penetration (as share of total real purchases) is given on the left-hand vertical axis.

As transport costs decline from infinity to unity (τ increases from 0 to 1), the transport cost advantage of being close to the largest market outweighs the lower wages of skilled workers in the small market, and Z-sector firms will agglomerate in Big. For the parameter chosen here, the effect is not dramatic – the relative number of firms increases from 10 in autarky to about 11.75 at its peak. As transport costs decline further from this peak, their relative importance decline and firms start entering the Small market in order to benefit from its labour cost advantage. Notice, however, that import penetration in both regions keeps rising even as the relative number of intermediate inputs produced in

Big starts declining. The reason for this is that the relative price of imported intermediates, (inclusive of transport costs) declines, and the quantity of each imported intermediate input increases (see equations 18). Import penetration in Big increases to about 9 percent when transport costs are eliminated, while imports account for more than 90 percent of the market in Small if transport costs are eliminated.

Figure 1: Adjustment in the services market

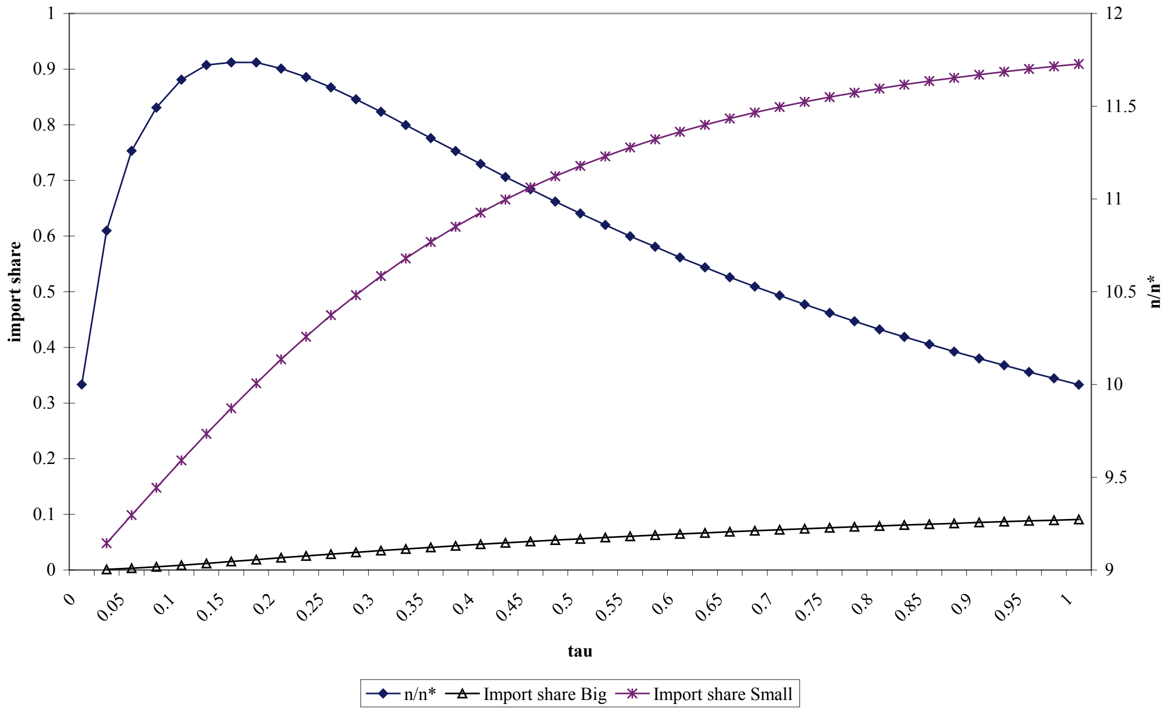
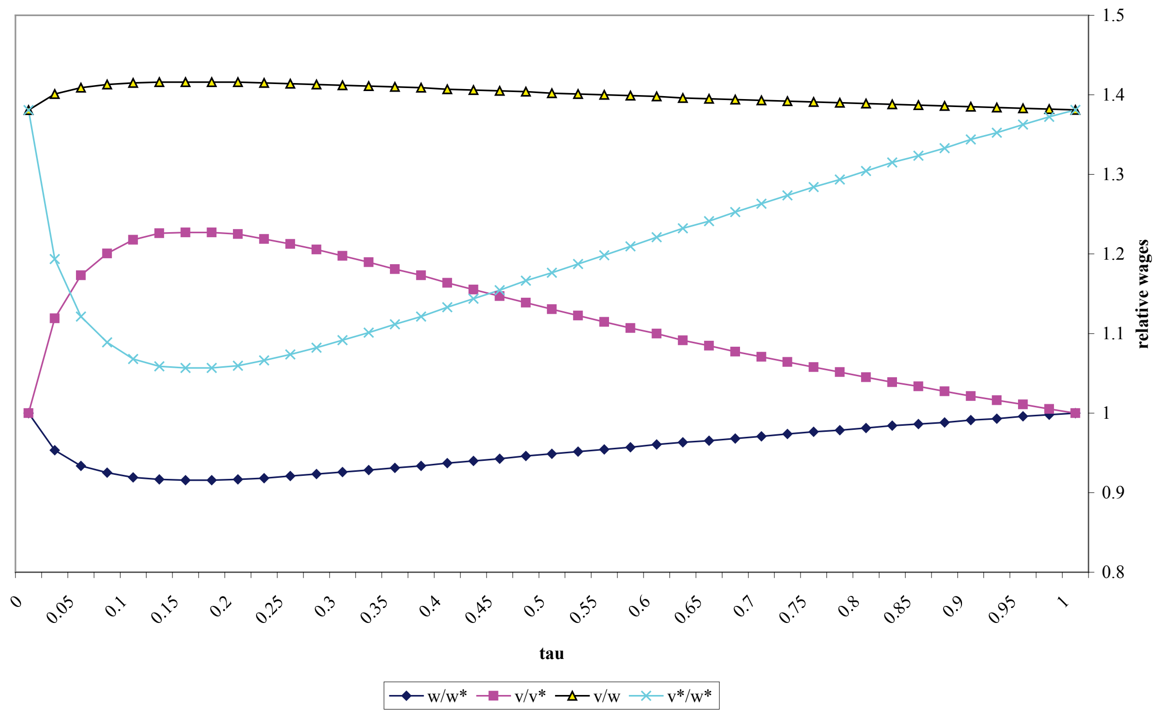


