Internationalisation, industrial policy and clusters

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Abstract

This paper analyses industrial policy in an open economy hosting an agglomeration consisting of vertically linked upstream and downstream firms. We show that optimal policy towards upstream and downstream industries may typically differ radically in this setting as compared to the case of a closed economy. Internationalisation in terms of international mobility of firms as well as reduced trade costs is found to have significant impact on policy design. We find that in addition to technology and demand characteristics, degree of mobility and level of trade cost are key determinants of tax and subsidy levels.

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1. Introduction

The ongoing integration of the world market has led 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 to the break-up of already existing ones. Policy makers care
about industrial clusters and their geographical location, because clusters are associated with rents. Membership in clusters and inter-firm networks is strongly believed to enhance the productivity and competitive performance of firms.

Industrial clusters rely on localized positive externalities, which may be pecuniary or pure in nature. Governments may therefore want to intervene in order to ensure that a cluster reaches its optimal size. In a closed economy, the rents created in the cluster will—by definition of a closed economy—be 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 who receives the rents generated in an industrial cluster: locals or foreigners. The government must also consider that firm mobility may limit the scope for taxation. Industrial policies that maximise welfare under a closed regime may no longer be optimal.

In this paper, we analyse a stylised case of a country hosting an industrial cluster—a situation familiar to many developed countries. The cluster is modelled as two vertically linked industries—an upstream and a downstream industry—and we use a two-country setting. We show that both trade costs as well as firm mobility matter for whether the government would want to tax or subsidise the industries in the cluster. The more rents generated in the cluster that accrue to foreigners, the less a national welfare maximising government would want to subsidise the cluster. We also show that optimal industrial policy directed towards the downstream industry may differ radically from optimal policy directed towards the upstream industry.

Other authors have also lately looked into the issue of economic policy and industrial agglomeration, e.g. Ludema and Wooton (2000), Haaland and Wooton (1999), Andersson and Forslid (2003), Baldwin and Krugman (2004), Kind et al., 2000, Norman and Venables (2001), and Baldwin et al., 2003. Our study is distinct from the above in many respects. 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 an upstream and a downstream industry. In Section 3, we summarize the equilibrium outcomes supported by the model and investigate the stability properties of the model. Industrial policy directed towards clusters and the impact of internationalisation on optimal policy design are analysed in Section 4. Section 5 concludes the paper.

2. A model with vertically linked firms

We employ a version of the economic geography model outlined by Venables (1996). There are two countries, h (home) and 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 (downstream sector) and manufacturers’ suppliers (upstream
sector). Both final and intermediate goods are subject to trade costs. An alternative approach to the modelling of industry linkages is, e.g. the one employed by Eaton and Kortum (2000), where goods can be used either as intermediates or final goods. However, as we here want to focus on how the rank in the value chain may affect industrial policy design, we have chosen the former approach.

There is one factor of production, labour, which is mobile between sectors but immobile between countries. Countries are symmetric in the sense that their endowment of labour is equal \( L_h = L_f \). 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 tax income to equal public transfers. Hence, if a government chooses to subsidise 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

\[
U = C_A^{1-\gamma} C_M^{\gamma}, \quad 0<\gamma<1, \tag{1}
\]

where \( C_A \) and \( C_M \) denote consumption of goods from the agriculture and manufacturing sector, respectively, and \( \gamma \) 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.\(^2\) The A-good is chosen as numeraire, so that the world market price of the agricultural good, \( p_A \), is equal to unity. By choice of scale, unit labour requirement in the A-sector is one, which gives

\[
w_h = w_f = 1, \tag{2}
\]

provided that \( \gamma<0.5 \). This implies that demand for agricultural goods is large enough to guarantee that the agricultural sector is active in both countries irrespective of the location of manufacturing.

The consumption of final goods from the manufacturing sector is defined as an aggregate of \( n \) differentiated goods,

\[
C_M = \left[ \sum_{k=1}^{n} c_k^{\sigma} \right]^{1/\sigma}, \quad \sigma > 1
\]

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 \( \sigma \).

