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Clusters and comparative advantage: Implications for industrial policy

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Abstract

Cases of industrial agglomeration or "clusters" arise in the presence of industry-specific and local externalities, also called Marshallian externalities. The standard argument is that such externalities may justify a policy of infant-industry protection to allow and encourage clusters to emerge. In this paper I explore this carefully, and show that different policy implications emerge under a more realistic modeling of clusters. In particular, rather than distorting prices to promote clusters in "advanced sectors" that may exhibit strong clustering possibilities, countries should focus instead on promoting clustering in current sectors, which have revealed to have the strongest comparative advantage. Import substitution is not a proper way to achieve this.

JEL classification: F13; O24; O33; O41

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1. Introduction

A long tradition among academics and development practitioners holds that economic development is associated with the realization of agglomeration economies. In policy circles, this is evident in the focus on "clusters" as an important concept in understanding growth and in thinking about development policy (Porter, 1990). Clusters arise in the presence of "Marshallian externalities," which signifies that firms benefit from the production and innovation activities of neighboring firms in the same and related industries.[1] There is abundant evidence that such externalities exist and lead to industry-level agglomeration (Rosenthal and Strange, 2004). But

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[1] See Duranton and Puga (2004) for recent survey of the microfoundations of agglomeration economies.

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what is the appropriate policy in the presence of Marshallian externalities (ME)? From a classical optimal-policy perspective, the correct approach would be to provide a production subsidy to firms generating ME, with the subsidy calibrated to match the value of the externality. The problem, of course, is that this places very stringent information requirements on policy. The general view is that "advanced" or "technology-intensive" sectors are the ones in which ME are stronger. In fact, recent empirical evidence appears to be consistent with this idea.[2] Does this validate the common suggestion that countries should promote development of technologically advanced sectors, perhaps through import substitution?

In this paper I will argue that import substitution, or any policy that distorts prices so as to push resources toward "advanced" industries, is not an appropriate way to deal with ME in small developing countries. There are two reasons for this. First, ME are not an intrinsic characteristic of an industry: the same industry could generate ME in one place and not the other, in one stage of its evolution and not another. A good example of this is the experience of many countries that promoted basic manufacturing through Export Processing Zone systems, but failed to generate clustering and benefit from ME (see Altenburg and Meyer-Stamer, 1999). The second reason why import substitution is not necessarily appropriate in the presence of ME is that if an industry generates stronger ME, some advanced country is likely to be already benefiting from the higher productivity that comes from clustering in this sector. International prices would then be lower and nullify the stronger benefits of clustering.

The consequence of this last point is that the strength of ME does not matter in choosing which clusters to promote. Rather, what matters is plain old comparative advantage. To show this in the simplest manner, in the next section I review the standard model of a small open economy in which one of the sectors exhibits ME. This model has been used to motivate the use of import substitution (IS) as a development strategy (see Ros, 2000). I derive the standard result (or Mill test, see Corden, 1997) that IS makes sense only if the economy has a (natural or Ricardian) comparative advantage in the sector that has ME. If "advanced" sectors are the ones exhibiting ME, then this already suggests that IS is not a reasonable policy for poor countries, which are not likely to have a comparative advantage in these sectors.[3]

But consider the case of a developing country that *has* a comparative advantage in a sector with ME. According to the standard model, temporary IS would make sense. The problem here is that if — as argued above — ME are not intrinsic to particular sectors, but rather arise from the particular way in which production is organized, then IS may not work. To explore this possibility, Section 3 develops an alternative model in which all sectors are amenable to experiencing ME (although the intensity of these externalities may vary across sectors) but this depends on the mode of production. Thus, instead of assuming that externalities are associated with certain *industries*, I postulate that externalities are related to the *technology* with which goods are produced. This captures the idea that what matters is not "what you produce, but how" (Porter, 1998; De Ferranti et al., 2001), and is related to the concept of "industrial districts" in which firms attain high productivity thanks to the formation of dense networks (Markusen, 1996). I will discuss several implications of this model, and in particular show that IS does not

[2] In a recent review of the evidence, Rosenthal and Strange (2004) conclude that an important component of ME is knowledge spillovers, which are obviously stronger for knowledge intensive industries.

[3] Some authors would claim that East Asian countries did have a natural comparative advantage in manufacturing, and that infant-industry protection was a key to allow this sector to develop (Amsden, 1989; Wade, 1990). Others disagree that industrial policy played a major role (Noland and Pack, 2003).

make sense; rather, the best policy entails the *direct* promotion of clustering in the sector in which the country has a comparative advantage. Interestingly, the optimal policy is not affected by the inter-sectoral differences in the strength of ME; in particular, the focus should always be on the sector with the strongest comparative advantage, rather than the sector that enjoys the strongest possible ME.

One drawback of both the standard model and this alternative model is that they incorporate only static externalities, whereas the empirical literature reveals that dynamic externalities (e.g., external learning by doing) are equally if not more important. Moreover, since dynamic externalities are strongly associated with knowledge spillovers (Rosenthal and Strange, 2004), then they are very likely to be accompanied by international spillovers, something left out of most models. The static nature of the models also has the disadvantage of making it difficult to relate them to the recent literature on endogenous growth. In Section 4, I show a simple way of generalizing the model presented in Section 3 to incorporate dynamic externalities and international spillovers, while preserving the same policy implications.

