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Document de travail

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N° 2009-09
April 2009

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Some Thoughts on Industrial Policy and Growth

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March 7, 2009

1 Introduction

In the aftermath of WWII, many developing countries have opted for policies aimed at promoting new infant industries or at protecting local traditional activities from competition by products from more advanced countries. Thus several Latin American countries advocated import substitution policies whereby local industries would more fully benefit from domestic demand. East Asian countries like Korea or Japan, rather than advocate import substitution policies, would favor export promotion, which in turn would be achieved partly through tariffs and non-tariff barriers and partly through maintaining undervalued exchange rates. For at least two or three decades after WWII, these policies which belong to what is commonly referred to as "industrial policy", remained fairly non-controversial as both groups of countries were growing at fast rates.

However, the slow down in Latin America as of the 1970s, and then in Japan as of the late 1990s, contributed to the growing scepticism about the role of industrial policy in the process of development. Increasingly since the early 1980s, industrial policy has raised serious doubts among academics and policy advisers in international financial institutions. In particular, it was criticized for allowing governments to pick winners and losers in a discretionary fashion, and consequently for increasing the scope for capture of governments by local vested interests. Instead, policy makers and growth/development economists would advocate general policies aimed at improving the "investment climate: the liberalization of product and labor markets, a legal and enforcement framework that protects (private) property rights, and macroeconomic stabilization. This new set of growth recommendations came to be known as the "Washington consensus", as it was primarily advocated by the IMF, the World Bank and the US Treasury, all based in Washington D.C.

The Washington consensus advocates did have a case: for example recent empirical work by Frankel and Romer (1999) and Wacziarg (2001) would point to a positive effect of trade liberalization on growth. Thus Wacziarg (2001) showed that increasing trade restrictions by one standard deviation would reduce productivity growth by 0.264% annually. Similarly, Keller (2002,2004) showed that 70% of international R&D spillovers are due to cross-country trade flows, and more recently Aghion et al (2008) pointed to large growth-enhancing effects of the trade liberalization and delicensing reforms introduced in India in the early 1990s, particularly in more advanced sectors or in Indian states with more flexible labor market regulations.

The main goal of this paper is to see a case can still be made for policies aimed at supporting or protecting some local sectors, or whether the proponents a full and unconditional liberalization, have definitely won the debate. The paper is organized as follows. Section 2 summarizes the infant industry argument as it is traditionally stated, and then discusses recent empirical work that refutes this argument. Section 3 develops a first counterargument, based on the discouragement effect of trade liberalization. Section 4 develops a second potential counterargument, which like the initial infant industry argument, emphasizes the existence cross-sectoral learning spillovers, but proposes a different strategy to test for such spillovers. Section 5 concludes with comments on the relationship between industrial policy and the conduct of macroeconomic policy over the cycle.

2 The traditional infant industry argument

2.1 The argument in a nutshell

The infant industry argument, e.g formalized by Greenwald and Stiglitz (2006)[1], can be summarized as follows: consider a local economy which comprises a traditional (agricultural) sector and a nascent (industrial) sector. The industrial sector's new activities involve high costs initially, however production and the resulting learning by doing reduces these costs over time. Moreover, suppose the existence of knowledge externailities between these new industrial activities and the traditional sector. Then two conclusions immediately obtain in this setting. First, full trade liberalization will make it very costly for domestic industrial sectors to invest in learning by doing: so involves producing but not selling in the short run since domestic costs are initially higher than foreign costs. Second, the social benefits from learning by doing are not fully internalized by industrial sectors, since they do not internalize the knowledge externalities they have on the agricultural sector. It is the combination of these two considerations which justifies domestic policies aimed at (temporarily) protecting nascent industries. Such policies may either take the form of targeted subsidies or import restrictions, or they may involve non-targeted policies, for example maintaining undervalued exchange rates which will benefit the local industry as a whole as long as it does not import too much inputs from abroad themselves.

2.2 Criticisms

The main objections to the infant industry argument have been empirical. Thus Krueger and Tuncer (1982) saw no systematic tendency for non-protected firms or industries in Turkey over the 1960s to display higher productivity growth than

[1] See also Young (1991).

less protected industries; moreover, they saw no apparent tendency for a new industrial activity to display higher rates of growth than the overall industry to which it belongs.