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

\[
TC_{Mi} = w_i^{1-\eta} Q_i^{\eta}(x + \beta x_{Mi}), \quad \eta \in [0, 1]. \tag{3}
\]

\(^2\) The assumption that trade costs are zero in the A-sector is not innocuous, as noted by Davis (1998), since this sector has to adjust to accommodate agglomeration in the manufacturing sector. Trade costs in this sector therefore dampen the tendencies of agglomeration. Davies notes that there is a knife edge case when trade costs are such that no agglomeration takes place.
In Eq. (3), the parameter $\eta$ is the share of total costs that goes to the purchase of intermediates (with price $Q_{Si}$) while $1-\eta$ to labour. 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). As part of its industrial policy, the government may want to tax or subsidise manufacturing production, in which case a tax $(t_{Mi}>0)$ or subsidy $(t_{Mi}<0)$ based on total costs will be introduced. Profits in downstream 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 inapplicable.

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 $\sigma/\sigma-1$ over marginal costs the f.o.b. price from country $i$ is given by

$$p_{Mi} = \frac{\sigma}{\sigma-1} \beta w_{i}^{1-\eta} Q_{Si}^{\eta}(1 + t_{Mi}).$$

Manufactured goods are tradeable, but we assume Samuelson iceberg type trade costs, so that only $1/\tau_{M}$ of each unit shipped actually reaches its destination. This means that the c.i.f. price is $\tau_{M}$ 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 $x_{Mi}=x_{M}=z(\sigma-1)/\beta$ in equilibrium. Choosing units $\beta=\sigma-1/\sigma$, this gives $x_{M} = z\sigma$ and $p_{Mi}=w_{i}^{1-\eta} Q_{Si}^{\eta}(1 + t_{Mi})$.

Taking the dual of $C_{M}$, we find that the price index for the manufacturing good is

$$Q_{Mi} = \left[ n_{i} p_{Mi}^{1-\sigma} + n_{j} \left( \tau_{M} p_{Mj} \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}},$$

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

$$P_{i} = p_{i}^{1-\eta} Q_{Mi}^{\eta} \quad i = h,f.$$

The production technology for manufactured goods requires a composite of intermediate goods and labour. 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 labour as fixed costs and $b$ per unit of output, thereafter, and has a total cost function given by

$$TC_{Si} = w_{i}(a + bx_{Si}).$$

Again, a government may choose to tax $(t_{Si}>0)$ or subsidise $(t_{Si}<0)$ the cost of producing intermediate goods, i.e. profits are given by $\pi_{Si}=p_{Si}x_{Si}(1+t_{Si})TC_{Si}$. The elasticity of substitution between any pair of differentiated intermediate goods is equal to
and firms thus set a constant markup $\varepsilon/\varepsilon - 1$ over marginal costs the f.o.b. price from country $i = h, f$, is given by

$$p_{Si} = \frac{\varepsilon}{\varepsilon - 1} b w_i (1 + t_{Si})$$

(8)

Intermediates are also tradeable, and we assume iceberg trade costs, $\tau_S$, in this sector. 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 $x_{Si} = x_S = a(\varepsilon - 1)/b$, and after setting $b = \varepsilon - 1/\varepsilon$, $x_S = a\varepsilon$ in equilibrium.

The dual price index for the intermediate good is

$$Q_{Si} = \left[ m_i p_{Si}^{1-\varepsilon} + m_j (\tau_{PS})^{1-\varepsilon} \right] \tau_S^{1-\varepsilon}, \quad i \neq j,$$

(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 down stream firms, as seen in Eq. (3).

