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Globalization, Industrial Policy and Clusters

by

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Globalization, industrial policy and clusters *

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Abstract

This paper analyses industrial policy in a high wage open economy hosting an agglomeration consisting of vertically linked upstream and downstram firms. We show that optimal policy towards upstream industries typically differ from the optimal policy towards downstream industries. Internationalisation impacts on the costs as well as on the benefits related to sustaining an industrial agglomeration. Whether maintaining the agglomeration is compatible with a welfare maximizing policy is shown to depend on level of economic integration.

Keywords: globalization, industrial policy, industrial clusters, economic geography
JELs: F2, F12, F15, H2, R13

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1 Introduction

The ongoing integration of the world market has lead to a high degree of specialisation in industrial production. The resulting relocation of industry leads to the formation of new industrial clusters as well as the break-up of already existing ones. Policymakers care about industrial clusters and their geographical location, since clusters are associated with rents. Membership of clusters and inter-firm networks is strongly believed to enhance the productivity, and competitive performance of firms.

Industrial clusters rely on localised positive externalities, which may be pecuniary or pure in nature. Governments may therefore want to intervene in order to ensure that the cluster reaches its optimal size. In a closed economy the rents created in the cluster will be – by defintion of a closed economy – entirely absorbed by domestic factors of production or domestic consumers. This also means that if a government chooses to intervene, the subsidies given to the cluster will in the end be returned to the domestic economy.

In a globalised world a government has to take into account by whom the rents generated in an industrial cluster are received: locals or foreigners? The government must also consider that firm mobililty may limit the scope for taxation. In a world with internationally mobile firms and falling international trade cost, industrial policy initiatives that allow for welfare maximization under a closed regime, may no longer be optimal.

In this paper we analyse industrial policies towards manufacturing clusters as countries become integrated in the world economy. We investigate this in a two-country setting, where there is one high wage and one low wage economy. Our point of departure is one where there is a cluster that consists of two vertically linked industries – an upstream and a downstream industry - located in the high wage country. We show that both trade costs as well as firm mobility matter for whether the government would want to tax or subsidize the industries in the cluster. The more of the rents generated in the cluster that accrue to foreigners, the less a national welfare maximizing government would like to subsidize the cluster. We also show that the optimal industrial policy directed towards the upsteam industry differs radically from the policy towards the downstream industry. It is emhasized that crucial for whether or not the government would want to intervene in the first place is the gap between factor prices in the high wage and the low wage country.

Lately, other authors have also looked into the issue of economic policy and industrial agglomeration, e.g. Ludema and Wooton (1998), Haaland

and Wooton (1999) Andersson and Forslid (1999), Baldwin and Krugman (2000), Kind, Midelfart-Knarvik and Schjelderup (2000), and Norman and Venables (2001). Our study is distinct from the above in many respects and, in particular, none of the recent contributions to this literature has dealt with the difference between upstream and downstream industries. The distinction turns out to be important for the conduct of industrial policy, because it affects who earns the rents created in the agglomeration.

The paper is organised as follows. Section 2 presents an economic geography model of a cluster with upsteam and downstream industries. In section 3 we elaborate on agglomeration forces and investigate the sustainability of clusters. Thereafter industrial policy directed towards clusters and the impact of globalization on optimal policy design are analysed in section 4, and finally section 5 concludes.

2 A model with vertically linked firms

We employ a version of the economic geography model outlined by Venables (1996). There are two countries; the industrialised high wage country h (home) and the non-industrialised country f (foreign). Each country may be active in two sectors: agriculture and manufacturing. Manufacturing, which produces differentiated goods under imperfect competition, is further split into two vertically linked industries: Manufacturers of final goods and suppliers of manufacturing intermediates. Both final and intermediate goods are subject to trade costs. Our point of departure is one where the two manufacturing industries are agglomerated in the home country.

There is one factor of production, labour, which is mobile between sectors, but immobile between countries. A country may levy taxes on wage income and firms' revenues or costs. We abstract from considerations related to the provision of public goods and assume a binding budget condition requiring that tax income equals public transfers. Hence, if a government chooses to subsidize firms, a positive tax on labour income must be levied; and vice versa. Since labour is in fixed supply, tax on labour income is lump sum in nature.

The representative resident in country i receives income from labour only. Preferences are given by the utility function

$$U = C_A^{1-\gamma} C_M^{\gamma}, \qquad 0 < \gamma < 1, \tag{1}$$

where C_A and C_M denote consumption of goods from the agriculture and manufacturing sector, respectively, and γ is the expenditure share on manufacturing. Agricultural (A) goods can be costlessly traded internationally and are produced under constant returns to scale and perfect competition.[1] The A-good is chosen as numeraire, so that the world market price of the agricultural good, p_A, is equal to unity. We assume that labour productivity in agriculture in the foreign non-industrialised low wage country is $\phi(< 1)$ times the productivity in the home country. By choice of scale, unit labour requirement in the A-sector in the home country is one, which gives

$$w_h = 1, w_f = \phi. \tag{2}$$

Within the chosen setting, this will hold as long as $\gamma < 0.5$, which implies that demand for agricultural goods is large enough to guarantee that the agricultural sector is active in both countries irrespectively of the location of other production sectors. Factor prices are, thus, given, and we are consequently analysing an industrial agglomeration that is so small that it does not affect factor prices.

Important for the location of industry is, moreover, the size of the home market. Here, we want to investigate the effects of international factor price differences isolated from differences in market size. It is therefore assumed that the labour stock in country f is $1/\phi$ larger than that of country h $(L_f = L_h/\phi)$, which makes pretax income equal in the two countries.

