DEPARTAMENTO DE ECONOMIA
PUC/RJ
MARÇO DE 1989

TEXTO PARA DISCUSSÃO
Nº 219

Key Issues on Industrial Promotion: the Current Brazilian Debate

Winston Fritsch
Gustavo H.B.Franco

ABSTRACT

The paper offers a survey of the key novel features emerging in recent discussions on industrial promotion in Brazil. The paper starts by discussing the role of differential access to technology as a determinant of North-Nics patterns of trade in manufactures. Three issues are then addressed: (i) the implications of shortening product cycles; (ii) feasible levels of vertical integration and (iii) combinations of size and foreign onwership that could enhance technology acquisition.

SUMÁRIO

O ensaio traz uma resenha dos principais temas relacionados à política industrial no Brasil. De início discute-se o papel de assimetrias no tocante ao acesso à tecnologia enquanto determinantes de padrões de comércio em manufaturas de NICs e países industriais. Três questões fundamentais são discutidas em detalhe: (i) as implicações do encurtamento dos ciclos de produto; (ii) os níveis aceitáveis de integração vertical e (iii) as combinações de tamanho e participação estrangeira que maximizam a capacitação tecnológica.

Key Issues on Industrial Promotion: the current Brazilian debate

by

Winston Fritsch
&
Gustavo H. B. Franco
Departamento de Economia
Pontifícia Universidade Católica
do Rio de Janeiro
Rua Marques de São Vicente 225
Rio de Janeiro RJ 22453 Brasil

† Paper to be presented at the Second Interamerican Seminar on Economics, co sponsored by the National Bureau of Economic Research, Inc., the Pontificia Universidade Católica do Rio de Janeiro and Fedesarollo. Bogota, March 30-April 1, 1989.

Rio de Janeiro, February 1989

1) Introduction

After the extraordinary advance of industrialization in the post-war years, which placed her manufacturing sector as the sixth largest in the capitalist world, industrial policy in Brazil is at the crossroads. The collapse of the rates of industrial investment stemming from the uncertainties generated by the unstable macroeconomic environment prevailing since the debt shock, a rather inconclusive soul-searching as to the quality of her trade and industrialization policies spurred by the continued success of the East Asian NICs, and the perception that these are times of rapid technical progress and emerging new industries which may have far reaching consequences for comparative advantage in manufacturing, all combined to produce, at the same time, a sense of urgency for reform and a state of confusion in the industrial policy debate. This is reflected even in official positions which exhibit a high degree of variation, ranging from the ultra liberal text of the preamble of the recent decrees forming what was called the "New Industrial Policy"[1] to the very restrictive industrial promotion policies being followed in the computer industry and microelectronics.

A positive fact, however, is that due to a large extent to the perceived imperative of a high export performance as a response to the long term balance of payments difficulties created by the debt problem - as opposed to import substitution as non-oil imports represent nowadays only 3% of GDP - the past few years also witnessed an important change in the focus of the industrial policy debate towards a quest for efficiency. However, sustained export dynamism is not only dependent on the quality of government policies but also, and crucially, on a sound interpretation of the pace and

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[1] Decress nos. 2,433-2,436 and 96,056 of May 19, 1988.

character of technical progress in the central countries which to a large extent conditions the policy choices open to the technologically "dependent" periphery aimed at increasing its competitive advantage over time. In fact empirical evidence on the technological content of patterns of trade in manufactures of a large sample of countries to be reviewed in this paper seems to suggest the existence of a process of continuous "immitation *cum* upgrading", or of a continuous transfer of industrial capacity in sucessive generations of mature products to the South. Technological progress is transfered to selected regions in the periphery with a lag which depends on complex interactions between the rates of innovation in the North and of technological transfer, so that the NICs may actually ride the train of technological progress - in spite of the pessimistic view traditionally prevailing in Latin America as to the consequences of asimmetric modes of integration into the world economy - though at the back seat.

Although this continuous export upgrading for peripheral countries has been described as a quasi-automatic one stemming from the natural accumulation of human capital in the NICs[2], there is nothing simple or automatic about remaining in the back seat for a particular country. As the North abandons senescent industries that relocate in the South, only a small proportion of the periphery qualifies for receiving these industries and, as the lower end of the technological spectrum in the center moves, the more stringent becomes the locational requirements for efficient redeployment in a developing country. Moreover, if the technological frontier in the innovating countries is moving fast in already established industries, to remain in a situation of "dependence" but with a relatively stable

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[2] B. Balassa (1979).

technological gap means that the absolute level of technological content and of skill intensity should grow over time and, if entirely new industries appear, technological choices are far more risky, given the high R & D investment requirements, and the high rate of technological obsolescence in the fiercely competitive environment which characterizes new industries.