Figure 2 shows that the burden of adjustments induced by integration of intermediate services markets mainly falls on skilled labour in Small. In the segment of the graph where Z-sector firms agglomerate in Big, there is a dramatic fall in the skills premium of skilled workers in Small, reflecting the exit of Z-sector firms and a reallocation of skilled workers to the Y-sector. Skilled workers in Small also fall behind their colleagues in Big, while unskilled workers in Small gain both relative to skilled workers in Small and relative to unskilled workers in Big. Income distribution becomes more equal in Small, while it does not change much in Big. The price of consumer services in Small declines by about 29 percent as τ increases from zero to 0.25, and by another 14 percent as τ increases from 0.25 to 0.5. At high transport costs the assemblage of X-services contains only small "tastes" of each imported intermediate input, but yet these inputs can improve quality and reduce costs substantially.

Figure 2: Adjustment in the labour market



I also solved the model for the case where $\widetilde{S} = 20; \widetilde{L} = 10$ and Small hence has a comparative advantage for the Y-sector. The results were qualitatively quite similar to the ones presented in Figs. 1 and 2. However, although the relative number of Z-sector firms followed a similar pattern as in the previous case, $\widetilde{n}$ remained above its autarky level even when τ =1 because of Big's comparative advantage in skills-intensive services. In addition the skills premium in autarky was higher in Small than in Big, due to the relative scarcity of skills. The adjustment on the part of skilled workers in Small was therefore even more immense, although factor prices are equalised at τ =1 also in this case.