The consumption of final goods from the manufacturing sector is defined as an aggregate of n differentiated goods, $C_M \equiv \left[\sum_{k=1}^{n} c_k^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$ with $\sigma > 1$, where c_k represents consumption of each good. Each producer operates under increasing returns to scale at the level of the plant, and in line with Dixit and Stiglitz (1977) we assume that there is large group monopolistic competition between manufacturers. Thus, both the perceived elasticity of demand and the elasticity of substitution between any pair of differentiated goods are equal to σ.

A representative manufacturing firm in country i produces its output x_{Mi} using α units of input as fixed costs and β per unit of output thereafter, and has a total cost function given by

[1] We maintain the standard labelling of the two sectors for ease of comparison. More generally, sector A should be interpreted as a labour-intensive industry.

$$TC_{Mi} = w_i^{1-\eta} Q_{Si}^{\eta} (\alpha + \beta x_{Mi}),\ \eta \in [0, 1\rangle\,. \tag{3}$$

In (3) the parameter η is the share of total costs that goes to the purchase of intermediates (with price Q_{Si}), while $1-\eta$ goes to labor. Notice that for $\eta > 0$ we have vertical industry linkages in the sense that the manufacturing industry (M) uses intermediates produced by the manufacturing supplier industry (S). The government may want to tax or subsidize manufacturing production, in which case, a tax ($t_{Mi} > 0$) or subsidy ($t_{Mi} < 0$) based on total costs will be introduced. Profits in manufacturing are then equal to $\pi_{Mi} = p_{Mi} x_{Mi} - (1 + t_{Mi}) TC_{Mi}$. Note, that since we shall be assuming free entry and zero profit, a tax on costs is equivalent to a tax on revenues. Due to zero profits in equilibrium, tax on profits becomes unapplicable.

All producers have access to the same technology, so prices do not differ between firms in a given country. Since firms face a constant demand elasticity they set a constant markup $\frac{\sigma}{\sigma-1}$ over marginal costs, the f.o.b. price from country $i = h, f$, is given by

$$p_{Mi} = \frac{\sigma}{\sigma - 1} \beta w_i^{1-\eta} Q_{Si}^{\eta} (1 + t_{Mi}) \tag{4}$$

Manufactured goods are tradeable, but we assume Samuelson iceberg type trade costs, so that only $\frac{1}{\tau}$ of each unit shipped actually reaches its destination. This means that the c.i.f. price is τ times higher than the f.o.b. price of an imported good. Trade costs should be thought of as a synthetic measure of a wide range of trade barriers that are intrinsically wasteful.

Due to free entry there is zero profit in the manufacturing sector. Using the zero profit condition in combination with the expression for price and the cost function, we have that $x_{Mi} = x_M = \frac{\alpha(\sigma-1)}{\beta}$ in equilibrium, and by choosing units $\beta \equiv \frac{\sigma-1}{\sigma}$, $x_M = \alpha\sigma$ in equilibrium.

Taking the dual of C_M we find that the price index for the manufacturing good is

$$Q_{Mi} = \left[n_i p_{Mi}^{1-\sigma} + n_j (\tau p_{Mj})^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \qquad i \neq j, \tag{5}$$

where n_i and n_j are the number of varieties produced in countries i and j. Accordingly, the consumer price index can be expressed as

$$P_i = p_A^{1-\gamma} Q_{Mi}^{\gamma} \qquad i = h, f. \tag{6}$$

The production technology for manufactured goods requires a composite of intermediate goods and labor. Intermediate goods are produced by a supplier industry S, which similarly to industry M is characterised by monopolistic competition, i.e. all upstream producers have access to the same technology, so prices do not differ between firms in a given country. A representative supplier firm in country i produces its output x_{Si} using a units of input as fixed costs and b per unit of output thereafter, and has a total cost function given by

$$TC_{Si} = w_i(a + bx_{Si}). \tag{7}$$

Again, a government may choose to tax or subsidize the cost of production of intermediate goods, i.e. profits are given by $\pi_{Si} = p_{Si}x_{Si} - (1 + t_{Si})TC_{Si}$. Firms set a constant markup $\frac{\epsilon}{\epsilon-1}$ over marginal costs, the f.o.b. price from country $i = h, f$, is given by

$$p_{Si} = \frac{\epsilon}{\epsilon - 1} bw_i (1 + t_{Si}) \tag{8}$$

Intermediates are also tradeable, and we assume the same iceberg trade costs, which implies that only $\frac{1}{\tau}$ of each unit shipped actually reaches its destination. There is free entry and zero profits in the supplier industry. Using the zero profit condition in combination with the expression for price and the cost function, we have that $x_{Si} = x_S = \frac{a(\epsilon-1)}{b}$, and after setting $b \equiv \frac{\epsilon-1}{\epsilon}$, $x_S = a\epsilon$ in equilibrium.

Duality allows us to derive the price index for the intermediate good

$$Q_{Si} = \left[m_i p_{Si}^{1-\epsilon} + m_j(\tau p_{Sj})^{1-\epsilon} \right]^{\frac{1}{1-\epsilon}} \qquad i \neq j, \tag{9}$$

where m_i and m_j are the number of varieties produced in countries i and j. In the presence of positive trade costs, a larger share of domestic supplier firms leads to a lower Q_S, which leads to lower cost for local downstream firms, as seen in (3).