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

$$E_{Mi} = \gamma Y_i, \quad i = h, f.$$

(10)

Using Shepard’s lemma on Eq. (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

$$E_{Si} = \eta T C_{Mi} n_i, \quad i = h, f.$$

(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 $i$:

$$x_{Mi} = p_{Mi}^{1-\varepsilon} Q_{Mi}^{\varepsilon-1} E_{Mi}, \quad x_{Mj} = p_{Mi}^{1-\varepsilon} q_{Mj}^{\varepsilon-1} E_{Mj}, \quad i \neq j.$$  

(12)

$$x_{Si} = p_{Si}^{1-\varepsilon} Q_{Si}^{\varepsilon-1} E_{Si}, \quad x_{Sj} = p_{Si}^{1-\varepsilon} q_{Sj}^{\varepsilon-1} E_{Sj}, \quad i \neq j.$$  

(13)

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

$$\sigma x \geq p_{Mi}^{1-\varepsilon} q_{Mi}^{\varepsilon-1} E_{Mi} + \tau_M^{1-\varepsilon} q_{Mj}^{\varepsilon-1} E_{Mj}, \quad n_i \geq 0, \quad i \neq j.$$  

(14)

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

$$a \varepsilon \geq p_{Si}^{1-\varepsilon} q_{Si}^{\varepsilon-1} E_{Si} + \tau_S^{1-\varepsilon} q_{Sj}^{\varepsilon-1} E_{Sj}, \quad m_i \geq 0, \quad i \neq j.$$  

(15)

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

$$L_{Ai} = L_i - (1 - \eta)w_i^{-\eta}Q_S^i n_i x\sigma - m_i a e.$$ (16)

Eqs. (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 affect wages.

A government may choose to tax or subsidise 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 back to the consumers in the same way. The public budget constraint is given by

$$w_i L_i t_i + t_M w_i^{-1 - \eta} Q_S^i n_i x\sigma + t_S w_i a e m_i = 0,$$ (17)

and disposable consumer income equals

$$Y_i = (1 - t_i)w_i L_i.$$ (18)

The general equilibrium is characterized by the Eqs. (2), (4), (5), (8–11), (14-17), and (18), which can be solved to give equilibrium values for $w_i, Q_S, Q_M, p_M, p_S, E_M, E_S, n_i, m_i, t_i, Y_i, L_{Ai}$, for $i = h, f$.

### 3. Equilibrium locations of manufacturing

In this paper, we focus on industrial policy directed towards industrial clusters. Before turning to the policy analysis, however, we now investigate the conditions for an equilibrium with such a cluster to emerge. Table 1 provides an overview of the—in principle, possible—equilibrium location configurations. M and S indicate that the M- and S-industries are active in their respective countries, and we leave out the mirror image of each configuration.

The first thing to note is that with equal wages, as in our case, equilibria of types (c) and (e) are ruled out. The reason is that demand for the S-sector stems entirely from the downstream M-sector. The S-sector would therefore never locate in a region without M-sector firms as long as the cost of labour is equal in both locations. Second, as in virtually all models of this type, agglomerated equilibria of type (a) as well as symmetric equilibria of type (b) exist. The parameter space for which the equilibria (a) and (b) are (locally)

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<td>(a)</td>
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stable can be analytically established, and is derived below for our case of interest—the agglomerated equilibrium. For the remaining types of equilibria, we must rely on numerical simulations to establish their existence and stability properties. Such numerical simulations are based on the assumption that upstream and downstream firms move in response to locational profit differentials, e.g. that the localization of firms in the two vertically linked industries is governed by the following laws of motion:

\[
\begin{align*}
\dot{s}_M &= s_M(1 - s_M)(\pi_{M1} - \pi_{M2}) \\
\dot{s}_S &= s_S(1 - s_S)(\pi_{S1} - \pi_{S2}),
\end{align*}
\]

where \(s_M\) and \(s_S\) are the shares of downstream and upstream firms in country \(h\), and \(\pi_{Mj}\) and \(\pi_{Sj}\) are the profits of an upstream and downstream firm in country \(j\). Laws of motion of this type imply that firms have static expectations and quadratic moving costs, see Baldwin, 1999. The stability properties of the model can then be gauged from velocity plots, where arrows show the composant of the right-hand side of the two equations. Because of space considerations the actual graphs of the simulations are suppressed, and instead we describe the outcomes.

Symmetric distribution (of type b in Table 1) and complete agglomeration (type a) of manufacturing activity are always equilibria, as is in line with the standard new economic geography of the type employed here. For high trade costs, the symmetric equilibrium is globally stable, while agglomeration is unstable. The opposite is true for low trade costs. Finally, for a very small range of intermediate trade costs, there exist asymmetric equilibria (of type b). The asymmetric equilibria are unstable, whereas both complete agglomeration and symmetric distribution are locally stable equilibria for this level of trade costs. In our case, with equally sized countries, no equilibria of type (d) appear.