However the most compelling case against the traditional infant industry argument, was recently made by Nunn and Trefler (2007), henceforth NT. Nunn and Trefler's argument goes as follows: if we were to believe the above infant industry argument, then we should see a positive correlation between growth and the extent to which the domestic tariff structure is skilled-biased, the idea being that learning by doing on new activities with knowledge spillovers on the rest of the economy, should require more skills than other activities. Thus NT regress average per capita GDP growth, measured by the log of (y_{c1}/y_{c0}), where y_{c1} (resp. coefficienty_{c0}) denotes per capita GDP at the end (resp. the beginning of the period), on the extent to which the tariff structure is skill-biased (which in turn is measured by the correlation coefficient between skill intensity and the level of tariffs across sectors). A straight cross-country regression with region and cohort fixed effects, shows a positive and significant correlation between growth the skill-bias of the tariff structure.

Thus, at first sight, NT's regression results seem to confirm the infant industry argument. However, NT push the analysis further by regressing, for each sector in each country, per capita growth on both, the country-level measure of skill bias of tariffs, and a new (industry-level) tariff-skill interaction term: this latter term interacts the tariff for that particular industry with the ratio of skills over unskilled labor in that same industry. The intriguing result is that the coefficient for this industry-level tariff-skill interaction, is negative and significant! In other words, the positive coefficient on the aggregate measure of skill-biased tariff found in the previous regression, reflects something else than the growth effect of protecting more skill-biased industries, Actually NT argue that the explanation for the positive coefficient involves a third variable, namely the quality of local institutions, which is positively correlated with growth and also with the government's propensity to emphasize skill intensive sectors. But it does not seem to reflect a direct causality between industrial policy and growth.

Does this render the Greenwald-Stiglitz story and/or more generally the case for infant industry policies fully irrelevant? In the remaining part of the paper we argue otherwise, yet taking the positive effects of liberalization into account.

3 The discouragement effect of trade liberalization

In this section we analyze the effects of trade liberalization on innovation and growth in the domestic economy. In particular, we discuss the possibility that trade liberalization could inhibit growth in some economies, and whether this might in turn justify some form of temporary protection.

3.1 Preliminary: the closed-economy model

We first analyze innovation and growth in a closed-economy, which we use as benchmark case to analyze the effects of trade liberalization.

3.1.1 Production and national income

There is a single country in which a unique final good, which also serves as numéraire, is produced competitively using a continuum of intermediate inputs according to:

$$Y_t = L^{1-\alpha} \int_0^1 A_{it}^{1-\alpha} x_{it}^{\alpha} di, \ 0 < \alpha < 1 \tag{1}$$

where L is the domestic labor force, assumed to be constant, A_{it} is the quality of intermediate good i at time t, and x_{it} is the flow quantity of intermediate good i being produced and used at time t.

In each intermediate sector there is a monopolist producer who uses the final good as the sole input, with one unit of final good needed to produce each unit of intermediate good. The monopolist's cost of production is therefore equal to the quantity produced x_{it}. The price p_{it} at which she can sell this quantity of intermediate good to the competitive final sector is the marginal product of intermediate good i in the final good production function (1)

The monopolist will choose the level of output that maximizes profits, namely

$$x_{it} = A_{it} L \alpha^{2/(1-\alpha)} \tag{2}$$

resulting in the profit level

$$\pi_{it} = \pi A_{it} L \tag{3}$$

where $\pi \equiv (1-\alpha)\, \alpha^{\frac{1+\alpha}{1-\alpha}}$.

The equilibrium level of final output in the economy can be found by substituting the x_{it}'s into (1), which yields

$$Y_t = \varphi A_t L \tag{4}$$

where A_t is the average productivity parameter across all sectors

$$A_t = \int_0^1 A_{it} di$$

and $\varphi = \alpha^{\frac{2\alpha}{1-\alpha}}$.[2]

[2] To derive this expression for Y_t, substitute the x_{it}'s into (1) to get

$$\begin{aligned} Y_t &= L^{1-\alpha} \int_0^1 A_{it}^{1-\alpha} \left(A_{it} L \alpha^{2/(1-\alpha)} \right)^{\alpha} di \\ &= \left(\alpha^{2/(1-\alpha)} \right)^{\alpha} L \int_0^1 A_{it}^{1-\alpha} A_{it}^{\alpha} di \\ &= \zeta A_t L \end{aligned}$$