From the utility function it follows that the consumer will spend a share γ of income Y_i on manufactured goods, i.e. the value of consumption expenditure on differentiated goods, E_{Mi} is given by

$$E_{Mi} = \gamma Y_i \qquad i = h, f. \tag{10}$$

Using Shepard's lemma on (3), we can derive the demand for intermediates in the manufacturing industry. Total intermediate demand in country i, E_{Si}, can thus be expressed as

$$E_{Si} = \eta TC_{Mi} n_i \qquad i = h, f. \tag{11}$$

We use Shepard's lemma to derive domestic and foreign demand for a variety of the final and the intermediate manufactured good produced in country i:

$$x_{Mii} = p_{Mi}^{-\sigma} Q_{Mi}^{\sigma-1} E_{Mi}, \qquad x_{Mij} = p_{Mi}^{-\sigma} Q_{Mj}^{\sigma-1} \tau^{1-\sigma} E_{Mj}, \qquad i \neq j. \tag{12}$$

$$x_{Si} = p_{Si}^{-\epsilon} Q_{Si}^{\epsilon-1} E_{Si}, \qquad x_{Sj} = p_{Si}^{-\epsilon} Q_{Sj}^{\epsilon-1} \tau^{1-\epsilon} E_{Sj}, \qquad i \neq j. \tag{13}$$

Using (12) and the zero profits condition, the product market equilibrium in the downstream manufacturing industry takes the form

$$\sigma\alpha \geq p_{Mi}^{-\sigma} \left[Q_{Mi}^{\sigma-1} E_{Mi} + \tau^{1-\sigma} Q_{Mj}^{\sigma-1} E_{Mj} \right], \qquad n_i \geq 0, \qquad i \neq j. \tag{14}$$

The product market equilibrium in the upstream manufacturing industry is similarly derived using (13) in combination with the zero profits condition for the supplier sector:

$$a\epsilon \geq p_{Si}^{-\epsilon} \left[Q_{Si}^{\epsilon-1} E_{Si} + \tau^{1-\epsilon} Q_{Sj}^{\epsilon-1} E_{Sj} \right], \qquad m_i \geq 0, \qquad i \neq j, \tag{15}$$

Factor market clearing requires that the supply of labor (L_i) in equilibrium is equal to demand for labour in manufacturing (L_{Mi}), the manufacturing supplier industry (L_{Si}), and agriculture (L_{Ai}) so $L_i = L_{Mi} + L_{Si} + L_{Ai}$. Using Shephard's lemma on equations (3) and (7) to derive labour demand in the two manufacturing industries, we can rewrite the labour market clearing condition as

$$L_{Ai} = L_i - (1 - \eta) w_i^{-\eta} Q_{Si}^{\eta} n_i \alpha\sigma - m_i a\epsilon. \tag{16}$$

(2) and (16) imply that since each country is active in both manufacturing and agriculture, labour is totally elastic in supply to both sectors. If one sector expands, this draws resources out of the other, but does not impact on factor returns.

A government may choose to tax or subsidize the downstream and/or the upstream manufacturing industry. A net subsidy to manufacturing will have to be financed by a tax on labour income ($t_i > 0$), while a net tax on manufacturing will be redistributed in the same way back to the consumers. The public budget constraint is given by

$$w_i L_i t_i + t_{Mi} w_i^{1-\eta} Q_{Si}^{\eta} n_i \alpha\sigma + t_{Si} w_i a\epsilon m_i = 0, \tag{17}$$

and disposable consumer income equals

$$Y_i = (1 - t_i)\, w_i L_i. \tag{18}$$

The general equilibrium is characterized by the equations (2), (4), (5), (8), (9), (10), (11), (14), (15), (16), (17), and (18), which can be solved to give equilibrium values for w_i, $Q_{si}, Q_{Mi}, p_{Mi}, p_{Si}, E_{Mi}, E_{Si}, n_i, m_i, t_i, Y_i, L_{Ai}$ for $i = h, f$.

3 Manufacturing agglomeration

Our focus here is on industrial policy directed towards industrial clusters. But before we turn to the policy analysis we want to investigate the forces holding an economic cluster in place. Our point of departure is a situation where both the upstream- and downstream manufacturing industries are agglomerated in the home country. But if firms are internationally mobile, they may find it profitable to move away from the industrial cluster in h. Here, it is examined whether the given allocation of economic activity is a stable equilibrium; in other words, whether the industrial agglomeration in country h is sustainable.

This section focuses on how sustainability depends on the level of economic integration, whereas the analysis of taxes and welfare is postponed to section 4. Taxes will therefore all be set to zero.

The foreign country may be an attractive location of production because of its lower factor prices, and because trade costs attenuate the product market competition for a downstream firm. These dispersion forces, however, balance against agglomeration forces associated with the home country. Because firms are vertically linked there are backward and forward linkages; more upstream firms in the region imply a lower price index of intermediate inputs for downstream firms (forward link), while more downstream firms

imply a larger market for upstream firms (backward link). Thus, the vertical industry linkages between the M and S industry give rise to location specific external economies of scale if there are positive trade costs.

Agglomeration of manufacturing in h is sustainable if, and only if, the sales of a first (potential) deviating firm relocating to country f are too low to break even; in which case there will not be any firms migrating from country h to country f. Because of constant mark-up, profits only depend on sales. The first manufacturing firm that moves to country f faces demand

$$x^*_{Mf} = \left(\frac{p_{Mf}}{p_{Mh}}\right)^{-\sigma} \left(\frac{\tau^{1-\sigma}\gamma Y_h + \tau^{\sigma-1}\gamma Y_f}{n_h p_{Mh}}\right), \tag{19}$$

whereas the first deviating supplier faces demand

$$x^*_{Sf} = \left(\frac{p_{Sf}}{p_{Sh}}\right)^{-\epsilon} \left(\frac{\tau^{1-\epsilon}E_{Sh} + \tau^{\epsilon-1}E_{Sf}}{m_h p_{Sh}}\right). \tag{20}$$

Note that (19) is derived under the assumption that the entire upstream industry is concentrated in country h, and (20) similarly relies on the entire downstream industry being located in country h. The zero profit scale is $x_M = \alpha\sigma$ for M-sector firms, and $x_S = a\epsilon$ for S-sector firms. The asymmetric equilibrium with agglomeration in h is therefore sustained as long as

$$\frac{x^*_{Mf}}{\alpha\sigma} < 1. \tag{21}$$

for final producers, and

$$\frac{x^*_{Sf}}{a\epsilon} < 1 \tag{22}$$

for producers of intermediate goods.