Our point of departure in the policy analysis is an agglomerated equilibrium where one country—say home—possesses a cluster of upstream and downstream firms. As noted, this type of equilibrium exists, and is stable for a certain range of parameter values. We now establish analytically the exact parameter range for which this equilibrium is locally stable.

Formally, agglomeration of both manufacturing industries in \(h\) is locally stable if, and only if, the sales of a first (potential) deviating firm relocating to country \(f\) are too low to break even. In such a case, there will not be any firms migrating from country \(h\) to country \(f\). Because of constant mark-ups, profits only depend on sales. The first final producer that moves to country \(f\) faces demand

\[
x_{Mf}^* = \left(\frac{p_{Mf}}{p_{Mh}}\right)^{-\sigma} \left(\frac{\pi_M^{-\sigma}Y_h + \pi_M^{\sigma-1}Y_f}{n_hp_{Mh}}\right),
\]

whereas the first deviating supplier faces demand

\[
x_{Sf}^* = \left(\frac{p_{Sf}}{p_{Sh}}\right)^{-\varepsilon} \left(\frac{\pi_S^{1-\varepsilon}E_{Sh} + \pi_S^{-1}\varepsilon E_{Sf}}{m_hp_{Sh}}\right).
\]

Note that Eq. (20) is derived under the assumption that the entire upstream industry is concentrated in country \(h\), and Eq. (21) 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 is \( x_S = a \varepsilon \) for S-sector firms. The equilibrium with agglomeration in \( h \) is therefore stable—in other words, sustainable—as long as

\[
\frac{x^*_M}{\alpha \sigma} < 1. \tag{22}
\]

for final producers and

\[
\frac{x^*_S}{a \varepsilon} < 1 \tag{23}
\]

for producers of intermediate goods.

An asymmetric equilibrium implies that \( n_f = m_f = 0 \), giving price indices

\[
Q_M = n_h^{-1} p_{Mh}, \quad Q_M = \tau_M Q_{Mh}, \quad Q_S = m_h^{-1} p_{Sh}, \quad Q_S = \tau_S Q_{Sh}, \tag{24}
\]

with \( p_{Sh} = (1 + t_{Sh}) w_h \) and \( p_{Mh} = (1 + t_{Mh}) Q_{Sh}^{-1} w_h^{1+\eta} \). Using these together with price Eqs. (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 stability conditions may be rewritten as

\[
\frac{x^*_M}{\alpha \sigma} = \left( 1 + t_{Mf} \right)^{-\sigma} \tau_S^{-\alpha \eta} \tau_M^{1-\sigma} \left( 1 + \frac{Y_f}{Y_h} + Y_f \left( \tau_M^{2(\sigma-1)} - 1 \right) \right) < 1 \tag{25}
\]

\[
\frac{x^*_S}{a \varepsilon} = \left( 1 + t_{Sf} \right)^{-\varepsilon} \tau_S^{1-\varepsilon} < 1. \tag{26}
\]

A plot of these conditions reveals that Eq. (25), the sustainability condition of the downstream industry, exhibits a U-shape in trade costs while Eq. (26) the sustainability condition of the upstream industry does not. The U-shape is a result of the well-known, non-linear interaction of agglomeration and dispersion forces (cf. Fujita et al., 1999): A low degree of product market competition attracts downstream firms to the foreign country. The inferior access to intermediate inputs facing a deviating firm works in the other direction, and this latter force is strongest for intermediate trade costs. The production of a deviating upstream firm, on the other hand, rises monotonically as trade costs fall. Its entire market lies in the home country, so the disadvantage of locating in the foreign country decreases monotonically as trade costs fall.

Higher elasticity of demand (\( \sigma \)) 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 not—in the absence of taxes—affect the sustainability of the supplier sector. We return to the latter point below. In contrast, a higher \( \varepsilon \) leads to increased competition among upstream firms, and implies that market access becomes 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 falls with decreasing trade costs.