3.1.2 Innovation

Productivity growth comes from innovations. In each sector, at each date there is a unique entrepreneur with the possibility of innovating in that sector. She is the incumbent monopolist, and an innovation would enable her to produce with a productivity (quality) parameter $A_{it} = \gamma A_{i,t-1}$ that is superior to that of the previous monopolist by the factor $\gamma > 1$. Otherwise her productivity parameter stays the same: $A_{it} = A_{i,t-1}$. In order to innovate with any given probability μ she must spend the amount

$$c_{it}(\mu) = (1-\tau) \cdot \phi(\mu) \cdot A_{i,t-1}$$

of final good in research, where $\tau > 0$ is a subsidy parameter that represents the extent to which national policies encourage innovation, and ϕ is a cost function satisfying

$$\begin{aligned} \phi(0) &= 0; \text{ and} \\ \phi'(\mu) &> 0, \ \phi''(\mu) > 0 \text{ for all } \mu > 0 \end{aligned}$$

Thus the local entrepreneur's expected profit net of research cost is

$$\begin{aligned} V_{it} &= E\pi_{it} - c_{it}(\mu) \\ &= \mu\pi L\gamma A_{i,t-1} + (1-\mu)\pi L A_{i,t-1} - (1-\tau)\phi(\mu) A_{i,t-1} \end{aligned}$$

She will choose the value of μ that maximizes these expected profits.

Each local entrepreneur will choose a frequency of innovations μ^* that maximizes V_{it}. The first-order condition for an interior maximum is $\partial V_{it}/\partial\mu = 0$, which can be expressed as the research arbitrage equation:

$$\phi'(\mu) = \pi L(\gamma - 1)/(1-\tau). \tag{5}$$

If the research environment is are favorable enough (i.e. if τ is large enough), or the population large enough, so that:

$$\phi'(0) > \pi L(\gamma - 1)/(1-\tau)$$

then the unique solution μ to the research arbitrage equation (5) is positive, so in each sector the probability of an innovation is that solution ($\widehat{\mu} = \mu$), which is an increasing function of the size of population L and of the policies favoring innovation τ. Otherwise there is no positive solution to the research arbitrage equation so the local entrepreneur chooses never to innovate ($\widehat{\mu} = 0$).

Since each A_{it} grows at the rate $\gamma - 1$ with probability $\widehat{\mu}$, and at the rate 0 with probability $1 - \widehat{\mu}$, therefore the expected growth rate of the economy is

$$g = \widehat{\mu}(\gamma - 1)$$

So we see that countries with a larger population and more favorable innovation conditions will be more likely to grow, and if they grow will grow faster, than countries with a smaller population and less favorable innovation conditions.

3.2 The effects of openness on innovation and long-run growth

Now, let us open trade in goods (both intermediate and final) between the domestic country and the rest of the world, and we first take productivities in all domestic and foreign sectors to be given. Productivity-enhancing innovations are introduced in the next section.

To keep it simple, suppose that there are just two countries, called "home" and "foreign", which differ in terms of the size of population and the policies favoring innovation. Suppose that the range of intermediate products in each country is identical, that they produce exactly the same final product, and that there are no transportation costs. Within each intermediate sector the world market can then be monopolized by the producer with the lowest cost. We use asterisks to denote foreign-country variables.

To begin with, each country does no trade, and hence behaves just like the closed economy described in the previous section. Then at time t we allow them to trade costlessly with each other. The immediate effect of this opening up is to allow each country to take advantage of more efficient productive efficiency. In the home country, final good production will equal

$$Y_t = \int_0^1 Y_{it} di = L^{1-\alpha} \int_0^1 \widehat{A}_{it}^{1-\alpha} x_{it}^{\alpha} di, \; 0 < \alpha < 1 \tag{6}$$

where $\widehat{A}_{it}$ is the higher of the two initial productivity parameters:

$$\widehat{A}_{it} = \max \{A_{it}, A_{it}^*\}$$

Likewise in the foreign country final good production will equal

$$Y_t^* = \int_0^1 Y_{it}^* di = (L^*)^{1-\alpha} \int_0^1 \widehat{A}_{it}^{1-\alpha} (x_{it}^*)^{\alpha} di, \; 0 < \alpha < 1 \tag{7}$$

The monopolist in sector i whose intermediate good has productivity $\widehat{A}_{it}$, can now sell to both countries, and thereby achieve the profit level

$$\pi_{it} = \pi \widehat{A}_{it} (L + L^*) \tag{8}$$

where once again $\pi \equiv (1-\alpha) \alpha^{\frac{1+\alpha}{1-\alpha}}$.