These facts raise important policy issues as regards industrial promotion in semi-industrializsed economies to be addressed in this paper. Its purpose is to stress the cleavage between mature and new industries and, using the classical framework of feasibility analysis of infant industry promotion, to show that, given relative wages, the justification of temporary protection in a strategy aimed at efficient industrialization depends on: (i) the length of the product cycle in the South, which is affected by protection and by lags in technology transfer, (ii) the extent of vertical integration among infant industries usually enforced with resort the import content requirements, and (iii) the speed of productivity growth and learning in the immitating periphery relative to the innovating centre. These three themes actually concern three key policy variables: the choice of industry to be promoted, the levels of "national content" and the market structure to be enforced so as to maximize technological activity.

The paper is organized as follows. The next section considers the role of technology as a determinant of patterns of trade in manufactures, with the purpose of assessing the importance of a technological upgrade in industrial structures and in exports as an essential feature of more ambitious growth trajectories in "follower" countries. Section 3 considers the basic conditions for development of competitiveness in both mature and new industries, and section 4 discusses three crucial policy issues for industrial promotion in new technologically dynamic industries: the feasibility of

promotion, or the points of entry in these new sectors, levels of "national content" compatible with feasibility over the product cycle and the relation between market structure and innovation in this context.

2) The moving technology band and patterns of trade in manufactures

A central issue in the context of the industrial policy debate in Latin America in recent years is how to achieve or sustain continued export dynamism, or more generally, the continuous technological upgrading of the industrial output structure in peripheral economies in the present context of far reaching technological innovations in developed countries. To pave the way for the normative analysis of this issue to be done in the next two sections, this section considers the empirical evidence on: (i) patterns of specialization emerging in countries have different degrees of access to technological innovation; (ii) the evolution of the absolute level of technological content of exports and output over time in technologically dependent economies

In order to consider the first of these issues Graph 1 pictures the "R&D orientation" in exports and imports of a group of manufacture exporters, computed by trade weighting specific industries' (SITC-three digit) R&D orientation[3]. The clusters in the graph suggest an association between a low R&D "endowment" - proxied by the position in the rank for R&D expenditure

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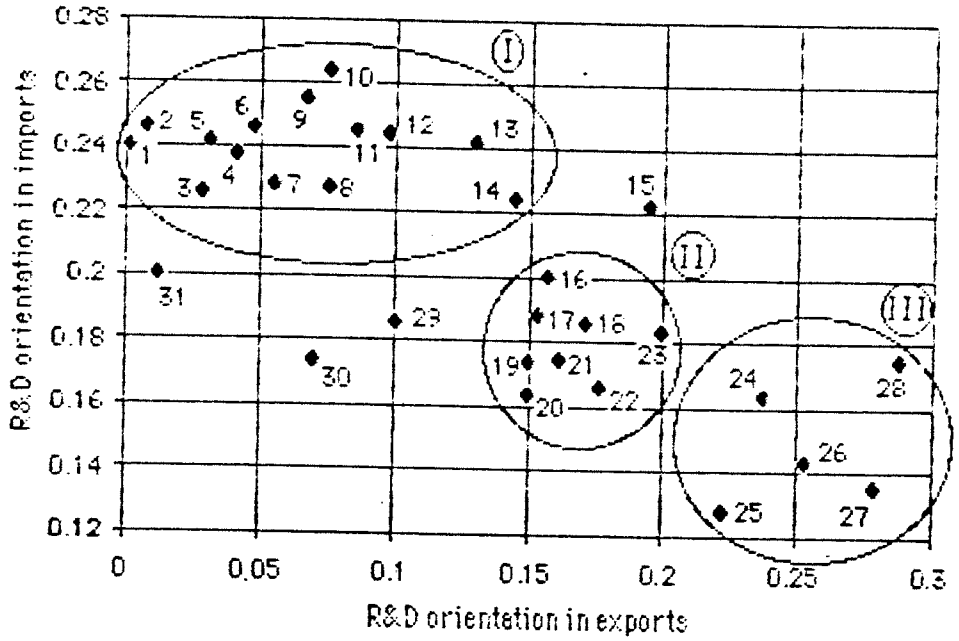
[3] A specific industry R&D orientation is defined as the correlation coefficient between revealed comparative advantage indexes in this industry for the 32 countries in the sample and these countries' R&D expenditure per worker. According to this procedure the theoretical range for country indexes would be between the values of minus 0.311(obtained in SITC 851-Footwear) and 0.586 (obtained in SITC 726-electrical apparatus for medical purposes). Actual ranges were much narrower, as shown in the graph. Note that these R&D orientation indexes for specific industries are actually "revealed R&D orientation" indexes. For details on methodology see UNIDO (1985, p. 113).

per worker - and the lowest R&D orientation in exports and the highest R&D orientation in imports. These are the countries in group I. In contrast, those of group III, are those with the highest R&D expenditure per worker and the ones with the greatest R&D orientation in exports and the lowest for imports. Group II show countries in an intermediate position.