An asymmetric equilibrium implies that $n_f = m_f = 0$ giving price indices

$$Q_{Mh} = n_h^{\frac{1}{1-\sigma}} p_{Mh},\ Q_{Mf} = \tau Q_{Mh},\ Q_{Sh} = m_h^{\frac{1}{1-\epsilon}} p_{Sh},\ Q_{Sf} = \tau Q_{Sh}, \tag{23}$$

with $p_{Sh} = (1 + t_{Sh})w_h$ and $p_{Mh} = (1 + t_{Mh})Q_{Sh}^{\eta} w_h^{1-\eta}$. Using these together with price equations (4) and (8), and product market clearing conditions, $E_{Sh} + E_{Sf} = p_{Sh}x_{Sh}m_h$ and $E_{Mh} + E_{Mf} = p_{Mh}x_{Mh}n_h$, the sustainability conditions may be rewritten as

$$\frac{x^*_{Mf}}{\alpha\sigma} = \left(\frac{1+t_{Mf}}{1+t_{Mh}}\right)^{-\sigma} \tau^{1-\sigma(1+\eta)} \left(\frac{w_f}{w_h}\right)^{-\sigma(1-\eta)} \left(1+\frac{Y_f}{Y_h+Y_f}\left(\tau^{2(\sigma-1)}-1\right)\right) < 1 \tag{24}$$

$$\frac{x^*_{Sf}}{a\epsilon} = \left(\frac{1+t_{Sf}}{1+t_{Sh}}\right)^{-\epsilon} \left(\frac{w_f}{w_h}\right)^{-\epsilon} \tau^{1-\epsilon} < 1. \tag{25}$$

We plot (24) and (25) for the case without taxes ($t_{Mh} = t_{Sh} = t_{Mf} = t_{Sf} = 0$). For maximal comparability between the M- and S-sector we set $\sigma = \varepsilon$. Figure 1 illustrates the relationship between sustainability and trade costs, i.e. shows how x^*_{Mf} and x^*_{Sf} vary with trade costs in a typical case.[2]

The first thing to note is that the downstream industry exhibits a U-shape in trade costs; while the upstream industry does not. The U-shape is a result of the well known non-linear interaction of agglomeration and dispersion forces (c.f. Fujita et al, 1999): a low degree of product market competition and low factor prices attract downstream firms to the foreign country, while the inferior access to intermediate inputs facing a deviating firm, works in the other direction. The production of a deviating upstream firm, on the contrary, rises monotonically as trade costs fall. Its entire market lies in the home country, so the attractiveness of locating in the foreign country, where factor prices are lower, increases monotonically as trade costs fall.

Higher elasticity of demand (σ) leads to reduced mark-ups and fiercer competition in the market for final products, and increases the tendency for an M-sector firm to move to country f (and thus shift the U-shaped curve upward), but does – in the absence of taxes – not affect the sustainability of the supplier sector. We return to the latter point below. In contrast, higher demand elasticity regarding intermediates, ϵ, has an ambiguous impact on the S-sector firms' propensity to migrate. A higher ϵ leads to increased competition among upstream firms. This implies that both market access and low factor prices become relatively more important. The foreign country provides an inferior market access since, by assumption, all downstream firms are concentrated in the home country. This disadvantage rises with increasing trade costs. However, the foreign country moreover offers cheaper labour.

[2] We use the following standard parameter values in all simulations: $\gamma = 0.45, k = \gamma^\gamma(1-\gamma)^\gamma, a = 0.1, \alpha = 0.1, \epsilon = 2.5, \sigma = 2.5, \eta = 0.4, \phi = 0.9$.

However, our results are valid in a qualitative sense for a large range of parameter values.

As a consequence, considerations related to product market access will dominate for high trade costs; meaning that higher demand elasticity discourages migration of S firms. For low trade costs factor market considerations will start to dominate, and higher demand elasticity encourages migration to the low wage country.

An increased use of intermediates (η) strengthens the agglomeration forces sustaining the industrial core in country h, shifting the curves down. As for the expenditure share on manufacturers (γ), as long as labour is totally elastic in supply to the manufacturing agglomeration, a change in this parameter will not affect the sustainability of the agglomeration. Finally, a lower ϕ, and thus an enhanced wage gap between the two countries, unambiguously increases the attractiveness of the foreign country, and therefore shifts both curves up.

Consider now the impact of economic integration on the home country. Starting at high trade costs the S-sector will never migrate since its entire market lies in the home country. For M-sector firms, on the contrary, the advantage of being the sole locale provider of manufacturing goods in the foreign is most pronounced for high trade costs. Product market competition will, thus, for high enough trade costs induce migration of downstream firms in country f, unless the linkages to the upstream sector are too strong. This is illustrated by the right upward sloping part of the U in Figure 1.

As integration proceeds, the agglomeration forces created by the inter-industry linkages become relatively more dominant, and serving the foreign market through exports becomes a more profitable alternative. The propensity of the downstream sector to move out of the home country accordingly declines. Finally, as integration deepens, choice of location is primarily determined by factor market considerations. This implies that both downstream and upstream firms are encouraged to deviate from the industrial core in country h, and move out to the low wage economy f. However, the upstream industry is relatively more labour intensive than the downstream industry, and international wage differences therefore matter more for upstream firms' choice of location. As a consequence, when we approach free trade, the propensity of upstream firms to migrate will ceteris paribus be relatively greater than that of downstream firms.[3]

[3]This point has also been made by Puga and Venables (1996), although within a different setting.