There are, of course, some papers that explore the interaction between growth and clustering. For example, Martin and Ottaviano (2001) present a model in which agglomeration and growth are mutually self-reinforcing, so that trade (with transportation costs) may lead to both higher growth and agglomeration. The main goal of the extension presented in Section 4 is more modest, namely to establish that the results derived in Section 3 remain valid in a more realistic setting in which there are both endogenous growth and international spillovers. In addition, Section 4 shows how the income gap between countries that succeed in developing clusters versus those that do not is limited but not eliminated by international spillovers.

Finally, Section 5 presents some concluding remarks.

2. The standard model

This section presents a simple two-sector model to explicitly show how comparative advantage affects the ranking among equilibria in the presence of Marshallian economies. There is an extensive theoretical and empirical literature about the different sources of ME. Knowledge or technical externalities are much simpler to model because one can maintain the assumption of perfect competition, and this is the approach I follow below.[4] The reader should keep in mind, however, that ME also arise in the presence of increasing returns and transportation costs, which lead to pecuniary externalities and agglomeration economies.[5] As shown in Rodríguez-Clare (1996) and Rodrik (1996), increasing returns and transportation costs may lead a small open economy to exhibit multiple equilibria and coordination failures of the type presented below. Thus, the assumption of technical rather than pecuniary externalities is not essential to generate the kind of results presented in this and the next sections.

There are two countries, North and South, two goods and one factor of production, labor, in fixed supply, L_i, where $i=S$; N is a country index. Good 1 is produced with constant returns to scale and no aggregate externalities, with productivity possibly differing across North and South: a unit of labor produces λ_{1i} units of good 1 in country i. Good 2 is produced with constant

[4] See Audretsch and Feldman (2004) for a recent survey of the empirical literature related to knowledge externalities and their relevance for agglomeration economies.

[5] See Ottaviano and Thisse (2004) and Head and Mayer (2004) for recent surveys of the theoretical and empirical aspects of this literature.

returns to scale at the firm level, but there are aggregate externalities, so that labor productivity in country i is:

$$\lambda_{2i}\left[1+\alpha\min\left(\bar{L},L_{2i}\right)\right]$$

with $\alpha>0$ and $\theta\equiv 1+\alpha\bar{L}>1$. The term $1+\alpha\min(\bar{L},L_{2i})$ captures ME (i.e., static, local, industry-specific external economies) that are increasing with industry-wide employment, L_{2i}, but that are exhausted once the labor force in a sector reaches the level $\bar{L}$. The term θ can be seen as the maximum benefits of clustering in sector 2.[6] Just as for good 1, there may be exogenous productivity differences (independent of ME) across North and South in the production of good 2 (captured by differences in the productivity parameter λ_{2i}).

It is assumed that preferences satisfy the Inada conditions, hence any equilibrium must have positive production of both goods. Given the simple production structure of the model, this is all that is needed to assume about preferences to derive the main results.

I focus on a situation where the South is "small," so that international prices can be derived from the equilibrium of the North as if it were an isolated economy. Choosing labor in North as the numeraire, international prices are simply given by the North's unit labor requirements. Assuming that in equilibrium $L_{2N}>\bar{L}$ then $p_1^*=1/\lambda_{1N}$ and $p_2^*=1/\theta\lambda_{2N}$. Note that the benefits of clustering are reflected in a lower international price of good 2. This will become important later on.

Turning to the equilibrium analysis for South, imagine first that there are no Ricardian productivity differences, $\lambda_{ji}=1$ for all j, i. Let us confirm that there are multiple equilibria, with one equilibrium characterized by complete specialization in good 1 and the other by complete specialization in good 2. To confirm that specialization in good 1 is an equilibrium, note that with $\lambda_{1N}=1$ then $p_1^*=1$. Letting w denote the wage in South, this implies that $w=1$ if South is specialized in good 1. The unit cost of producing good 2 in South given that all labor is devoted to production of good 1 (and hence no benefits of clustering are realized) is then simply $w/\lambda_{2S}=1$, which is higher than the international price of this good $p_2^*=1/\theta<1$. The alternative equilibrium entails specialization in good 2. In this case, the wage in South would be such that the unit cost of producing good 2 would be equal to the price, or $w/\theta=p_2^*=1/\theta$,[7] hence $w=1$. Since $p_1^*=1$, complete specialization in good 2 is also an equilibrium.

Although there are multiple equilibria, the wage is not higher in the equilibrium with specialization in good 2. This is because even though the economy benefits from clustering in this equilibrium, this is exactly compensated by the lower price of this good, which in turn arises from the higher productivity in North derived from clustering.

There are two scenarios in which the equilibrium with complete specialization in good 2 would be superior to the one with specialization in good 1 for South. In the first one South is

[6] In the traditional model, $\bar{L}$ is infinite, so labor productivity is simply $\lambda_{2i}(1+\alpha L_{2i})$. The alternative assumption that these aggregate externalities are bounded is not only more realistic, but also leads to a simpler analysis. Moreover, this assumption allows us to focus on the issue of Ricardian or "natural" comparative advantage, as opposed to advantages arising from differences in size or scale. For an analysis where scale (but not infant-industry protection) takes center stage, see Ethier (1982), which formalizes the discussion relating to Frank Graham's argument for protection (Graham, 1923).