The equilibrium in this section was implicitly based on the assumption that there is a coordinated entry into the other region's market. If we instead look at each individual firm's decision whether to enter the other region or not when the initial situation is autarky, the outcome will be different. The individual firm will not take the impact of its own actions on prices into account. Thus, a firm in Big will break out of autarky and start exporting to Small if its mark-up on sales to Small covers the fixed cost $g; bq^{-\varepsilon}\tau E^* / \rho P_x^{*1-\varepsilon} > g$ where the autarky price index in Small is $P_x^{*1-\varepsilon} = n^* q^{*1-\varepsilon}$. Inserting the price index in the entry condition, we get: $\widetilde{v}^{-\varepsilon} b \tau E^* / \rho n^* q^* > g$. E^*/n^*q^* represents purchases per local firm in Small in autarky and is given by equation (5), which yields: $\tau > \widetilde{v}^{-\varepsilon}(1-\rho)g / f$. We have from (14) that in autarky the relative wages of skilled workers are $\widetilde{v} = \widetilde{w}\widetilde{L} / \widetilde{S}$ and relative wages of unskilled workers (when measured in physical units of sector Y products) are $\widetilde{w} = \left(\widetilde{S} / \widetilde{L}\right)^{1-\alpha}$. The condition for the first firm in Big to break out or autarky is then given by (27a) and the equivalent for the first firm in Small by (27b):

$$\tau > \left(\frac{\widetilde{L}}{\widetilde{S}}\right)^{\alpha\varepsilon} \frac{g}{\varepsilon f} \tag{27a}$$

$$\tau > \left(\frac{\widetilde{L}}{\widetilde{S}}\right)^{-\alpha\varepsilon} \frac{g}{\varepsilon f} \tag{27b}$$

The higher the fixed costs of entering the distant market, the lower the transport cost must be in order for traders to enter the market. If $\widetilde{S} = \widetilde{L}$, the entry barriers are the same in the two regions, while (27b) is more restrictive than (27a) when $\widetilde{S} > \widetilde{L}$.[6] The findings here are similar to those of the Big-push literature (e.g. Murphy, Shleifer and Vishny, 1989). The trading equilibrium is sustained in the market once it is established, but no single firm would break out of autarky on its own before transport costs have come sufficiently down. Coordinated entry may be encouraged by regional or development policy measures aiming at providing rural areas or developing countries with adequate services. In the event of significant entry costs this will, however, reduce variety of intermediate services in Big.

SOME FIRMS IN BIG EXPORT

When some firms in Big export, there are two possible trade regimes; either all (case 2) or none (case 3) firms in Small export. By implication, as soon as one firm in Small finds it profitable to enter the Big market, all firms in Small will follow suit and the trade regime will switch from 3 to 2. It is therefore useful to identify the conditions under which this switch of trade regimes occurs. A firm in Small will break even in the Big market even if it enters on its own when $bq^{*-\varepsilon}\tau E / \rho P_x^{1-\varepsilon} > g$. $P_x^{1-\varepsilon} = nq^{1-\varepsilon}$ when only local firms serve the Big market. Inserting the price index in the entry condition, we get $\widetilde{v}^{\varepsilon} b\tau E / \rho nq > g$. Relative skilled wages are given by (29) below, while *E/nq* represents purchases per local firm in Big and is given by equation (5). This yields the condition:

$$\tau \geq \frac{g}{f}\left(\frac{1}{\varepsilon}\right)^{1/2} \tag{28}$$

[6] For the parameters and chosen in our numerical simulations individual firms in Big and Small will break out of autarky at $\tau = 0.1$ in the case of equal relative factor endowments and firms in Big will break out of autarky at $\tau = 0.014$ and firms in Small for $\tau = 0.7$ when $\widetilde{S} = 20, \widetilde{L} = 10$.