3.2.1 Innovation

We now endogeneize the growth of productivities A_{it} and A_{it}^*. Consider the innovation process in a given sector i. In the country where the monopoly currently resides, the country is on the global technology frontier for sector i, and the local entrepreneur will aim at making a frontier innovation that raises the productivity parameter from $\widehat{A}_{it}$ to $\gamma \widehat{A}_{it}$. If so, that country will retain a global monopoly in intermediate product i. In the other country, the local entrepreneur will be trying to catch up with the frontier by implementing the current frontier technology. If she succeeds and the frontier entrepreneur fails to advance the frontier that period, then the lagging country will have caught up, both countries will be on the frontier, and we can suppose that each entrepreneur will monopolize the market for product i in her own country. But if the frontier entrepreneur does advance the frontier then the entrepreneur in the lagging country will still remain behind and will earn no profit income.

Over time, the lead in each sector will tend to pass from country to country, as long as the lagging sector is innovating. (Otherwise the lead will remain the country that starts with the lead when trade is opened up.) However there will be no immediate leapfrogging of one country by the other, because in order to retake the lead a country must first catch up. So in between lead changes there will be a period when the sector is level, or neck-and-neck. The growth rate of productivity will be determined by the incentives to perform R&D in the different cases (when the country is the sole leader, when it is the laggard, and when the sector is level.) So we need to study each case in turn.

3.2.2 Three cases

Three possibilities must be considered. Either a domestic sector leads over the corresponding sector in the foreign country (case A); or the domestic sector is at level (neck-and-neck) with its counterpart in the foreign country (case B); or the domestic sector lags behind its foreign counterpart (case C). More precisely.

A Case A is the case in which the lead in sector i resides in the home country, while the foreign country lags behind. In this case the expected profit of the entrepreneur in the home country, net of R&D costs, is

$$EU_A = \mu_A \gamma (L + L^*) \pi + (1 - \mu_A) (L + (1 - \mu_A^*) L^*) \pi - (1 - \tau) \phi (\mu_A)$$

while the expected profit of the foreign entrepreneur is

$$EU_A^* = \mu_A^* (1 - \mu_A) \pi L^* - (1 - \tau^*) \phi (\mu_A^*)$$

where everything is normalized by the pre-existing productivity level. That is, with probability μ_A the home entrepreneur will innovate, thus earning all the global profits in the market at productivity level γ times the pre-existing level; if she fails to innovate then she will still earn all domestic profits in the market, at the pre-existing profit level, and if the foreign entrepreneur fails to innovate (which occurs with probability $1 - \mu_A^*$) she will also earn all the foreign profits in the market. In any event she must incur the R&D cost $(1 - \tau) \phi (\mu_A)$. Likewise the foreign entrepreneur will earn all the profits in the foreign market if she innovates and her rival doesn't, which occurs with probability $\mu_A^* (1 - \mu_A)$.

B Case B is the case in which the sector is level. In this case the expected profits of the respective entrepreneurs net of R&D costs are

$$\begin{aligned} EU_B &= (\mu_B (L + (1 - \mu_B^*) L^*) \gamma + (1 - \mu_B) (1 - \mu_B^*) L) \pi - (1 - \tau) \phi (\mu_B) \text{ and} \\ EU_B^* &= (\mu_B^* (L^* + (1 - \mu_B) L) \gamma + (1 - \mu_B^*) (1 - \mu_B) L^*) \pi - (1 - \tau^*) \phi (\mu_B^*) \end{aligned}$$

That is, for example, the home entrepreneur innovates with probability μ_B, which earns her all the home profits for sure and all the foreign profits if her rival fails to innovate, whereas if both fail to innovate then she retains all the domestic profits.