[7] It is assumed here that the total labor force in South is higher than $\bar{L}$, so that — just as in North — full clustering is realized when there is complete specialization in good 2. Otherwise, specialization in good 2 would not be an equilibrium. Note that this assumption implies that scale is not a relevant determinant of comparative advantage (see previous footnote).

the only producer of good 2. For this, of course, the South could no longer be assumed "small." Instead, one would need to solve for the two-country equilibrium. As shown in Helpman and Krugman (1985, chapter 3), the presence of ME in sector 2 allows the country that produces this good to have a higher wage than the country that specializes in good 1. For this to happen in equilibrium, however, it is necessary that the country that specializes in good 2 be small *relative* to the world demand for this good, so that this country produces *only* this good.

The second scenario under which the equilibrium with specialization in good 2 is superior to the one with specialization in good 1 entails exogenous productivity differences, so that the South has a "latent" or "natural" comparative advantage in the good subject to clustering. To see this, drop the assumption that $\lambda_{ji}=1$ for all j, i, and assume instead that

$$\lambda_{2S}/\lambda_{1S}>\lambda_{2N}/\lambda_{1N} \tag{CA}$$

Specialization in good 1 implies $w/\lambda_{1S}=p_1^*$ and for this to be an equilibrium we need $w/\lambda_{2S}>p_2^*$. Combining these two equations, the condition for specialization in good 1 to be an equilibrium is:

$$\frac{\lambda_{2S}/\lambda_{1S}}{\lambda_{2N}/\lambda_{1N}}<\theta$$

That is, the South's comparative advantage in sector 2 must be weaker than the benefits of clustering. On the other hand, specialization in good 2 implies that $w/\lambda_{2S}\theta=p_2^*$. This is an equilibrium if $w/\lambda_{1S}>p_1^*$. But given assumption CA, this inequality is always satisfied when $w/\lambda_{2S}\theta=p_2^*$. Thus, under assumption CA, specialization in good 2 is always an equilibrium.

To see which equilibrium has a higher wage, note that the equilibrium with specialization in good j has $w=\lambda_{jS}/\lambda_{jN}$. Given assumption CA, the wage with specialization in good 2 is higher. Just as in basic trade theory, the wage is higher if the economy specializes in the sector where it has a comparative advantage.[8] The difference here is that, due to Marshallian economies, the economy could find itself specialized in a sector where it doesn't have a natural comparative advantage. In this case, the goal of trade policy would be to push the economy towards the other equilibrium, a goal that could be achieved through a temporary tariff on good 2. Of course, this is nothing more than the classic case for infant-industry protection, where policy is supposed to turn a natural comparative advantage into an effective one.[9] Such a policy would be welfare

[8] There is actually a third scenario in which this can happen. This entails the existence of rents in sector 2, so that world prices in that sector are higher than production costs in North. In this case, South could be better off specializing in good 2 rather than good 1 even if it does not have a natural comparative advantage in that sector. Of course, such a move towards sector 2 would only be fruitful if the North doesn't react by lowering its prices to compete with Southern producers. Clearly, the conditions under which this argument becomes relevant (i.e., MEs, significant rents, and the absence of a competitive response in North) seem highly unrealistic. Also note that if whatever causes rents to arise in North is also present in South, then it could be advisable for South to engage in permanent protection of sector 2, but this is no longer a case of ME and infant-industry protection, but rather a standard application of the theory of domestic distortions and trade policy.

[9] John Stuart Mill (1909) is generally credited for being the first to express this idea in a clear and simple way, although it was Friedlich List (List, 1985) who vigorously argued for the adoption of infant-industry protection of manufacturing in European countries. See Corden (1997) for a discussion of the different arguments for and against infant-industry protection, and Irwin (1996) for an excellent treatment of its intellectual history.

enhancing provided it passes both the Mill and Bastable tests: the Mill test is that the protected sector can eventually survive international competition without protection, whereas the Bastable test is more stringent in requiring also that the discounted future benefits compensate the present costs of protection (see Corden, 1997). Infant-industry protection passes the Mill test if and only if condition CA is satisfied. Exploring the Bastable test would require a dynamic adjustment model that is beyond the scope of this paper.

Fig. 1 illustrates the previous results. The curve labeled PPF represents the production possibilities frontier for South, which is convex when $L_{2S}<\bar{L}$ (or $Q_2<\lambda_{2S}\theta\bar{L}$) and becomes linear when $L_{2S}\geq\bar{L}$ (or $Q_2\geq\lambda_{2S}\theta\bar{L}$). The curve labeled PPF_{NC} is the hypothetical production possibilities frontier when there are no ME (i.e., $\alpha=0$), given simply by a line with slope $\lambda_{1S}/\lambda_{2S}$, as in the standard Ricardian model. Note that the slope of the PPF is the same as the slope of PPF_{NC} at the corner where there is complete specialization in good 1. Thus, if the international relative price of good 2 (i.e., p_2^*/p_1^*) is lower than $\lambda_{1S}/\lambda_{2S}$ there is an equilibrium with complete specialization in good 1, whereas if p_2^*/p_1^* is higher than the slope of the PPF along its linear segment — namely, $\lambda_{1S}/\theta\lambda_{2S}$ — then there is an equilibrium with complete specialization in good 2. Clearly, then, if

$$\lambda_{1S}/\theta\lambda_{2S}<p_2^*/p_1^*<\lambda_{1S}/\lambda_{2S} \tag{P}$$

there is multiple equilibria, with the equilibrium with specialization in good 2 clearly delivering a superior consumption possibilities frontier for South. Noting that $p_2^*/p_1^*=\lambda_{1N}/\theta\lambda_{2N}$, the condition for there to exist an equilibrium with specialization in good 2 (i.e., condition P) is equivalent to CA.[10]

This analysis emphasizes that for infant-industry protection to make sense, it is not only necessary that the protected sector exhibit Marshallian externalities but also that the country has a natural comparative advantage in that sector.[11] This may present a problem for the practical relevance of this idea, since the good with Marshallian externalities is usually regarded as an "advanced" good, making it unrealistic to expect LDCs to have a comparative advantage in this sector relative to developed countries.