Graph 1: Selected countries
Technology intensity in trade. 1976-1978



Countries (the numbers in parentheses indicate ther country ranking for R&D per worker):

Group I:
1-Philippines(29)
2-Chile(22)
3-New Zeland(18)
4-Finland (15)
5-Turkey (23)
6-Korea (24)
7-Australia (14)
8- Portugal(27)
9- Argentina (25)
10-Brazil(21)
11-Colombia(31)
12-Spain (20)
13-Canada (11)
14-Singapore (24).

Group II:
16-Austria (17)
17-Italy (16)
18-Sweden (3)
19-Ireland (19)
20-Denmark (13)
21-Belgium (9)
22-Netherlands (4)
23-France (7)

Group III:
24- UK (12)
25- Japan (10)
26- Germany (5)
27- USA (1)
28- Switzerland (2)

Ungrouped:
15-Israel (8)
29- Norway (6)
30- India (30)
31- Greece (26)

Source: original figures from UNIDO (1985, p. 114)

These numbers seems to bring a very clear pattern of international specialization, and one consistent with the neo-factor proportions theory, namely that advanced (in terms of their R&D "endowment") countries, export high tech and import low tech goods, and NICs, the ones with a low R&D "endowment" would do just the opposite, namely, import high tech and export low tech. These patterns - the existence of a technology rich or "innovating" region and an "immitating" or "dependent" region - have been recurrently observed. They were discussed by authors like Prebish[4], and much less recently by no less than Marshall[5]. Several models have been recently advanced to rationalize these patterns, notably those characteristically "Ricardian"[6], those centered on the notion of a persistent technological gap[7], and also the "stages approach" to comparative advantage[8].

The important issue to address in the context of these models is related to the implications of this allegedly "perverse" international division of labor for industrialization in "follower" countries, and in this respect the composition of the "dependent" group is quite revealing: the company of Canada, Australia, New Zeland, Spain and Finland, for example, can be useful to illustrate the point that the position of technological "inferiority" or "dependence", or simply of a "late start", carries little implication as regards

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[4] A discussion of this specific issue in Prebish thought can be found in M. J. Flanders (1964).

[5] The origins of trade theories in which technology play a leading role, and in particular Marshall's views on the international division of labor engineered by different rates of innovation in different regions of the world, and the role of innovators and immitators can be found in G. Harberler (1977, appendix A).

[6] As in P. R. Krugman (1987a).

[7] As in M. Posner (1961), R. Vernon(1966) and L. Wells Jr. (1972), P. R. Krugman (1979) and D. Dollar (1986).

[8] B. Balassa (1979).

economic performance and standards of living. The pattern of specialization pictured in the graph does not seem to be correlated in any strong sense with rich-poor, or low-high growth performers, or any other relevant clear-cut dichotomies.

Success in terms of a development strategy which has to rely on export dynamism has much to do with the second issue proposed above namely whether it is possible, or if there has been a technological upgrade in NICs exports and output over the years. Some evidence in this respect is provided by Table 1 below.

Table 1: NICs'
Foreign trade with OECD countries: technological intensity*, 1964-1985

	1964	1973	1980	1985
	NICs' share in OECD imports			
high	0.6	5.6	8.4	11.3
medium	1.4	1.8	2.9	5.0
low	4.6	7.1	8.3	12.1
	composition of NICs' exports to OECD			
high	2.2	17.6	21.5	25.0
medium	15.9	13.9	18.5	21.6
low	81.6	68.4	59.8	53.2
total	100.0	100.0	100.0	100.0

' refers to the "gang of four" (South Korea, Singapore, Hong-Kong, and Taiwan) plus Brazil and Mexico. * technological intensity classification based on average R&D intensity of specific industrial branches. Adapted from OECD (1988, pp. 23-24).