An increased use of intermediates (\( \eta \)) strengthens the agglomerations forces sustaining the industrial core in country \( h \), shifting the curves down. As for the expenditure share on manufacturers (\( \gamma \)), 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.

Consider now the impact of economic integration ($\tau$) on the home country. Starting at high trade costs S-sector firms will never migrate since their entire market lies in the home country. For M-sector firms, on the other hand, the advantage of being the sole local provider of manufacturing goods in the foreign country is most pronounced for high trade costs. Product market competition will therefore induce migration of downstream firms in country $f$ for high enough trade costs, provided that the linkages to the upstream sector are not too strong.

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 declines accordingly. However, as integration deepens further, the forces for agglomeration become weaker and then cease to matter as trade costs go to zero ($\tau=1$).

To be able to abstract from features other than the industries’ rank in the value chain of the cluster, we shall assume trade costs to be the same for intermediates and final goods when discussing sustainability of an industrial cluster. However, it is instructive to discuss the effect of different trade costs for upstream and downstream goods on equilibria configurations and stability. First, consider the two extreme cases where intermediates and final goods are alternatively non-tradable. From Eqs. (25) and (26), it is easily seen that with non-tradable intermediates, an equilibrium with agglomeration of manufacturing in one country is always sustainable. The opposite is true for the case of non-tradable final goods, where a cluster is never sustainable simply because consumers are equally divided between locations and no market can be served through export. These examples underscore the general tendency that trade costs in the two sectors may pull in opposite directions: High trade costs in the M-sector lead to dispersion of this sector and therefore also to a tendency of dispersion of the S-sector. High trade costs in the S-sector, on the other hand, lead to concentration of this sector and therefore also to a stronger tendency for concentration of the M-sector.

4. Industrial policy

We now turn to the analysis of optimal industrial policy directed towards a vertically linked manufacturing cluster. We concentrate on a case where the cluster is stable in the absence of government intervention. This implies that we are analysing the model within a parameter space where Eqs. (25) and (26) hold. When analysing industrial policy, it is assumed that the government is restricted by its wish to maintain the cluster. Consequently, we analyse policies that may improve the allocation within one type of locational equilibrium, namely the one where all manufacturing is agglomerated in one country, say home. Industries in a cluster may require differential treatment, and in particular, we show that optimal policy may differ for upstream and downstream firms. To make this point, we focus on the case where the upstream and downstream sectors are as similar as possible in terms of technology and demand characteristics, thereby abstracting from other features
than their rank in the value chain of the cluster. Consequently, our central parameter case is based on the assumption of $\tau_S = \tau_M$, $\epsilon = \sigma$, and $\eta = \gamma$. Moreover, we assume the foreign country to be entirely passive, i.e. not to pursue any industrial policy, so that questions related to policy competition are left untouched.

Industrial policy is, as such, an issue, because the present economic geography model gives rise to two sources of pecuniary externalities. The first is associated with the link between upstream producers and their customers-downstream firms. The second is associated with the link between down-stream 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. Hence, policy interventions may be justified. Hence, the question we address is whether a government can enhance national welfare by conducting an active industrial policy or whether laissez-faire is a preferred option.

Internationalisation has two important features: it affects the mobility of firms and it affects trade costs. With respect to mobility we shall treat the two polar cases. First, we consider the situation where firms are immobile, for instance, due to capital controls. Second, we look at the situation where firms can move without cost. With immobile firms, policy can, by assumption, never induce the migration of firms. In contrast, with internationally mobile firms, policy makers need to take firms’ profits into account when designing industrial policy, in order to avoid outflow of firms and thus the vanishing of the industrial cluster.