A valid reaction to this last remark is to ask why LDCs would not have a comparative advantage in "advanced" goods. A simplistic answer based on a Hecksher–Ohlin view of the world is that this is because LDCs are scarce in human and physical capital. This would not be correct, however, because from a development perspective it is clearly incorrect to think of capital stocks as endowments, rather than as the result of past investment decisions. In this case, capital scarcity cannot be the basis for comparative advantage. In fact, if labor is the only non-produced or primary factor of production, then Samuelson's nonsubstitution theorem implies that the long run production possibilities frontier is linear, just as in the Ricardian model (see Findlay, 1995). Thus, infant-industry protection would make sense only if South has a *Ricardian* comparative advantage in good 2. For countries with an abundance of natural resources (a true

[10] Fig. 1 may also be used to understand how specialization in good 2 may be superior to specialization in good 1 when South is no longer a small economy. To see this, imagine that there are no productivity differentials between South and North, imagine that these two regions have equal size, and imagine that demand for good 2 is sufficiently high that the equilibrium entails one country fully specialized in good 2 and the other fully specialized in good 1. Then, if condition P is satisfied, the country that specializes in good 2 is better off than the country that specializes in good 1.

[11] A key (but reasonable) assumption in generating this result is that the gains from clustering in sector 2 are the same across North and South. If such gains were somehow stronger in South, then cluster promotion against natural comparative advantage could make sense.

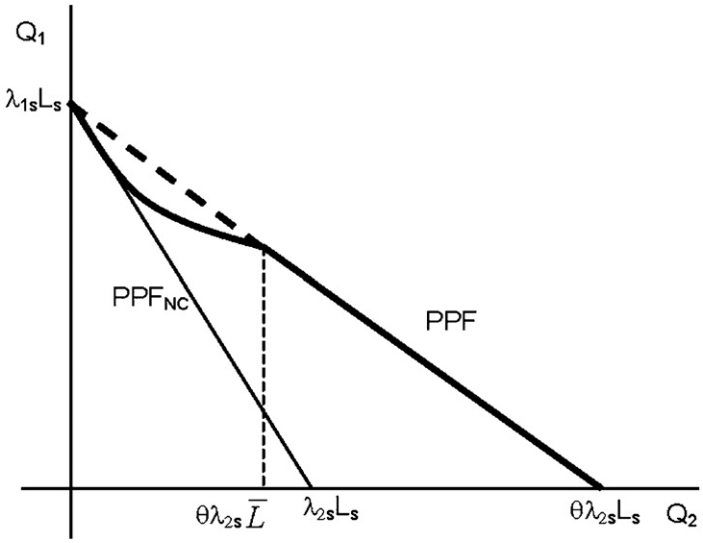

Fig. 1. Specialization in the presence of clusters.

endowment), this implies that it would not be advisable to think of manufacturing activities as being good candidates for infant-industry protection. For such countries, protection could increase investment and growth temporarily, but the ultimate effect would be a reduction in welfare.[12] The reverse argument, of course, could be relevant for land-scarce countries such as those of East Asia, which could be argued to posses a natural or Ricardian comparative advantage in manufacturing.

Moving beyond the issue of comparative advantage, a problem with the model presented in this section is that it assumes that the expansion of sector 2 *necessarily* brings about the benefits of clustering. As mentioned in the Introduction, however, this is not a reasonable assumption. In the next section I explore this issue in detail.

3. An alternative model

This section presents a model that deviates from the standard model in that both sectors exhibit Marshallian economies (perhaps to different degrees), although the realization of these economies is not a necessary outcome of the expansion of the sector. The critical assumption is that there are different technologies that can be used to produce a good, and that these technologies differ in the extent to which they generate externalities: clustering only happens if firms use the "modern" technology. This captures the idea that even sectors that are seen as "advanced" in developed countries can behave as backward or traditional sectors when they operate in LDCs, and hence fail to generate any externalities. Thus, this model shifts attention from sectors to modes of production as the crucial determinants of clustering.

[12] Even such a strong proponent of the infant-industry argument as List was clear on this, as he argued that "a country of the torrid zone would make a very fatal mistake, should it try to become a manufacturing country. Having received no invitation to that vocation from nature, it will progress more rapidly in riches and civilization if it continues to exchange its agricultural productions for the manufactured products of the temperate zone" (cited by Irwin, 1996, p. 126).