The table shows a very impressive penetration of NICs' exports in OECD markets and also a remarkable change in the composition of NICs' exports very clearly towards a higher technological content. One should note, however, that the technological classification in Table 1 provides little information on whether NICs are effectively making inroads in the highest ends of the technological spectrum. Exports of simple aircrafts, black and white TV sets, and old fashioned chips belong in the high tech classification

in the table, but are clearly at the lower end of the technological spectrum considering broader definitions of the products under consideration. The evidence in Table 1 should not convey the the idea of NICs trading at the technological frontier, yet it is significant that the absolute level of technological intensity of NICs trade has increased very substantially over time. NICs exports might be heavily dependent on "mature" products, as the simpler products just mentioned could almost certainly be included among NICs imports of a few years back, when these were high tech products, or at least had not yet "matured". However, this brings no implication as regards changes in the absolute level of technological intensity embodied in these products, which seems to be growing significantly as successive waves of newly matured products are transfered to NICs - either through a deliberate rellocation decision or by an increased world market share of NICs' firms.

The evidence presented above suggests: (i) a pattern of international division of labor, especially in trade in manufactures, where differentiated access to technology plays a crucial role; (ii) a technological upgrade in NICs exports, and, last but not least, (iii) the fact that the position of the "technological dependence" - measured in this context by the difference in R&D intensity of exports and imports - seems not to be associated with the degree of development of the country under consideration. It should be noted, however, that the evidence presented above says nothing about the evolution of the technological gap over time which depends crucially on exogenous factors affecting the pace and character of technical progress in the innovating countries but which, as discussed below, has important implications for industrial policy design in technologically "dependent" economies.

3) Industrial promotion and export upgrading in "mature" industries: the Brazilian experience

The transfer of industrial capacity on successive waves of mature products to the South, as suggested above, brings together a continuous technological upgrade of the latter's productive structure which translates itself into an upgrading of their exports. This process basically involves the development of comparative advantage in new sectors or industries - that is carrying the policies of promotion of infant industries to the point newly matured industries play a leading role in the export drive. Indeed, in latecomers all industries are "infants" by definition, so that it is hardly surprising that the recent discussion around industrial strategies in NICs has touched the very same issues the old infant industries' debate has so exhaustively dwelled upon.

It is important to note in this respect that the infant industry phenomenon is by no means an argument for protection, but just for the industry's promotion, which could include fiscal or credit subsidies - and even less for an "inward" trade orientation - since, as argued by Krueger, "if there were infant industries whose development could result in large scale cost reductions, restriction of their output to the quantities demanded in the domestic market would reduce the dynamic gains from the development of the industry to far smaller magnitudes than would be possible if the industry could be induced to export. Viewed in this light, there is nothing in the infant industry argument that indicates that import substitution, or more generally protection, is preferable to an unbiased or export-oriented strategy for trade and growth"[9]. However, many recent studies, along the lines of the

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[9] A. O. Krueger (1984, p. 148).

"new trade theory", have indeed made convincing cases for industrial promotion, and even protection, in "strategic" industries basing their arguments on economies and scale, learning effects, and R & D application[10].

The successful promotion of infants", as it is well known, involves mechanisms to foster learning and technology acquisition, that is, to foster technological transfer and develop and support a complex domestic technological and industrial base to allow replication, adaptation, and also the creation of indigenous technological capabilities. Government intervention is often necessary to overcome the externalities - thus providing investments in technological infra-structure (education, technical trainning, applied research, etc.)[11] - and the perverse incentives naturally created by protection and, obviously, to enforce the promotion schemes, that might be through the capital market or through fiscal or commercial policy. Of course, not all industries can be successfully promoted in this fashion, and very often government policies are trapped during the process of maturation by rent seeking motivations. As put by an authoritative review of the Korean experience "a government's ability to intervene selectively in pursuit of dynamic efficiency cannot be taken for granted. Indeed most government's lack this ability. But it appears to be a critical fator in using selective intervention to achieve faster and more successful industrialization"[12].

The record of the maturation of "infant industries", when considering the universe of LDCs is sufficiently weak to invalidate a general case for industrial promotion, yet there is a high enough number of successful cases

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[10] P. R. Krugman (1984 and 1986), D. Rodrik (1988) for example.

[11] The importance of these elements to whatever path of technology aquisition a country chooses has been repeatedly emphasized in the relevant literature, as for exemple in several of the papers in the M. Fransman & K. King (1984) volume.