4.1. Internationally immobile firms

The point of departure is an equilibrium with the entire manufacturing sector agglomerated in country $h$, while country $f$ is completely specialised in agriculture. We consider a tax system that allows for taxes on (or subsidies to) labour income, costs in the upstream industry, as well as costs in the downstream industry. The government’s objective is to maximise agents’ indirect utility function with respect to $t_M^h$ and $t_S^h$ subject to the public budget constraint. The government’s maximisation problem is therefore given by

$$\max_{t_M^h, t_S^h} V_h = \frac{\gamma^\eta (1 - \gamma)^{(1 - \gamma)} Y_h(\cdot)}{L_h P_h(\gamma)^\gamma},$$

subject to

$$w_h L_h t_h + t_M^h w_1^h Q_S^h n_h \sigma + t_S^h w_h a e m_h \geq 0.$$  \hspace{1cm} (27)

Examining the solution to the maximisation 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 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

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3 This type of tax instrument is natural, since it allows the government to achieve a first best allocation contrary to, for instance, a tax on the fixed cost or on the marginal cost.
that the interaction between the desirability of variety, increasing returns and imperfect competition leads to a market outcome that does not yield the socially optimum number of varieties. 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 fixed costs. 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 a straightforward matter to show that the results are completely analogous: Subsidies are determined by the elasticity of demand in the respective industry with $t_{Mh}^* = -\frac{1}{\sigma}$ and $t_{Sh}^* = -\frac{1}{\epsilon}$. 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 Eq. (8). Moreover, the total subsidy given to the upstream industry amounts to the sum of fixed costs in the industry, $TC_{Sh} = (1/\epsilon)W_h(a+bx)m_h = am_h$. 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 an open economy. The government chooses taxes so as to maximise Eq. (27), and in line with the result for a closed economy, the optimal tax in the upstream sector is again

$$t_{Sh}^* = -\frac{1}{\epsilon}.$$ (28)

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

The optimal tax for the downstream sector is a much more complicated expression (see Appendix A). For the case with equally sized countries, which we concentrate on here, extensive numerical simulation suggests that optimal policy typically involves a tax rather than a subsidy for this sector $(t_{Mh}^* > 0)$. However, we note that this result is indeed sensitive to our assumption that countries are symmetric in size.

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 affect wages, since due to the assumptions of the model, wages are fixed and equalised across sectors. The rents that are regenerated by the industrial agglomeration will thus be passed on in full to consumers—domestic and foreign—through prices and number of varieties. This means that downstream subsidies imply increased 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 must 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 economic integration and reduction of obstacles to trade, such a policy mix hardly seems a relevant option.
While simulations show that the tax rate $t_{Mh}^*$ is generally positive, it follows from the expression for $t_{Mh}^*$ as shown in Appendix A, that elasticities of substitution, linkages and consumer preferences are decisive for sign and magnitude of $t_{Mh}^*$. We find that stronger vertical linkages ($\eta$) and an increased expenditure share on manufacturing ($\gamma$) give enhanced agglomeration rents and a higher optimal tax rate: The stronger the linkages, the larger the equilibrium size of the upstream sector and the more subsidies it receives. Gains to consumers from the policy interventions in the upstream sector are larger as well as are the rents which the national government would like to extract back from foreign consumers. 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.

Based on the arguments of Dixit and Stiglitz (1977), it is moreover straightforward to explain the relationship between elasticities of substitution and tax on downstream: Increased elasticity of substitution among final goods ($\sigma$) reduces the market failure and the incentive to subsidise the downstream industry, while the incentive to use tax as an instrument to shift rents back to domestic consumers remains, and becomes more predominant. All else being equal, this thus increases the optimal tax rate. However, an enhanced elasticity of substitution in the upstream industry ($\epsilon$), which reflects a less significant market failure regarding intermediates, also has an effect on the downstream policy. Export of final goods not only allows foreigners to benefit from agglomeration rents, but also allows them to benefit indirectly from subsidies given to upstream. The tax on downstream allows for both to be shifted back. A higher $\epsilon$ is consequently associated with a lower $t_{Mh}^*$, since there are less rents and subsidies to be shifted back.

Finally, the expressions for optimal tax rates on upstream and downstream convey that these are indeed independent of trade costs. As we shall see shortly, this is in contrast to what is the case when firms are internationally mobile.