There are two goods, *both* of which could exhibit Marshallian economies. Each good can be produced using two technologies, which I call "backward" and "modern". The backward technology entails labor productivity λ_{ji}, where $j=1, 2$ is a sector index and $i=S, N$ is a country index. The modern technology entails labor productivity equal to:

$$\lambda_{ji}\left[\beta+\alpha\min\left(\overline{L}_j, L_{jiM}\right)\right]$$

where $0<\beta<1$ and $\theta_j \equiv \beta+\alpha\bar{L}_j>1$ for all j. There are two differences relative to the assumptions made above. First, ME now depend on the amount of labor employed *using the modern technology*, L_{jiM}. Second, if there are no ME realized (i.e., $L_{jiM}=0$) then productivity with the modern technology is lower than productivity with the backward technology ($\lambda_{ji}\beta<\lambda_{ji}$). This assumption is necessary for a situation with no cluster to be an equilibrium and is reasonable in that the benefits of the modern technology are realized only with enough ME realized. I allow $\bar{L}_j$ to vary across sectors, and hence θ_j will vary with j. Also, note that the exogenous productivity parameter λ_{ji} is independent of the technology used.

Goods are ordered in such a way that $\lambda_{2N}/\lambda_{2S}\geq\lambda_{1N}/\lambda_{1S}$, so that North has a natural comparative advantage in good 2. To simplify the exposition, I rule out the possibility that the static benefits of clustering are decreasing in j to such an extent that $(\lambda_{jN}/\lambda_{jS})\theta_j$ is lower for $j=2$ than for $j=1$. That is, I rule out the possibility that the sector in which the North has a Ricardian comparative advantage has much lower clustering potential. The role of this assumption will become clear below.

As in the previous section, I focus on the case where South is "small," so that international prices are completely determined by the equilibrium in North. To derive this equilibrium, note that North could be producing *each good* with clustering, with all labor employed in the sector using the modern technology ($L_{jNM}=L_{jN}$) and productivity higher than the one associated with the backward technology, or without clustering, with all labor employed in the sector using the backward technology ($L_{jNB}=L_{jN}$) and productivity higher than with the modern technology. In other words, there are multiple equilibria.[13] To simplify the analysis, it is assumed in the rest of this section and the next one that there are clusters in all sectors in North. Thus, equilibrium prices are simply $p_j^*=1/\theta_j\lambda_{jN}$ (recall that we use labor in North as the numeraire).

Turning to the South, imagine first that there are no Ricardian productivity differences, $\lambda_{ji}=1$ for all j, i, and also that $\theta_j=\theta$ for $j=1, 2$. There are multiple equilibria: an equilibrium in which the South specializes in a sector with a cluster (it could be either good 1 or good 2), in which case there is no income gap between North and South (i.e., $1/w=1$), and an equilibrium where the South has no clusters and there is no trade, in which case the income gap is given by $1/w=\theta>1$. In this second equilibrium, North is richer than South thanks to its clustering-induced higher productivity.

With Ricardian productivity differences and differences in the intensity of static externalities across sectors (i.e., $\theta_1\neq\theta_2$), there is an equilibrium in which South specializes completely in sector 1 and there is no cluster in this sector. The income gap would be $\theta_1\lambda_{1N}/\lambda_{1S}$. There is also an equilibrium with complete specialization in sector 1 with a cluster, in which case the income gap would be $\lambda_{1N}/\lambda_{1S}$. Finally, it could also be that South specializes completely in sector 2. This would only happen if good 2 was produced with the modern technology and clustering.

[13] To be more precise, there are four equilibria: one with no clustering, one with clustering in both sectors, one with clustering in good 1 and no clustering in good 2, and another one with clustering in good 2 and no clustering in good 1.

This is an equilibrium if and only if nobody wants to deviate and produce good 1 with the backward technology. To derive a condition for this, note that if South specializes in sector 2 with a cluster, then it must be that:

$$\frac{w}{\theta_2 \lambda_{2S}} = p_2^* = \frac{1}{\theta_2 \lambda_{2N}}$$

Thus, $w=(\lambda_{2S}/\lambda_{2N})$. The unit cost of good 1 produced in South without a cluster would be $w/\lambda_{1S}=(\lambda_{2S}/\lambda_{2N})/\lambda_{1S}$. For complete specialization in good 2 with a cluster to be an equilibrium, it is necessary that this be higher than p_1*, or:

$$\left(\frac{\lambda_{2S}}{\lambda_{2N}}\right)\left(\frac{1}{\lambda_{1S}}\right) > \frac{1}{\theta_1 \lambda_{1N}}$$

Simplifying,

$$\frac{\lambda_{1S}/\lambda_{1N}}{\lambda_{2S}/\lambda_{2N}} < \theta_1 \qquad (*)$$

This simply states that for complete specialization in good 2 with a cluster to be an equilibrium, it must be that comparative advantage in sector 1 relative to sector 2 not be too strong relative to the benefits of coordination in sector 1.[14]

Summarizing, there are multiple equilibria in the (small) South. One equilibrium entails complete specialization in the sector with the highest relative productivity (i.e., sector 1) and clustering in this sector. Another equilibrium entails complete specialization in this same good, but *without* a cluster. Finally, there is another equilibrium with complete specialization in sector 2 as long as condition (*) is satisfied. The first equilibrium, which entails clustering in the sector with the strongest comparative advantage, generates the highest income level. The second equilibrium, with specialization in that sector but without clustering, generates the lowest income level. The third equilibrium has an intermediate level of income. However, note that θ_2 does not affect income in this equilibrium. This is because the higher productivity generated by the stronger static externalities in sector 2 when θ increases is exactly compensated by a lower international price.