4 Industrial policy

We now turn to the analysis of optimal industrial policy in the high wage home country hosting the agglomeration. In the present modelling framework there are two sources of pecuniary externalities in the precence of trade costs. The first is associated with the link between upstream producers and their customers - downstream firms. The second with the link between downstream producers and consumers. The pecuniary externalities are symptoms of the market failure created by the interaction of vertical linkages, increasing returns to scale, and imperfect competition (see Norman, 1996). Hence, policy interventions might be called for.

In particular, we focus on how optimal industrial policy is affected by the process of international integration. Globalization has two dimensions; it affects the mobility of firms and it affects trade costs. In relation to mobility we treat two extreme cases: one where firms are immobile - for instance due to capital controls - and one where firms can move without cost.

Throughout the analysis we assume that the low-wage foreign country is passive, and that it does not pursue any industrial policy.

4.1 Internationally immobile firms

The entire manufacturing sector is assumed agglomerated in country h, while country f is completely specialized in agriculture.

We consider a tax system that allows for taxes on labour income, on costs in the upstream industry, as well as on costs in the downstream industry. The government's objective is to maximize agents' indirect utility function with respect to t_{Mh} and t_{Sh} subject to the public budget constraint. The government's maximisation problem is therefore given by

$$\max_{t_{Mh},t_{Sh}} V_h = \frac{\gamma^{\gamma}\left(1-\gamma\right)^{(1-\gamma)} Y_h(.)}{L_h P_h(.)}, \tag{26}$$

$$s.t. \quad w_h L_h t_h + t_{Mh} w_h^{1-\eta} Q_{Sh}^{\eta} n_h \alpha\sigma + t_{Sh} w_h a\epsilon m_h \geq 0$$

Examining the solution to the maximization problem, we shall use the case of a closed economy as benchmark. Thus, for comparison, consider a closed economy version of the model above, where country h is active

in both agriculture and manufacturing, but where there is no international trade. Dixit and Stiglitz (1977) analyse such a case employing a model with one perfectly competitive sector and one monopolistically competitive sector. They show that the interaction between a desirability of variety, increasing returns and imperfect competition leads to a market outcome that does not yield the socially optimum number of kinds. With constant elasticity of demand, the market equilibrium is, in fact, identical to an optimum constrained by the lack of lump sum subsidies, but an unconstrained optimum is characterised by a greater number of firms of the same size as in market equilibrium. In the unconstrained optimum the price charged by each firm equals marginal costs, and each firm covers exactly its variable cost, i.e. each firm receives a subsidy equal to its fix cost. The subsidy is financed by a lump sum tax on consumer income.

The model employed here differs from that of Dixit and Stiglitz in the sense that the imperfectly competitive sector is split into a downstream and an upstream industry. However, it is straightforward to show that the results are completely analogous: Subsidies are determined by the elasticity of demand in the respective industry with $t^*_{Mh} = -1/\sigma$ and $t^*_{Sh} = -1/\epsilon$. A subsidy of $1/\epsilon$ to the S sector gives price (p_{Sh}) equal to marginal cost, as can be seen by inserting the subsidy in (8). Moreover, the total subsidy given to the upstream industry amounts to the sum of fixed costs in the industry, $T_{Sh} = \frac{1}{\epsilon} w_h (a + bx) m_h = a m_h$. Similarly the subsidy of $1/\sigma$ to the downstream sector gives price equal to marginal cost, and implies a total subsidy equal to the fixed cost in the industry.

Next consider the open economy. The government chooses taxes as to maximize (26), and in line with the result for a closed economy, the optimal tax in the upstream sector is again[4]

$$t^*_{Sh} = -1/\epsilon. \tag{27}$$

Economies of scope in the use of intermediates implies that the market outcome gives to few varieties of intermediates, and government intervention allows for price equal to marginal cost and a greater number of varieties.

In deriving the optimal tax for the downstream sector we rely on numerical explorations of the model. Figure 2 illustrates the solution to the government's maximization problem for given parameter values by plotting the first order conditions. In a closed economy, analogous to the treatment

[4] Appendix B indicates how the calculations are made.

of the upstream industry, the downstream industry would have been given a subsidy equal to $1/\sigma$ financed by a tax t_h on labour income according to (17). However, as can be seen from Figure 2, in an open economy welfare maximization requires a tax – not a subsidy – on the downstream industry. Extensive numerical investigation shows that this will always be the case.

What is the intuition behind this discrepancy in results for closed and open economies? The pecuniary externality present in manufacturing generates a rent. Because of free entry, this rent will not be mirrored through firms' profits; nor will it impact on factor returns, since due to the assumptions of the model, wages are fixed and equalised across sectors. The rents that are generated by the industrial agglomeration will, thus, be completely passed on to consumers – domestic and foreign – through prices and number of varieties. This means that subsidies to downstream firms imply transfers abroad, while a tax allows for rents to be shifted back to the domestic consumers. The reasoning here is in line with that of an optimal tariff argument, but the outcome may be regarded as a second best alternative given the lack of tariff as an instrument. A first best outcome would have been reached by correcting for the market failure by using production subsidies in the downstream industry as well, while levying a tariff on exports to shift rents home. But in a world characterised by integration and reduction of obstacles to trade, such a policy mix hardly seems a relevant option.