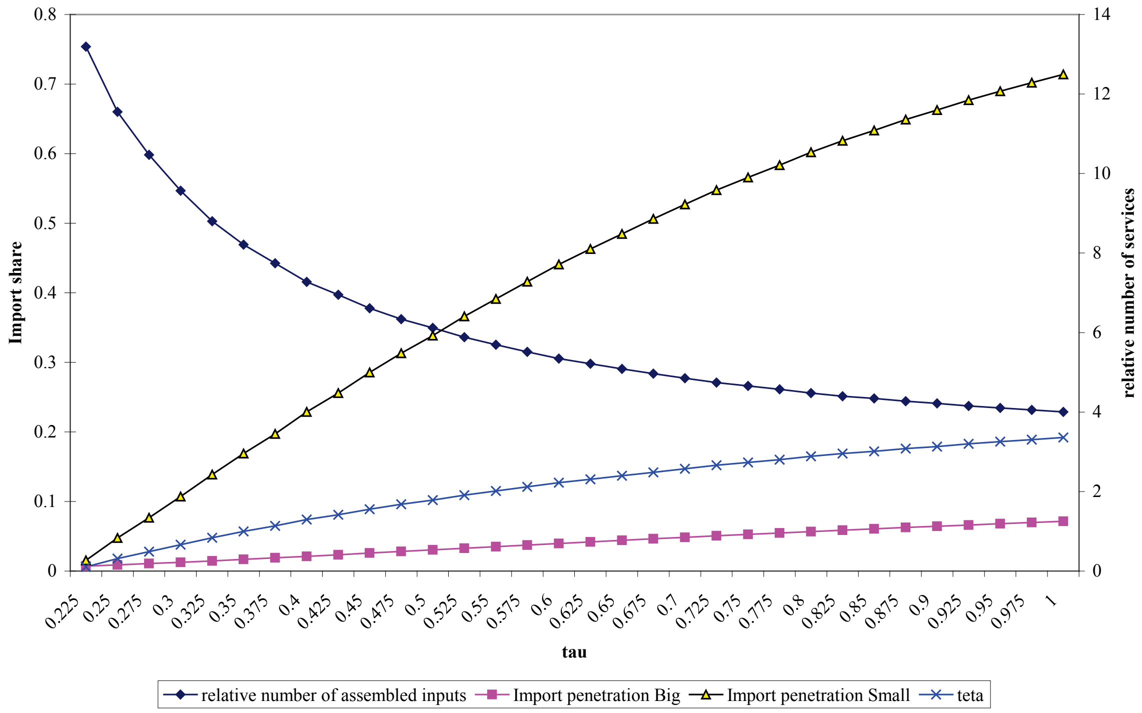
In our numerical example, the right-hand side of the expression is 0.025, and thus the trade regime 3 breaks down very soon. Condition (28) is more restrictive the higher is *g* and the lower is ε, reaching 0.375 when $g = 1.5$ and $\varepsilon = 2$. The trade regime is thus not irrelevant, but for consideration of space I limit the discussion in this section to case 2 and relative factor endowments are the same in both regions. When all firms in Small and some firms in Big export, $\theta^* = 1$ and $0 \leq \theta \leq 1$. I insert these values in equation (24). Equation (23) still applies, while relative wages are determined from (18a), (18b) and (18d) which yield:

$$\tilde{v} = \left[\frac{(g+f)\tau}{g+f\tau^2}\right]^{1/\varepsilon} \; ; \quad \tilde{w} = \left[\frac{(g+f)\tau}{g+f\tau^2}\right]^{(\alpha-1)/\alpha\varepsilon} \tag{29}$$