C Case C is the case in which the foreign country starts with the lead. By analogy with case A the expected profits minus R&D costs are respectively:

$$\begin{aligned} EU_C &= \mu_C \left(1-\mu_C^*\right) \pi L - (1-\tau)\, \phi\left(\mu_C\right) \text{ and} \\ EU_C^* &= \mu_C^* \gamma \left(L+L^*\right) \pi + \left(1-\mu_C^*\right)\left(L^* + \left(1-\mu_C\right) L\right) \pi - \left(1-\tau^*\right) \phi\left(\mu_C^*\right) \end{aligned}$$

3.2.3 Equilibrium innovation and growth

The research arbitrage equations that determine the innovation rates in equilibrium, are simply obtained by taking the first order conditions for each of the above expected profit minus R&D cost expression. Innovation rates in the domestic country thus satisfy:

$$\begin{aligned} (1-\tau)\, \phi'\left(\mu_A\right)/\pi &= (\gamma-1)\left(L+L^*\right) + \mu_A^* L^* \\ (1-\tau)\, \phi'\left(\mu_B\right)/\pi &= (\gamma-1) L + \mu_B^* L + \left(1-\mu_B^*\right)\gamma L^* \\ 1-\tau\phi'\left(\mu_C\right)/\pi &= \left(1-\mu_C^*\right) L \end{aligned}$$

and symmetrically for innovation in the foreign country.[3]

In steady state, there will be a constant fraction of sectors in each state, q_A, q_B and q_C, with $q_A + q_B + q_C = 1$, while aggregate productivity will be

$$\widehat{A}_t = q_A \widehat{A}_{At} + q_B \widehat{A}_{Bt} + q_C \widehat{A}_{Ct}$$

where for example $\widehat{A}_{At}$ is the average productivity level in sectors where the lead resides in the home country. It follows that the growth rate of aggregate productivity (and hence of each country's national income) in steady state will be

$$g = \eta_A g_A + \eta_B g_B + \eta_C g_C \tag{9}$$

where for each state $S = A, B, C$, $\eta_S = q_S \widehat{A}_{St}/\widehat{A}_t$ is the share of aggregate productivity accounted for by sectors in state S in the steady state, and g_S is the expected growth rate of the leading technology $\widehat{A}_{it}$ in each sector currently in state S.

Since the η's add up to one, this implies that the steady-state growth rate of the open economy is a weighted average of the productivity growth rates g_S.

[3] That is:

$$\begin{aligned} \left(1-\tau^*\right) \phi'\left(\mu_A^*\right)/\delta &= \left(1-\mu_A\right) L^* \\ \left(1-\tau^*\right) \phi'\left(\mu_B^*\right)/\delta &= (\gamma-1) L^* + \mu_B L^* + \left(1-\mu_B\right)\gamma L \\ \left(1-\tau^*\right) \phi'\left(\mu_C^*\right)/\delta &= (\gamma-1)\left(L+L^*\right) + \mu_C L \end{aligned}$$

These are respectively

$$
\begin{aligned}
g_A &= (\gamma - 1)\,\mu_A \\
g_B &= (\gamma - 1)\,(\mu_B + \mu_B^* - \mu_B \mu_B^*) \\
g_C &= (\gamma - 1)\,\mu_C^*
\end{aligned}
$$

Our conclusions in the remaining part of the section will be derived from comparing the home country research arbitrage equations under openness with the closed economy research arbitrage equation (5), which we reproduce here for convenience:

$$(1-\tau)\,\phi'(\mu)\,/\pi = (\gamma - 1)\,L. \tag{10}$$

3.2.4 Scale and escape entry

Comparing this closed economy research arbitrage equation with the one governing μ_A:

$$(1-\tau)\,\phi'(\mu_A)\,/\pi = (\gamma - 1)\,(L + L^*) + \mu_A^* L^* \tag{11}$$

we see that when the home country has the technology lead (case A) it will innovate at a faster rate than when it was a closed economy, because the right-hand side of the leader's research arbitrage equation (11) is larger than the right-hand side of the closed economy counterpart (10). This is because of two effects, scale and escape entry.

The scale effect arises because the successful innovator gets enhanced profits from both markets, not just the domestic market, thus giving her a stronger incentive to innovate. This is why (11) has the sum of size variables $L + L^*$ where (10) has just the domestic size variable L.