Our simulations show that the tax rate t^*_{Mh} is increasing in parameters that strengthen agglomeration forces and therefore increase agglomeration rents - i.e. in the elasticity of demand (σ), in the expenditure share on manufacturing (γ), and in the strength of vertical linkages (η) - while declining in elasticity of demand in the upstream industry (ϵ). The higher the elasticity of demand, the less significant is the market failure, and the smaller the optimal subsidy that would have been given if a complete range of policy instruments were available. A higher elasticity therefore diminishes the incentive to provide a subsidy, while the incentive to use taxes as an instrument to shift rents back to domestic consumers remains, and becomes more predominant. The more skewed consumer preferences are in the direction of manufacturing, the more manufacturing goods will be exported, and thus the larger the rents that are shifted abroad, and which can be shifted back via a tax on downstream. As for vertical linkages, the stronger the linkages, the larger the upstream sector, and the more subsidies it receives. The larger, in turn, are the gains to consumers from the policy interventions in the upstream sector, and the larger are the rents which the national government would like

to extract back from foreign consumers. The same type of argument applies when investigating the impact of demand elasticity in upstream on the tax on downstream. A lower ϵ implies greater subsidies to upstream, and more to be shifted back to the home country.

Our simulations also show that the income from taxing the downstream industry will always exceed the expenses related to subsidising the upstream activity, leading to a net subsidy to consumer (labour) income in the home country. Hereby, the inhabitants in country h are ensured a relatively greater share of the rents created by the industrial agglomeration.

4.2 Internationally mobile firms

Let us now proceed to a situation where internalization has led to firms being mobile without any costs related to migration. The mobility across borders affects the maximization problem faced by the government in country h, since taxes affect firms' incentives to migrate to the foreign market. Differentiation of (24) and (25) yields by inspection

$$\frac{\partial x^*_{Mf}}{\partial t_{Mh}} > 0, \quad \frac{\partial x^*_{Mf}}{\partial t_{Sh}} < 0, \quad \frac{\partial x^*_{Sf}}{\partial t_{Sh}} > 0, \quad \frac{\partial x^*_{Sf}}{\partial t_{Mh}} = 0. \tag{28}$$

It comes as no surprise that a tax on either sector encourages firms to move to the foreign country. But why does a tax on downstream firms have zero impact on upstream firms, and a tax on upstream firms discourage downstream deviants? Since the market for intermediates is entirely concentrated in country h, a tax (t_{Mh}) on downstream will only affect the propensity for upstream firms to deviate, if the tax has an impact on wages. As long as wages are constant and independent of tax regimes and tax rates, the sustainability condition for upstream firms is unaffected by a tax on downstream. However, tax on upstream affects downstream firms through two channels: First, the price for the intermediate composit goes up, as the price of each variety increases at the same time as number of upstream firms decreases. Second, the market for final goods expands, since a tax on upstream production is met by a subsidy to domestic consumer income. While the former effect applies equally to downstream firms in h and f, the latter effect entails relatively improved market access for downstream firms in country h. In terms of impact on sustainability, only the latter effect plays a role, and explains why a tax on upstream actually encourages downstream firms to stay in the industrial core in h.

A welfare maximising government has to take into account the impact of internationalization when deciding on industrial policy. Firms being mobile means that the policy mix that appeared optimal in a situation with immobile firms may not be optimal if it leads to firms moving out. We compare two main policy options - to intervene and not to intervene. The first policy implies that the government maximizes welfare subject to the constraint that the agglomeration is sustained. The second is not to intervene: decisive for its choice will be which alternative that gives the highest welfare. As we shall see, there is, however, not necessarily a unique answer to this. Which alternative that allows the government to attain a maximum level of welfare will rather depend on the level economic integration. To compare the options facing the government we shall again rely on numerical simulations. We report the outcomes for a given set of parameter values, but the results hold in a qualitative sense for a broad range of parameter values.

We first consider the case where the government chooses to intervene and maximize welfare as per (26) subject to the additional constraints that the agglomeration should be maintained, i.e. subject to (24) and (25). The slightly bell-shaped curve in Figure 3 illustrates the solution to this maximization problem, where welfare is drawn as a function of trade costs. Figure 4 shows the corresponding tax rates on upstream and downstream. We see that both welfare and taxes are affected by the level of economic integration. Welfare peaks at intermediate trade costs, when the agglomeration forces are strongest, and the scope for domestically extraction of the rents created in the industrial agglomeration is greatest.

In a situation with immobile firms, a welfare maximizing government would subsidize the upstream industry and tax the downstream industry. However, with internationally mobile firms, the sustainability condition for the downstream sector binds for the whole range of trade costs, and impedes a tax rate as high as what would have been optimal if firms were immobile (cf. Figures 2, 3 and 4). As we approach zero trade cost, sustainability may indeed require a subsidy and not a tax on downstream activity. For most trade costs the sustainability constraint related to the upstream sector does not bind, but because of the sectoral cross-effect that a subsidy to this sector has on downstream, there is a limit to the subsidy that can be given. The subsidy here will thus always be lower than the one used in the case with immobile firms. The kink in the t_s in Figure 4 marks the level of trade costs at which the sustainability condition for the upstream sector becomes binding.

Worth noting, though, is that the gains from the intervention line reach their maximum at intermediate costs, at which the tax on downstream and subsidy to upstream get as close as ever to what would have been optimal levels in a situation without international mobility. What characterises this situation is both relatively high subsidies and high taxes. This reflects the fact that strong aglomeration forces both allow for intervention correcting for the market failure as well as for the local extraction of the rents generated in the agglomeration.

But the government may also choose not to intervene. From the discussion of sustainability in section 3 we know that both the S and M industry will migrate when trade costs become low enough.[5] Figure 3 shows welfare when the government is passive. The agglomeration stays in the home country for a large range of trade costs, because firms are tied down by agglomeration rents. At point A the agglomeration is no longer sustained. When the dust has settled and the entire agglomeration is located in the foreign country, welfare has increased to B.[6] Further integration from this point leads to a steep increase in welfare.