We note that relative wages now depend on the fixed costs, but not on the share of firms that engage in exports. The relative wage of skilled workers increases with τ (transport costs decline) and peaks at $\left[(g/f)^{1/2}(g+f)/2g\right]^{1/\varepsilon}$ when $\tau = (g/f)^{1/2}$ and declines with τ thereafter. The relative wages of unskilled workers follow an opposite path and declines with τ and bottoms out at $\left[(g/f)^{1/2}(g+f)/2g\right]^{(\alpha-1)/\alpha\varepsilon}$ when $\tau = (g/f)^{1/2}$. The development is thus similar to that depicted in Fig. 2. We also notice that $\tilde{v} > 1$ when $g/f < \tau$, and that if $g < f$, there is a reversal of relative factor prices between the two regions at $g/f = \tau$. If on the other hand $g > f$, skilled workers in Small will always earn at least as much as their colleagues in Big. We finally notice that for $\tau = 1$, $\tilde{w} = \tilde{v} = 1$ and thus relative income converges as transport costs come down. The relative number of Z-sector firms and the share of such firms exporting in Big can be found numerically by combining (18a), (18b), (24) and (29).

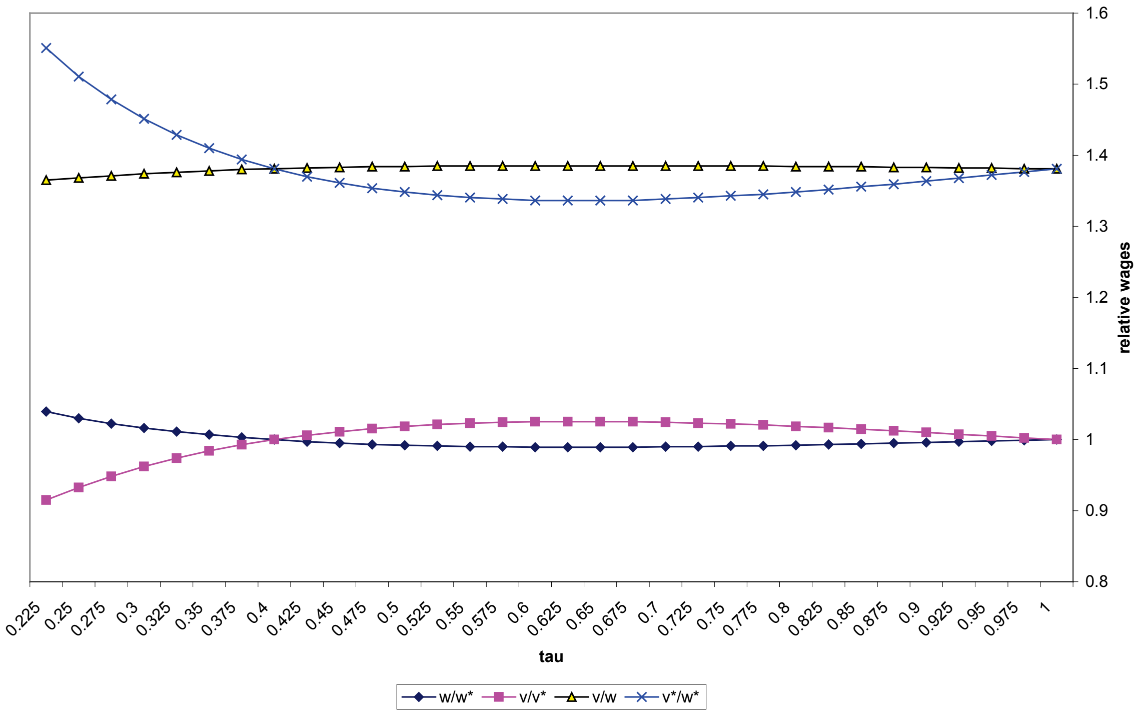
Adjustments in the intermediate services markets as transport costs come down are illustrated in Fig. 3. First notice that τ has to increase to about 0.2 before a coordinated entry by all firms in Small and some firms in Big is feasible. This entry point is further to the right the larger is the fixed entry cost *g,* as one would expect. The relative number of services $\tilde{n}$ peaks when $\tau = (g/f)^{1/2}$, which is further to the right the larger is *g*. For $g > f$ agglomeration of Z-sector firms in Big continues throughout the range $\tau \in (0.1)$. The $\tilde{n}$-curve follows the same pattern but is flatter and everywhere above the case 1 curve depicted in Fig. 1 (it ranges between 13 and 13.6 in the numerical example). This is due to the fact that between 80 and 90 percent of firms in Big does not export, as indicated by the curve depicting the value of θ (left-hand scale) and there are thus more firms in Big in this case than in case 1. The relative number of services *assembled* in the two regions, $(n+n^*)/(\theta n+n^*)$, declines at a decelerating rate as transport costs come down and θ increases. As in the previous scenario, import penetration increases continuously in both regions as transport costs come down.