There is one important implication of these results regarding the income ranking of the different equilibria. If the government could choose the equilibrium, it would always choose an equilibrium with clustering, which is not surprising, but it would also choose an equilibrium with specialization in the sector with the strongest comparative advantage; the strength of externalities is not relevant for the choice among equilibria. This has important and surprising policy implications, since it implies that the government should not necessarily choose to promote clustering in sectors with the strongest externalities.

[14] The reader may have expected the condition to be stated in terms of the benefits of clustering in sector 2, rather than sector 1. But recall that since there is clustering in North, the international price of good 2 reflects productivity gains from clustering in that sector. Thus, it is *not* because of the gains of clustering in 2 more than compensate the loss in relative productivity that specialization and clustering in sector 2 can be an equilibrium. In fact, specialization with clustering in good 2 can be an equilibrium even if $\theta_2=1$, so that there are no benefits of clustering in sector 2. Rather, when a single producer deviates from full specialization in sector 2 to produce good 1, there is a gain in relative productivity but there is a loss associated with the production of a good where North has and South does not have a cluster. This loss is given by θ_2. For specialization in 2 to be an equilibrium, it is necessary that this loss be greater than the benefits from higher relative productivity, as stated in condition (*).

3.1. Policy implications

There are several additional policy implications of this model that I wish to highlight and discuss. The first is that protection in no way makes it more likely that a cluster will form, since the good can be produced without a cluster. Consider an initial situation where South is completely specialized in sector 1 with no cluster. Imposing a policy of import substitution (IS) would increase the domestic prices of good 2 and at some point South would start producing some of this good. But it could produce it *without* a cluster, just as it produces good 1 without a cluster. There is no reason why IS would lead to clustering! In other words, once we accept that production in the advanced sector can take place using backward technologies or modes of production, then it becomes clear that IS does not necessarily lead to externalities and clustering. IS could simply push resources towards what are regarded in rich countries as "advanced" sectors, but that once in LDCs could be organized in ways that do not generate any externalities.[15]

This reasoning has broader implications. Not only IS, but any policy (even export promotion) that distorts prices so as to push resources into "advanced" sectors would have the same problem. Instead of policies to reallocate resources across sectors, it would be better to implement policies to promote clustering in sectors that already show comparative advantage. This implies that, as generally accepted by proponents of cluster-based policies, governments should not try to create clusters from scratch.

An additional implication is that promoting a cluster is not necessarily welfare enhancing, since it could be a cluster without a comparative advantage. To see this, imagine that the South has no clusters. This immediately implies that it is specialized in sector 1. Imagine further that the government tries to promote a cluster in sector 2 and that $\lambda_{1S}/\lambda_{1N} > \theta_1\lambda_{2S}/\lambda_{2N}$. To do so, it would have to distort prices, because — since condition (*) is not satisfied by assumption — clustering in sector 2 is not an equilibrium with undistorted prices. But if it does this, then welfare would decrease. Alternatively, if condition (*) is satisfied, then there is an equilibrium with full specialization in sector 2 with a cluster, and it is conceivable that the government could induce the economy to switch to this superior equilibrium. Still, this equilibrium is inferior to the one with complete specialization and clustering in sector one. To summarize, when there are Ricardian differences (more generally, comparative advantage coming from sources different than clustering), promoting the creation of a cluster from scratch may be inferior to the status quo, and is always dominated by promotion of a cluster in sectors where the economy is already showing comparative advantage.

Finally, the model shows that it is not the case that governments should favor clustering in industries with stronger externalities. As explained in the previous section, this is because such stronger externalities lead to higher productivity and hence lower international prices. Thus, for example, if we imagine that higher indexed goods are "more advanced" and that more advanced goods have stronger externalities, then $\theta_2 > \theta_1$. A common presumption here would be that policy should target more advanced sectors, to benefit from stronger clustering. The model presented here shows that this presumption is not correct. Instead, the appropriate policy is to promote clustering in the sector that has the strongest comparative advantage. Thus, industrial policy is not about "creating comparative advantage," but about achieving the high productivity that comes from a cluster in the sector where it has a comparative advantage.

[15] This is related to Baldwin's (1969) critique of the infant-industry argument, which states that protection does not necessarily lead to "maturation" of the infant, since it fails to provide the right incentives to invest in acquiring more advanced technologies.

4. Dynamic externalities and international spillovers

In contrast to the models explored above, which focus exclusively on static externalities, the empirical literature reveals that dynamic externalities play a very important role in industrial agglomeration. Moreover, given that knowledge spillovers are the main mechanism through which these dynamic externalities operate, it is likely that they are accompanied by international spillovers. Although the region where the knowledge originates is likely to benefit more and sooner, other regions are likely to benefit as well from spillovers. This section presents a very simple way to introduce dynamic externalities and international knowledge spillovers into the model developed above. The policy implications discussed are not affected; the purpose of this section is to add realism to the cluster-based model and allow for a sharper comparison between this model and the recent endogenous growth literature.

The model is similar to the one presented in the previous section, although now it is assumed that production with the modern technology generates both dynamic as well as static externalities. To introduce dynamic externalities and international spillovers, I allow for an additional productivity variable, A_{jit}, that increases with time thanks to external industry-specific learning by doing and international spillovers. Labor productivity across sectors and technologies is just as above, except that now it is also multiplied by this variable A_{jit}. Just as with λ_{ji}, A_{jit} is independent of the technology used.