Comparing the welfare attained with and without intervention, we see that whether or not the goverment will wish to conduct an active industrial policy depends on the level of integration. For high trade costs, the gains from having the agglomeration exceed the costs. Below A a passive government would be preferred. Essentially - given the underlying assumptions of the model - home has a comparative disadvantage in the agglomerated industy. For low enough trade cost, the gains from production taking place where factor prices are lowest outweigh the agglomeration benefits for the home country. This means that as trade costs approach zero, reversed patterns of specialisation and thus relocation of the agglomoration, provide for a welfare beyond that achieved in the case of immobile firms.

[5] Actually, the downstream industry will also migrate for very high trade costs - τ close to 200 percent for our parametrisation. This level of τ, however, is outside our range of interest.

[6] From section 3 it is clear that one of the sectors will be the first to move. However, this type of model does not display any stable equilibria with the two sectors located in different countries. The end result must therefore be that the entire agglomeration has moved to the foreign country.

4.3 Discussion

We have so far assumed that the government follows an optimal policy that allows for the country's inhabitants' welfare to be maximized. If we assume that we are at a stage where globalization has not yet had an impact on firms' mobility, it follows clearly from the analysis in section 4.1 and Figure 3 that policy intervention will be superior to a laisse-faire line. Pecuniary externalities symptomizing a market failure will always make us want to subsidize the agglomeration, while the fact that some of the rents from the agglomeration are attained by foreigners encourages a simultaneous taxation of the industry.

Still, political realities may prevent the government from following an optimal policy. In particular, a policy that allows for the agglomeration to move out to the low wage country may indeed not be feasible.

Consider the situation for the home country during a process of economic integration. Once we have reached point A in Figure 4 it would be optimal to stop interventions and let go of the agglomeration. However, this may not be politically feasible. A perhaps more politically acceptable policy would be to let the labour intensive upstream industry (industries) move, while intervening in order to keep the downstream industry. But this is not an attractive option at A, since it entails a downward shift in welfare to C. Indeed our, simulations show that this alternative will always be inferior to letting the entire agglomeration move.

However, once the point D is reached, the situation for the home country is different. The option of letting the S-sector leave while introducing interventions allowing for M to stay, becomes attractive. If this policy is followed, further liberalisation leads to strong welfare gains.

The analysis may have practical relevance. The movement of supplier firms to low wage countries is often viewed as a threat in high wage industrial countries. Our analysis indicates that this need not be the case. Once integration has proceeded far enough, the outmigration of supplier firms may instead be a factor that helps high wage countries keep part of an industrial cluster at a relatively lower cost.

5 Conclusion

This paper examines the design of industrial policy in a high wage economy hosting an industrial cluster of vertically linked industries. Policy analysis is undertaken within a non-strategic setting, and it is assumed that the goverment's objective is to maximize national welfare. We show that while in a closed economy optimal industrial policy would imply the subsidizing of both downstream and upstream industries, this is no longer optimal in an open economy setting. Disregarding issues related to internationally mobile firms and sustainability, optimal policy mix would in the latter case be to subsidise the upstream sector to correct for the pecuniary externality, but to levy a tax on the downstream sector as a means to rent-shifting from foreign consumers.

The sustainability of the industrial cluster does, however, put restrictions on the government's welfare maximization problem. In particular the possibility to tax the downstream sector is only present to a limited extent. Neverthelss, during early stages of economic integration, government intervention leads to higher national welfare than what would have been the case without intervention. As integration proceeds far enough, this is no longer true. Due to relatively lower factor prices in the foreign country, home utility would actually increase if the government let the agglomeration move out to the low wage foreign country.

A policy that involves maintaining the agglomeration in the high wage country may thus prove very costly as integration deepens. However, geographical fragmentation of production, in the sense of letting supplier firms move to the low wage countries makes it possible to maintain the downstream part of the industry in the high wage country at a relatively lower cost. Although this last alternative entails a welfare that is lower than what would have been achieved if the whole agglomeration had moved to the low wage country, it is still higher than the one achieved if one seeks to sustain the whole cluster – and under certain political circumstances it may indeed be more acceptable.

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A Appendix: Optimal taxes in a core-periphery case

In accordance with the priorly made assumptions, countries are assumed to have the same market size, so that income is given by

$$Y_f = 1, \qquad Y_h = (1 - t_h). \tag{29}$$

Free entry, zero profits, and product market clearing in the upstream sector (S) implies that $\frac{\eta\gamma(Y_h+Y_f)}{(1+t_{Mh})} = p_{Sh}x_{Sh}m_h$, which together with (29) and (8) gives number of upstream varieties:

$$m_h = \frac{\eta\gamma(2 - t_h)}{a\varepsilon(1 + t_{Sh})(1 + t_{Mh})}. \tag{30}$$

Number of downstream varieties is determined by zero profits and product market clearing in the market for M goods $\gamma(Y_h + Y_f) = p_{Mh}x_{Mh}n_h$, which together with (29) and (4) gives number of downstream varieties:

$$n_h = \frac{\gamma(2 - t_h)}{\alpha\sigma m^{\frac{\eta}{1-\varepsilon}}(1 + t_{Sh})^{\eta}(1 + t_{Mh})} \tag{31}$$

Using, (30),(31) and (17) yields t_h , tax on labour income, as a function of t_{Sh} and t_{Mh} :

$$t_h = \frac{-2\gamma(t_{Mh}(1 + t_{Sh}) + \eta t_{Sh})}{1 + (1 - \eta\gamma)t_{Sh} + t_{Mh}\left((1 - \gamma)\left(t_{Sh} + 1\right)\right)}. \tag{32}$$

(32) allows us to elliminate t_h in (26), which can then be solved for optimal t_{Sh}, whereas optimal t_{Mh} is found by numerical simulation.