Figure 3: Adjustments in the services market



Turning to adjustments in the labour market, Fig. 4 shows relative wages as a function of τ. The pattern of adjustment is similar, but less dramatic than in case 1. Note, however, that there is a reversal of relative factor prices at $\tau = g/f$. Empirical examples of small countries specialising in sophisticated services and paying high wages are Luxemburg and Hong Kong.

Figure 4: Adjustments in the labour market

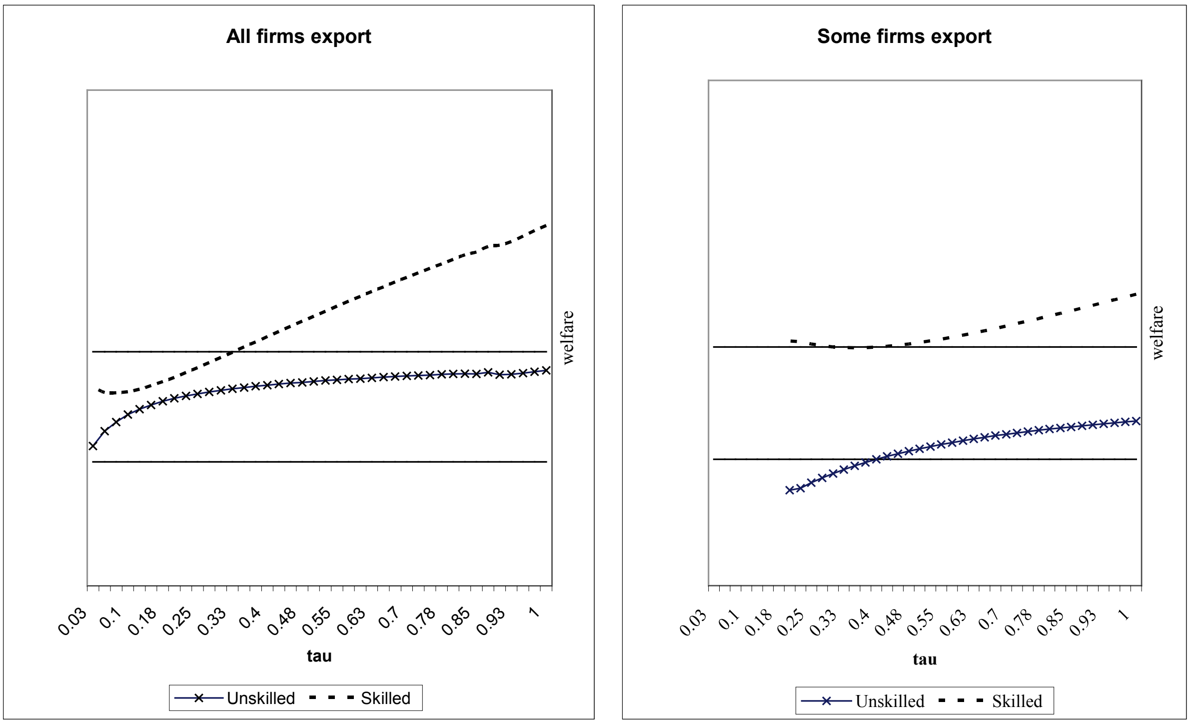


To summarise, in case 2 both the number of exporting firms and the volume of trade increase as transport costs come down. Small lags behind Big in terms of quality of the X-sector even if transport costs are eliminated, but the loss of quality in Big due to fewer intermediate inputs is smaller than in case 1. Interestingly, while θ increases with τ, it never reaches unity in the numerical example. There will in other words not be a spontaneous shift to case 1, which is only feasible with a coordinated entry into the Small market.