The escape entry effect arises because the unsuccessful innovator in the open economy is at risk of losing the foreign market to her foreign rival, a risk that she can avoid by innovating. By contrast the unsuccessful innovator in the closed economy loses nothing to a foreign rival and thus does not have this extra incentive to innovate. Formally, this effect accounts for the extra term $\mu_A^* L^*$ that appears on the right hand side of (11) but not of (10).

Comparing the closed economy research arbitrage equation (10) to the one governing the home country's innovation rate in a level sector:

$$(1-\tau)\,\phi'(\mu_B)\,/\pi = (\gamma - 1)\,L + \mu_B^* L + (1 - \mu_B^*)\,\gamma L^*$$

we see the same two effects at work. The term $\mu_B^* L$ is the escape entry effect; by innovating the home entrepreneur can avoid the risk of losing the local market. The term $(1 - \mu_B^*)\,\gamma L^*$ is the scale effect; by innovating the home entrepreneur can capture (with some probability) the foreign market as well as the domestic market.

It follows that both μ_A and μ_B will be larger than the closed economy innovation rate μ. The same will be true for the foreign innovation rates μ_C^* and μ_B^*, which will both be larger than the foreign countries innovation rate when it was closed, μ^*.

3.2.5 The discouragement effect of foreign entry

We saw in Chapter 12 above that a country behind the world technology frontier may be discouraged from innovating by the threat of entry because even if it innovates it might lose out to a superior entrant. This is reflected in the research arbitrage equation governing the home country's innovation rate in case C, the case where it is the technological laggard:

$$(1-\tau)\,\phi'\left(\mu_C\right)/\pi = \left(1-\mu_C^*\right)L$$

If the foreign country's innovation rate is large enough when it has the lead, then the right-hand side of this research arbitrage equation will be strictly less than that of the closed economy equation (10), so we will have $\mu_C < \mu$. This does not have a direct effect on the growth rate (9) because g_C depends only on the leader's innovation rate μ_C^*. That is, in this state the home country is just catching up, not advancing the global technology frontier. However, as we shall see, a fall in μ_C will nevertheless have an indirect effect on growth by affecting the steady state weights η_S in (9), which are the fractions of productivity accounted for by the sectors in each state.

3.2.6 How trade can reduce growth in one country

The fact that trade raises growth in both countries when either the countries are symmetrical or one country fails to innovate when behind suggests that trade will usually raise growth in both countries. But there can be exceptions. These exceptions of course must involve countries that are asymmetrical. For example, consider the case of a small country (home) whose policies used to be very unfavorable to innovation but which has recently undertaken a reform to make the country more innovative. Suppose these policies have been so successful that just before opening up to trade, the home country has a faster growth rate than the foreign country:

$$\mu > \mu^*$$

but the reforms have been so recent that the home country is still behind the foreign country in all sectors. Then initially after the opening up to trade all monopolies will reside in the foreign country; that is, all sectors will be in case C above. Now suppose furthermore that the discouragement effect is large enough that the home country does not innovate when behind ($\mu_C = 0$). Then as we have seen all monopolies will remain forever in the foreign country.

This is the case in which, as we saw above, the home country's level of national income might actually fall when trade is opened up, because the increased efficiency of the selection effect might be outweighed by the loss of profits from the home-country monopolists that are forced out of business by foreign competition. What we can now see is that whether or not national income falls at first, the home country's growth rate from then on may be lower than if it had never opened up to trade.

More specifically, if it had not opened up for trade then its growth rate would have remained equal to

$$g = (\gamma - 1)\,\mu$$

whereas under open trade its growth rate will be that of each sector in case C, namely

$$g' = (\gamma - 1)\,\mu_C^*$$

So the home country growth rate will be reduced by trade if and only if $\mu_C^* < \mu$. Now we know from our analysis above that μ_C^* must exceed the innovation rate that the foreign country would have experienced under autarky:

$$\mu_C^* > \mu^*$$

but this does not guarantee that it exceeds the innovation rate that the home country would have experienced under autarky. Indeed if μ_C^* is close enough to μ^* then it will be strictly less than μ and the home country's growth rate will indeed be reduced by trade.