It is simpler to first explain the assumptions regarding dynamic externalities for a single economy (i.e., no international spillovers). In each sector, production with the backward technology generates no learning, whereas production with the modern technology generates external but sector-specific learning by doing, which leads to increasing productivity according to:

$$\dot{A}_{jit} = \left(g/\overline{L}_j\right)\min\left(\overline{L}_j, L_{jiM}\right)A_{jit}$$

If $L_{jiM} > \bar{L}_j$ then $\dot{A}_{jit}/A_{jit} = g$.

Productivity increases caused by dynamic externalities in one country eventually diffuse to the other country even if there is no cluster there. Thus, in this model clusters are important to generate knowledge but are not critical to benefit from knowledge spillovers. Imagine for concreteness that North has a cluster in sector j but the South does not. Then it is assumed that the rate of growth of the productivity variable A_{jSt} is governed by:

$$\dot{A}_{jSt} = \varepsilon\left(1 - a_{jSt}\right)A_{jSt}$$

where $\varepsilon > g$ and $a_{jSt} \equiv A_{jSt}/A_{jNt}$. This formulation captures the idea that there are "benefits of backwardness," in the sense that a lower relative productivity in South (i.e., lower a_{jSt}) — ceteris paribus — leads to a faster rate of productivity growth. This implies that given parameter ε, there is a steady state gap $A_{jSt}/A_{jNt} = \hat{a}$ given implicitly by $g = \varepsilon(1 - \hat{a})$. If $a_{jSt} < \hat{a}$, then the benefits of backwardness will lead to an increase in a_{jSt} until it reaches $\hat{a}$. In contrast, if $a_{jSt} > \hat{a}$, then the benefits of backwardness are too weak, and the international spillovers will be weaker than learning by doing in North, leading to divergence and hence falling a_{jSt}, a process that will continue until a_{jSt} reaches the steady state gap $\hat{a}$.

More generally, letting $a_{jSt} = \max\{A_{jSt}/A_{jNt}, 1\}$ and $a_{jNt} = \max\{A_{jNt}/A_{jSt}, 1\}$, growth in A_{jit} is determined by both learning by doing (if there is a cluster) and international spillovers:

$$\dot{A}_{jit} = \left(g/\overline{L}_j\right)\min\left(\overline{L}_j, L_{jiM}\right)A_{jit} + \varepsilon\left(1 - a_{jit}\right)A_{jit}$$

The first term on the RHS captures learning by doing, whereas the second term captures international spillovers.

Given these assumptions governing dynamic externalities and international spillovers, if the South does not have a cluster in sector j, its labor productivity there at time t in steady state would be $\lambda_{jS}A_{jSt}=\lambda_{jS}\hat{a}A_{jNt}$. In contrast, the North's productivity in sector j — where we are assuming it has a cluster — would be $\lambda_{jN}\theta_j A_{jNt}$. Thus, the ratio of productivities in North versus South in sector j under these circumstances would be $(\lambda_{jN}/\lambda_{jS})\theta_j(1/\hat{a})$. The first term captures pure Ricardian productivity differences, whereas the second and third terms capture the impact of the static and dynamic benefits of clustering, respectively.

Just as in the previous section, prices are derived from the equilibrium in North as if it were an isolated economy. I then analyze the equilibrium in South considered as a small economy. The focus is on steady state equilibria. Assuming for simplicity that the North has clusters in all sectors (and that $L_{jNM}>\bar{L}_j$ for $j=1, 2$) the steady state equilibrium in North has productivity given by $\lambda_{jN}A_{jNt}\theta_j$ in sector j at time t. Thus, steady state international prices are $p^*_{jt}=1/\lambda_{jN}A_{jNt}\theta_j$ with: $\dot{A}_{jNt}/A_{jNt}=g$.

Imagine first that there are no Ricardian productivity differences, $\lambda_{ji}=1$ for all j, i, and also that $\theta_j=\theta>1$ for $j=1, 2$. There is an equilibrium where the South specializes in a sector with a cluster (in which case there would be no income gap) and an equilibrium where the South has no clusters, there is no trade, and $A_{jSt}=\hat{a}A_{jNt}$ for all j, t. Thus, in the backward equilibrium the income gap is given by $\theta/\hat{a}>1$. The term θ captures the benefits of static externalities, while $1/\hat{a}$ captures the benefits of dynamic externalities (although capped by the international spillovers). If the South moves to an equilibrium with a cluster in sector j, then productivity would jump instantaneously thanks to the static externalities, and there would also be a dynamic effect, reflected in a temporary increase in the growth rate of A_{jSt} above g, to:

$$\dot{A}_{jSt} = gA_{jSt} + \varepsilon\left(1 - a_{jSt}\right)A_{jSt}$$

where I have assumed that $L_{jSM}>\bar{L}_j$. Clearly, in this case, A_{jSt} would eventually converge to A_{jNt} and the income gap would disappear.