WELFARE

I finally compare the level of welfare of skilled and unskilled workers in trade regimes 1, 2 and autarky. Welfare levels are measured by inserting the quantity consumed of X and Y in the utility function (7) for skilled and unskilled workers respectively. The quantity consumed is given by $Y^*_{u-s} = \sigma w^* / P_y$, $Y^*_s = \sigma v^* / P_y$ $X^*_{u-s} = (1-\sigma) w^* / P_x$ and $X^*_s = (1-\sigma) v^* / P_x$, and equivalent for Big. Subscript *u-s* denotes unskilled and subscript *s* denotes skilled workers. Figure 5 depicts this measure of welfare in Small in the two trade regimes compared to autarky which is represented by the horizontal lines, the lower line for unskilled workers and the upper line for skilled workers. At low transport costs, both skilled and unskilled workers are best off in case 1, followed by case 2, which in turn is better than autarky. At high transport costs, however, unskilled workers would prefer case 1, but autarky is better than case 2, while skilled workers are better off in autarky, but prefer case 2 to case 1. In both trade regimes the welfare of unskilled workers increases continuously with τ, while the welfare of skilled workers first declines and then rises with τ. In the case where $\widetilde{S} = 20; \widetilde{L} = 10$, the welfare level of skilled workers never returns to its autarky level (not reported). In Big in contrast, both skilled and unskilled workers have a higher level of welfare in autarky than in case 1, while the level of welfare in case 2 is about the same as in autarky. Hence the gains in welfare in Small to some extent take place at the expense of Big, which loses in variety of intermediate services.

Figure 5: Welfare comparisons



SUMMARY AND CONCLUSIONS

In this paper I have demonstrated that trade in intermediate service inputs enhances the quality and lowers the price of consumer services in small economies, substantially reducing the gap in access to services between centre and periphery. The gains from trade are, however, unevenly distributed and also depend on which trade regime that emerges and the size of trade costs. For moderate to low transport costs all gain in Small, and income distribution tends to become less unequal both within Small and between Big and Small. Once adequate infrastructure is in place, therefore, there appears to be little reason for Small markets to worry about marginalisation due to ICT. If there are significant fixed cost of entering a distant market, firms that engage in trade need to be large and there will be fewer firms and fewer varieties of intermediate services than in autarky. Consumers in large markets may then be worse off as a result of larger firms producing fewer varieties of local intermediate service inputs than in autarky.

When a new technology, e.g. the Internet opens the opportunity to engage in services trade, the initial response by firms determines what trade regime will emerge. If all firms respond by getting connected and expand their markets simultaneously, this trade regime can be sustained after a shake-out of firms and at a cost to consumers in big markets. The Internet-hype followed by the recent consolidation could be a case in point. If on the other hand only a few firms choose to enter distant markets when the possibility opens up, more firms will follow suit as transport costs decline further, but many firms will still confine themselves to servicing the local market even if transport costs are totally eliminated. An event such as the Internet-hype can in other words have a lasting impact on the structure of the services market.

The four questions posed in the introduction can now be answered. Trade in intermediate services will improve the quality of for example education and health in small markets tremendously. However, the local teachers, lecturers or practitioners will increasingly convey information produced outside the region and work as intermediaries between local pupils/students/patients and external specialists. In the process their relative wages will be undermined, at least when transport costs are still high. However, if and when transport costs come down to a critical level, the local lecturers or practitioners will have the opportunity to specialise and sell their services both locally and abroad and thereby regain at least some of the lost ground in terms of relative wages.

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