This is where our assumption that the home country is small comes into play. For if it is very small relative to the foreign country then the scale effect of trade on the foreign innovation rate μ_C^* will be small. Since we are assuming that the home country never innovates when behind, therefore there is no escape entry effect on μ_C^*, so if the home country is small enough then μ_C^* will indeed be close enough to μ^* that it falls below μ and the home country's growth rate is diminished by trade.

So we have a presumption that if there are instances where trade is bad for growth, they are probably in small countries that start off far behind the global technology frontier. We also have an example of how economic reform needs to be sequenced properly in order to have its desired effect. That is, generally speaking a country's growth prospects are enhanced by liberalizing trade and by removing barriers to innovation. But if these reforms are undertaken simultaneously then their full benefits might not be realized. Instead it might be better to remove the barriers to innovation first and then to wait until several domestic industries have become world leaders before removing the barriers to international trade.

4 A case for targeted intervention: industrial niches

The notion that the existing pattern of specialization may limit the evolution of comparative advantage over time has not received much attention in the growth literature so far. For example in Romer (1990)'s product variety model, the current set of inputs display the same degree of imperfect substitutability with respect to any new input that might be introduced, and therefore does not make one new input more likely than any other: this property stems directly from the fully symmetric nature of the Dixit-Stiglitz model of product differentiation upon which the Romer model is built. However an important insight that emerges from the work of Alwyn Young (1991), Lucas (1993), and more recently Haumann and Klinger (2007), is that successful growth stories are one involving gradual processes whereby neighboring sectors experiment with new technologies one after the other because experimentation involves learning by doing externalities across sectors.

To illustrate the case for targeted intervention based on the existence of cross-sectoral externalities in the simplest possible way, consider the following toy model. Individuals each live for one period. There are four *potential* sectors in the economy, which we number from 1 to 4, but only one sector, namely sector 1, is active at date zero. Thus, the economy at date 0 can be represented by the 4-tuple

$$\Omega_0 = (1, 0, 0, 0),$$

where the number 1 (resp. 0) in column i refers to the corresponding sector i being currently active (resp. inactive). At date t, a sector that is active produces at the frontier productivity level $\overline{A}_t = (1 + g)^t$. Once activated a sector automatically remains active forever. Aggregate output at date t is

$$Y_t = A_t = N_t \overline{A}_t,$$

where N_t is the number of active sectors at date t.

R&D investments activate new sectors, but there is a cost of learning about faraway sectors. Specifically, there is a fixed R&D cost $\gamma(1 + g)^t$ of activating a sector in period t, but this is only possible if (a) the sector is adjacent to an already active sector or (b) the R&D cost $\gamma(1 + g)^{t-1}$ was also incurred in that sector last period.

Consider first the economy under laissez-faire. Being populated by one-period lived individuals, the economy will never invest in a sector that is not adjacent to a sector already active. At best, a local entrepreneur will find it optimal to activate a sector adjacent to an already active sector. This will be the case whenever

$$\gamma < \theta,$$

where θ is the fraction of output that can be appropriated by a private innovator. Note however that if

$$\theta < \gamma,$$

then private firms will not explore new sectors, even neighboring ones, even though it might be socially optimal to do so.

Coming back to the case where $\gamma < \theta$,in this case the laissez-faire sequence of active sectors will be:

$$\begin{aligned}
\Omega_1 &= (1, 1, 0, 0) \\
\Omega_2 &= (1, 1, 1, 0) \\
\Omega_t &= (1, 1, 1, 1), \qquad t \geq 3
\end{aligned}$$

Now consider a social planner. The social planner will invest in sector 2 in period 1, whenever the cost $\gamma(1 + g)$ of doing so is less than the net present revenue of activating sector 2, namely

$$\sum_{t=1}^{\infty} \frac{\overline{A}_t}{(1+r)^t} = \frac{1+g}{r-g},$$

that is whenever

$$\gamma < \frac{1}{r-g}.$$

For g sufficiently close to r or for γ sufficiently small, this inequality is automatically satisfied, in which case it will also be optimal to invest in sector 3 in period 2 because at that date sector 3 will be adjacent to an already active sector (namely sector 2).