Parameter values used

Parameters for Figures 1, 2, 3 and 4:

$g = 0.45, k = g^g(1 - g)^{(1-g)}, a = 0.1, \alpha = 0.1, \varepsilon = 2.5, \sigma = 2.5, \eta = 0.4, \phi = 0.9$

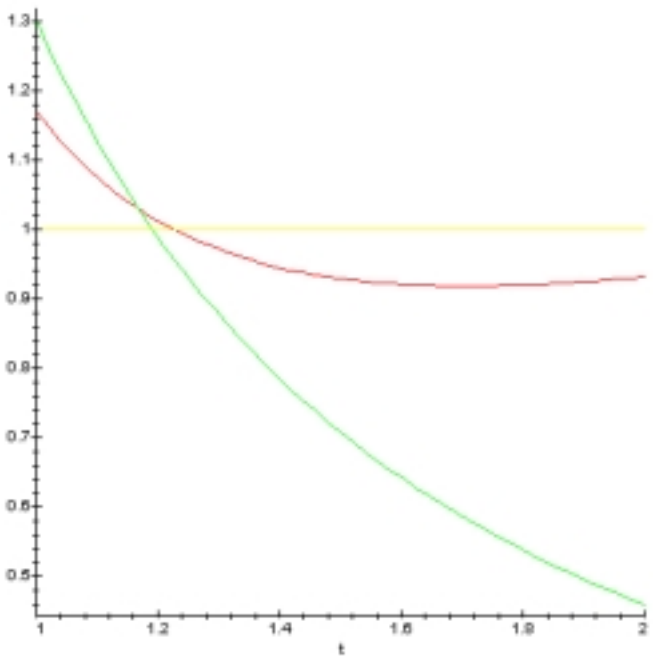

Figure 1: Sustainability of the agglomeration in the home country

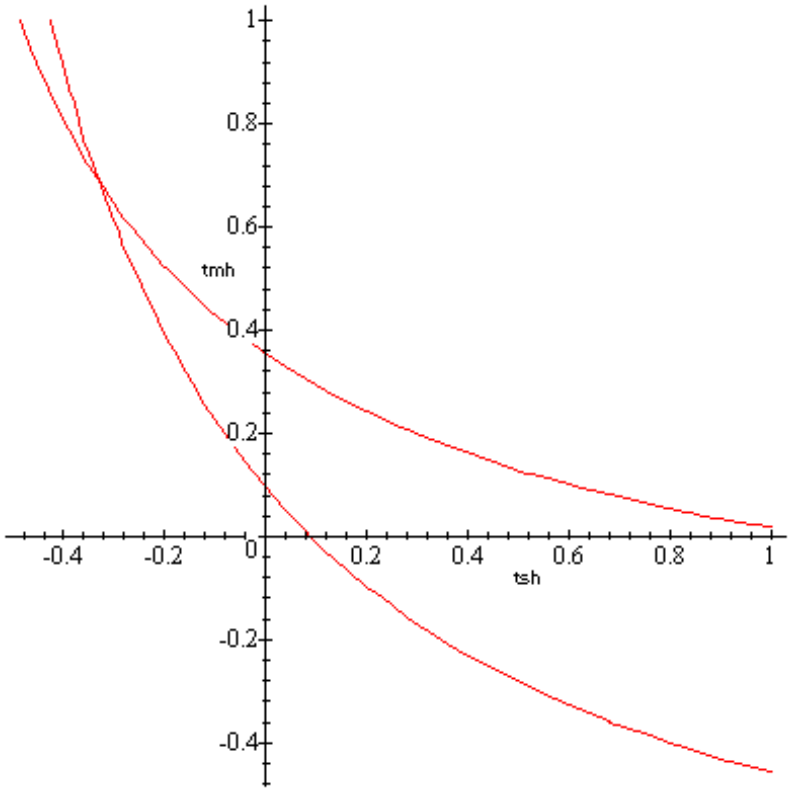

Figure 2: Welfare maximization with immobile firms

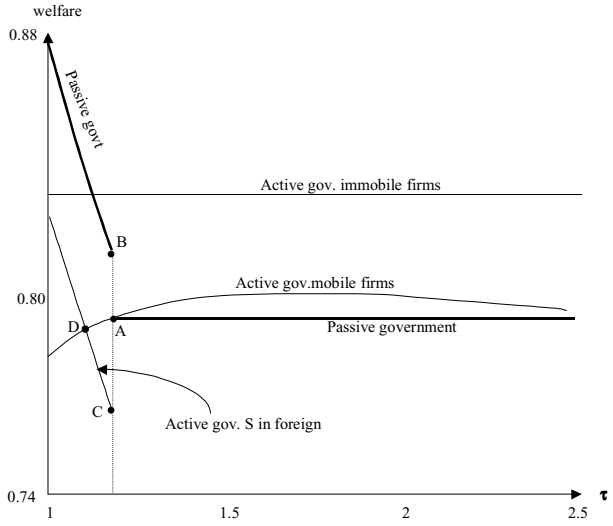

Figure 3: Welfaremaximization with internationally mobile firms

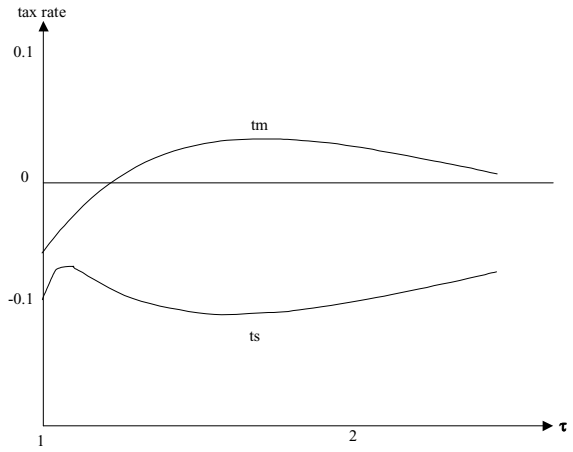

Figure 4: Economic integration and tax rates