4.2. Internationally mobile firms

Now we proceed to internationally mobile firms. The mobility across borders affects the maximisation problem faced by the government in country $h$, since taxes affect firms’ incentives to migrate to the foreign market. Differentiation of Eqs. (25) and (26) yields by inspection

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

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 composite goes up, as the price of each variety increases at the same time as
the 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 it explains why a tax on upstream actually encourages downstream firms to stay in the industrial core in $h$.

Firms becoming internationally mobile means that the policy mix that appeared optimal in a situation with immobile firms may no longer be optimal if it encourages firms to move out. We shall compare the two general policy options facing a government: (i) to conduct an active industrial policy maximising welfare subject to the constraint that the industrial agglomeration is sustained (i.e. solving Eq. (27) with the additional restrictions Eqs. (25) and (26); and (ii) to follow a line of “laissez-faire” (i.e. setting $t_{Mh}=t_{Sh}=0$).

Since we are primarily interested in the implications of internationalisation for the conduct of industrial policy, we examine how welfare evolves as trade costs decline. Parameter values at our point of departure are within the parameter space where the industrial agglomeration is stable in the absence of government intervention. To compare the options facing the government, we shall again rely on numerical simulations. We report the outcomes for our central set of parameter values, but qualitatively the same pattern emerges as long as the point of departure is within the mentioned parameter space.

We first consider the case where the government conducts an active industrial policy and maximises welfare as per Eq. (27) subject to the additional constraints that the agglomeration should be maintained, i.e. Eqs. (25) and (26). The slightly bell shaped curve in Fig. 1 illustrates the solution to the maximisation problem, where welfare is drawn as a

![Fig. 1. Policy evaluation—the impact of integration on welfare.](image-url)
function of trade costs. The notion “active government” refers to policy option (i), while the notion “passive government” refers to policy option (ii). Fig. 2 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 domestic extraction of the rents created in the industrial agglomeration is greatest. The non-monotonic relationship between welfare and trade costs reflects the non-monotonic agglomeration forces affecting the M-sector.

In a situation with immobile firms, we have shown that a welfare maximising government may typically want to subsidise 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. The sustainability constraint related to the upstream sector never binds, 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.4

Worth noting, though, is that the gains from the intervention line reach a maximum at intermediate costs, at which the tax on downstream and subsidy to upstream get as close as possible to what would have been optimal levels in a situation without internationally mobile firms. What characterises this situation is both relatively high subsidies and high taxes. This reflects the fact that strong agglomeration forces both allow for intervention correcting for

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4 For the choice of the parameter values used for the stimulations underlying Figures 4 and 5 optimal rates would have been $t_{Ma}^*=0.53$ and $t_{Sa}^*=-0.4$ in the case of immobile firms.
the market failure as well as for the local extraction of the rents generated in the agglomeration.

Finally, the laissez-faire line always gives lower welfare than an active government as long as trade costs are positive.

5. Conclusion

This paper examined the design of industrial policy in an economy hosting an industrial cluster of vertically linked industries. Policy analysis is undertaken within a non-strategic setting, and it is assumed that the government’s objective is to maximise national welfare. We show that while in a closed economy, optimal industrial policy would imply the subsidising of both downstream and upstream industries, this is not necessarily optimal in an open economy setting. Disregarding issues related to internationally mobile firms and sustainability of the industrial agglomeration, the optimal policy mix may in the latter case be to subsidise the upstream sector to correct for the pecuniary externality, but then to levy a tax on the downstream sector as means of rent-shifting from foreign consumers.

The sustainability of the industrial cluster does, however, put restrictions on the government’s welfare maximisation problem. In particular, taxing the downstream sector is only possible to a limited extent. Nevertheless, government intervention leads to higher national welfare than would have been the case without intervention.