But in addition, whenever γ is sufficiently small, it will be optimal to invest in sector 4 in period 1, because that will allow sector 4 to be activated in period 2 whereas otherwise it can only be activated in period 3. Investing in period 1 instead of period 2 in sector 4 will yield an additional

$$\overline{A}_2 / (1+r)$$

and will cost an additional $\gamma(1+g)$. So, if γ is small enough, namely if

$$\gamma < \frac{1+g}{1+r},$$

the optimal sequence of active sectors will be:

$$\begin{aligned} \Omega_1 &= (1,1,0,0) \\ \Omega_2 &= (1,1,1,1) \\ \Omega_t &= (1,1,1,1), \qquad t \geq 3 \end{aligned}$$

The laissez-faire equilibrium is suboptimal because people do not invest far enough away from already active sectors. In this example output will be lower than optimal in period 2 ($3\overline{A}_2$ versus $4\overline{A}_2$) because individuals were not far sighted enough to invest in sector 4, which was too far away from already active sectors, in period 1.

Thus this model suggests a role for targeted industrial policy: namely, to overcome the potential underinvestment in new sectors. In particular, if targeted subsidies were to be implemented by a government, we conjecture that such subsidies should be more growth-enhancing: (i) if they target sectors that are currently inactive but close "input-wise" to already active sectors, and (ii) if the country experiences low levels of financial development or low labor mobility or low average levels of education. Part (i) implies that the targeted sectors are more likely to benefit from learning-by-doing externalities from already active sectors. Part (ii) makes it less likely that market forces will spontaneously take advantage of these externalities.

The idea that the product space is heterogeneous, with an uneven density of active product lines, and that the current density distribution of active sectors impacts on the evolution of comparative advantage, is taken to the data by Hausmann and Klinger (2006), henceforth HK. HK measure the relatedness between two product lines by the probability $\varphi_{i,j}$ that on average countries exports enough of the two goods simultaneously. [4] Then, HK define the density around good i in country c as the average relatedness of that product with other products exported by the same country, namely:

$$density_{i,c,t} = \frac{\sum_k \varphi_{i,k,t}.x_{c,k,t}}{\sum_k \varphi_{i,k,t}},$$

where $x_{c,k,t}$ is the volume of export of product k by country c at time t.

A main finding in HK is that the probability of a country exporting product i in year $t+1$, is positively and significantly correlated with the country's density around product i in year t. This in turn provides empirical support to the idea that countries move towards new product lines that are adjacent to existing lines, even though this may be suboptimal as discussed above.

Two arguments at least can be opposed to targeted interventions of the kind suggested in this section: (a) such policies may serve as a pretext for government favors, particularly if input-output information can be manipulated by politicians or bureaucrats; (b) what guarantees that temporary support to industries will be terminated, especially if the investment turns out to be inefficient? One possible answer to these two objections, would be to involve third parties (for example private partners) which would access input-output information and would also act as cofinanciers.

5 Conclusion

In this paper we have tried to push the discussion on industrial policy a little further. In particular we have identified (extreme) situations where temporary protection might be called for, and we have also try to resurrect the case for targeted interventions.

An additional case for intervention can be made in relation to the business cycle. More specifically, recent work by Aghion, Hemous and Kharroubi (2009) uses a sample of 45 industries across 17 OECD countries over the period 1980-2005, to show that growth in industrial sectors that are more dependent upon external finance (using Rajan and Zingales (1998)'s methodology), benefits more from more countercyclical fiscal policies, i.e from policies that involve larger deficits in recessions (compensated by bigger surpluses during booms). Moreover, it is more the expenditure side than the revenue side of governments'

[4] More specifically, relatedness between products i and j is measured by:

$$\varphi_{i,j} = \min\{P(x_i/x_j), P(x_j/x_i)\},$$

where $P(x_i/x_j)$ is the probability that a country export (enough of) good i conditional upon exporting (enough of) good j.

budgets whose countercyclicality matters more for growth in such sectors. A natural issue then, is whether government support to such sectors during recessions does or does not amount to some other form of industrial policy.

Whether these arguments are in some cases stronger than the powerful political economy counterargument(s), needs to be assessed depending upon characteristics of the country or the sector, and also with regard to the economy's location in the business cycle. In any case, the general recommendation made by the Spence report with regard to industrial policy strikes us as stemming from common sense: namely, experiment, and then make sure you can stop the intervention if it turns out not be efficient.

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