With Ricardian productivity differences and differences in the intensity of static externalities across sectors (i.e., $\theta_1\neq\theta_2$) the set of equilibria is analogous to the set of equilibria derived in the model of the previous section: there is an equilibrium where South is specialized in good 1 with a cluster and income gap $\lambda_{1N}/\lambda_{1S}$; another equilibrium where the South is specialized in good 1 with no cluster, in which case the income gap is $(\theta_1/\hat{a})$ $(\lambda_{1N}/\lambda_{1S})$; and finally, there is another equilibrium where South is specialized in good 2 as long as a condition similar to (*) is satisfied, except that now we must also take into account the effect of dynamic externalities and international spillovers:

$$\frac{\lambda_{1S}/\lambda_{1N}}{\lambda_{2S}/\lambda_{2N}}<\theta_1/\hat{a}$$

Let us focus on the equilibrium where the South is specialized in good 1 with no cluster. As in many recent models of growth (Parente and Prescott, 1994; Klenow and Rodríguez-Clare, in press), both North and South grow at the same rate, so there is no convergence. In contrast to many of these models, however, it is not necessary for South to increase its investment in technology adoption to catch up with the North. Convergence would occur if South managed to develop a cluster, so that it too could generate both static and dynamic externalities.

To summarize, the insights gained with the static model remain valid when we move to a more realistic setting with dynamic externalities and international spillovers. Countries with no

clusters suffer from the lack of both static and dynamic externalities, although the income gap is bounded thanks to international spillovers. There are multiple equilibria, and the equilibrium with the highest income in South is the one where there is clustering in the sector where its comparative advantage is strongest. Policy should focus on promoting clustering in this sector and avoid price distortions.

5. Conclusion

The general conclusion that emerges from the models analyzed in this paper is that policy should focus on realizing the benefits of clustering in existing sectors, rather than distorting prices to promote the development of sectors with high clustering potential. One reaction to this is that apparently some countries' successful development has included policies to promote the development of new sectors. The case of Finland immediately comes to mind as an example of a country whose rapid development was associated with a shift from specialization in natural — resource intensive goods to knowledge — intensive industries. The question here, however, is whether this is an example of successful promotion of high-tech industries *against* comparative advantage. Perhaps there are some deep characteristics of the country and its government that give it a comparative advantage in industries that rely intensively on skilled workers and collaborative research.

In any case, I do not wish to argue that such policies never make sense. The point is only that when one thinks of clusters as arising from Marshallian externalities, which are intra-industry, then it is hard to make sense of policies that go against natural comparative advantage. If one postulates a different kind of externalities, however, then other possibilities emerge. An obvious case is that of inter-industry or economy-wide externalities, such that the expansion of one sector not only increases productivity in that sector through ME, but also increases productivity in other sectors.[16] Consider a case like that in Section 3, but with no benefits from clustering in sector 1 (i.e., $\theta_1 = 1$), and with comparative advantage being very mild (i.e., $\frac{\lambda_{1S}/\lambda_{1N}}{\lambda_{2S}/\lambda_{2N}}$ just above one). Finally, imagine that besides ME there are also economy-wide externalities. The losses from going against comparative advantage by specializing in sector 2 are small, since comparative advantage is mild, but the gains are related to the economy-wide externalities generated. If these externalities are large, then such a policy may be welfare enhancing. This may be one way of interpreting the argument in the late 1980s in favor of protecting the semiconductor industry in the United States (see Borrus et al., 1996).

Another case in which going against comparative advantage could make sense, already addressed in Section 2, is that of a large country that specializes completely in the good exhibiting ME, with the rest of the world not producing any of this good. This case corresponds to the literature on spatial agglomeration of industry and the core-periphery models, in which the country that "captures" the cluster is better off (e.g., Krugman and Venables, 1995). Although relevant for issues of economic geography, this argument has little relevance when it comes to industrial targeting in *small* developing countries.

Coming back to the main conclusion of the model, it is interesting to discuss what would be appropriate policies to induce clustering in existing sectors.[17] According to the models of

[16] Succar (1987) analyzes the optimal subsidy for the case of external learning by doing that benefits other industries besides the one where it is generated. She does not explore whether this justifies going against comparative advantage.

[17] In this discussion I leave out a potentially important issue, namely the costs associated with clusters, such as diseconomies of congestion and environmental costs, which would clearly need to be taken into consideration in a broader discussion of policies to induce clustering.

Sections 3 and 4, ME arise when firms switch to producing with modern technologies. One interpretation is that such technologies are characterized by their heavy reliance on a large variety of specialized inputs. If there are benefits to proximity between input suppliers and users, then the general use of modern technologies would lead to the existence of many domestic specialized input producers. In turn, with love of variety for inputs, this would lead to high productivity among final good producers. According to this interpretation, the most important policy would be to reduce transaction costs, so that firms would be willing to use modern technologies even if this means depending on many other firms for key inputs. Other more aggressive policies entail the promotion of domestic production of certain key inputs. According to Wade (1990), this was done in Taiwan in the plastics and mold-making industries. Attraction of FDI for the production of certain specialized inputs could be one way of achieving this (see Ramos, 1999).

Another interpretation of modern technologies is that they depend on a constant flow of innovations and hence are associated with high R&D investment rates. The adoption of modern technologies makes sense for a firm only if there is a critical mass of firms using them, so that firms benefit from knowledge spillovers, as well as from the availability of appropriate human capital, research centers and universities. In this case, cluster-promotion policies include R&D incentives in the form of tax breaks and matching grants for both individual and collaborative innovation projects. A more ambitious policy would encourage and partially finance a long-term strategy for research and the creation of skills between the relevant industry associations and the most important universities and research centers.

Of course, these are only some suggestions of ways to think about policies to induce clustering in existing sectors. The interested reader can consult Porter (1990), Ramos (1999) and Rodríguez-Clare (2005) for more complete treatments of this issue.

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