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Appendix A. Optimal taxes

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

\[ Y_f = 1, \quad Y_h = (1 - t_h). \]  

(30)

Free entry, zero profits, and product market clearing in the upstream sector (S) imply that

\[ \frac{\gamma (Y_f + Y_h)}{(1 + t_{sh})} = p_{sh} x_{sh} m_h, \]

which together with Eqs. (8) and (30) gives number of upstream varieties:

\[ m_h = \frac{\gamma (2 - t_h)}{ac(1 + t_{sh})(1 + t_{mh})}. \]

(31)
The number of downstream varieties is determined by zero profits and product market clearing in the market for M goods \( \gamma (Y_h + Y_f) = p_M x_M h n_h \), which together with Eqs. (4) and (30) gives the number of downstream varieties:

\[
n_h = \frac{\gamma (2 - t_h)}{x a m^{\frac{1}{2 \gamma}} (1 + t_{sh})^n (1 + t_{mh})}
\]  

(32)

Using Eqs. (31), (32) and (17) yields \( t_h \), taxon labour income, as a function of \( t_{sh} \) and \( t_{mh} \):

\[
t_h = \frac{-2 \gamma (t_{mh} (1 + t_{sh}) + \eta t_{sh})}{1 + (1 - \eta \gamma) t_{sh} + t_{mh} ((1 - \gamma) (t_{sh} + 1))}
\]  

(33)

Eq. (33) allows us to eliminate \( t_h \) in Eq. (27), which can then be solved for optimal \( t_{sh} \) and \( t_{mh} \):

\[
t_{sh}^* = -1 / \varepsilon
\]

\[
t_{mh}^* = \frac{1}{2} (2 \varepsilon + \gamma^2 - 2 - \gamma \varepsilon - \gamma^2 \varepsilon + \gamma - \gamma \eta \sigma + \gamma^2 \eta \sigma
\]

\[- \sqrt{(4 - 4 \gamma + 4 \gamma \eta \sigma + 4 \sigma^2 \gamma^3 \eta - 2 \gamma^3 \eta \sigma + \gamma^4 \varepsilon^2 - 2 \gamma^3 \eta \sigma^2 + 8 \gamma^2 \varepsilon^2 \sigma + 8 \sigma \gamma^3 \varepsilon)}
\]

\[-4 \sigma^2 \gamma^2 \varepsilon^2 - 8 \gamma \varepsilon \sigma - 16 \sigma^2 \gamma^2 \varepsilon + 4 \gamma^2 \sigma - 2 \gamma^4 \eta \sigma + \gamma^3 \eta^2 \sigma^2 - 4 \gamma \eta \sigma^2 - 4 \sigma \gamma^3 \varepsilon
\]

\[+ \gamma^4 \eta \sigma^2 + 8 \sigma^2 \gamma^2 \varepsilon - 8 \varepsilon + 8 \gamma \varepsilon \sigma + 6 \gamma^2 \varepsilon - 8 \sigma - 3 \gamma^2 + 4 \sigma^2 - 4 \sigma^2 \gamma^3 \varepsilon
\]

\[+ 2 \gamma^4 \varepsilon \eta \sigma + 2 \gamma^2 \varepsilon ^2 \varepsilon + 4 \gamma \eta \sigma \varepsilon + 4 \varepsilon \sigma - 4 \sigma \eta \sigma - 4 \gamma \sigma^2 - 4 \sigma^2 \gamma^2
\]

\[+ 4 \varepsilon^2 \sigma^2 - 8 \sigma \varepsilon^2 + 2 \gamma^4 \varepsilon - 4 \gamma^2 \varepsilon^2 - 4 \gamma^3 \varepsilon + 4 \gamma^3 \varepsilon^2 + 8 \sigma \gamma^2 - 8 \varepsilon^2 \sigma + 16 \varepsilon \sigma + 2 \gamma^3 \varepsilon^2
\]

\[-3 \gamma^2 \varepsilon^2 + 4 \gamma \sigma) / (- \sigma \gamma^2 + \sigma \gamma^2 \varepsilon - \varepsilon \sigma + \sigma)
\]

Solving for \( t_{mh} \) gives two roots, only one of which is economically relevant. Optimal policy typically involves a tax on downstream. Fig. 3 is drawn for \( \gamma = \eta \) and \( \varepsilon = \sigma \), and shows that \( t_{mh}^* > 0 \) as long as \( \sigma > 2 \).

Parameter values for Figs. 1 and 2: \( \gamma = \eta = 0.45, \ a = \alpha = 0.4, \ \varepsilon = \sigma = 2.5 \)

Fig. 3. Optimal tax rate on the downstream sector.
References