[12] H. Pack & L. E. Westphal (1986, p. 104).

concentrated on the leading NICs to permit inferences on the policies and conditions conducive to the maturation of "infants"[13]. On a purely *a priori* basis it may be argued that success in an industrial promotion strategy is crucially affected by the interplay between the speed of learning and technological transfer in the import substituting country *vis-à-vis* the dynamism of the technological frontier, given the initial cost disavantage determined by relative wages and other factors, such as for example the levels of vertical integration to other relatively inefficient domestic sectors, V, to be discused at greater length below. The interaction of these elements are best seen if we write the evolution of an infant industry's costs over time, C(t), and of the costs of "matured" competing industries in the North, $C^*(t)$, as follows:

$$C^*(t) = C^*_0(w^*) - \phi . t \qquad (1)$$

$$C(t) = C_0(w, V) - \beta . t = C_0(w, V) - (\beta_0 + \beta_1 \phi) . t \qquad (2)$$

where initial costs depend on wages and the extent of vertical integration and the parameters β and ϕ stand for the speed of productivity growth as translated into average costs reductions in each industry. It is assumed in particular that β is partly autonomous (β_0) but partly dependent on the speed of technological progress abroad ϕ, this meaning that β_1 stands for the rate of technological transfer or spillover. With (1) and (2) we may write the cost differential, or the competitive disavantage of Southern producers as:

$$C(t) - C^*(t) = C_0(w, V) - C^*_0(w^*) - [\beta_0 - (1 + \beta_1) . \phi] . t \qquad (3)$$

The desireability of industrial promotion schemes, as seen in graph 2, can thus be determined according to the classical Mill-Bastable criterion,

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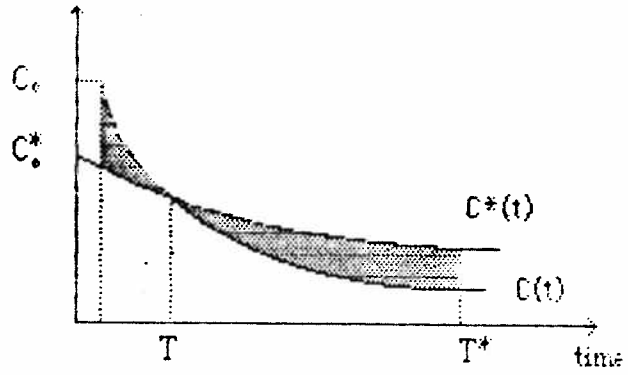
[13] M. Bell et al. (1984).

assumed to be satisfied at the moment T^*, which is determined so as to satisfy the following relation:

$$\int_0^{T^*} \exp(-\delta.t) \,.\, [C(t) - C^*(t)]\, dt \geq 0 \qquad (4)$$

where δ is a discount rate and the cost differential an undistorted measure of profitability. It is easily seen from the graph that, for a given initial cost differential, the faster the infant's learning (or the more significant the occurrence of economies of scale as the infant industry grows) or the slower the evolution of international prices/costs (the innovating country's technological frontier), the greater the chance of equation (4) be fullfilled.

Graph 2: An Infant Industry Trajectory



These *a priori* considerations provide a simple but powerful analytical framework for discussing the success of some infant industries in Brazil since the successful maturation of some "infants" along the lines described above was certainly a factor in the extraordinary manufatured export performance the country has experienced from the late 1960s on. In fact a suggestive explanation for the Brazilian export performance in relatively sophisticated manufactures has been provided by Teitel & Toumi who argued that given Brazil's large markets, the "new manufactured exports of the 1970s were not in fact, an exclusive consequence of export incentives but a 'natural' result of

the maturation of the process of industrial growth, helped by the substantial expansion of world trade verified during the period"[14]. An extensive recent survey of technology acquisition efforts in LDCs have observed in this respect that "when the size of the domestic market has led over time to the installation of large plants that do not exhibit static diseconomies *vis-à-vis* establishments in the developed world, and when the global technological frontier has remained stable for some time, protection policies systematically maintained for at least two decades seem to have induced the development of competitive enterprises in LDCs based upon sound indigenous technological capabilities"[15].

It is not clear why this interpretation should be restricted to national firms given the substantial concentration of foreign firms among exporters and especially in the more technologically sophisticated branches of manufacturing[16]. Clearly Brazil's changing comparative advantage in several technologically sophisticated sectors reflect the changing "outwardness" of the local affiliates of these firms. It is true that the roots of the growing comparative advantage which accompanied the "maturation" of these now dynamic foreign owned exporters in Brazil lie in the global developments affecting the trade orientation of multinational firms as a worldwide phenomenon[17]. However, when specific characteristics of the process of FDI penetration in Brazilian industry are taken into account, there are grounds to believe that the influence of these general trends upon the export propensity of foreign firms might have been strongly reinforced by the usual processes of learning and dynamic efficiency gains operating in already established

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[14] S. Teitel & F. E. Toumi (1986, p. 163)
[15] J. M. Katz (1984, p. 32) our emphasis.
[16] As can be seen in W. Fritsch & G. H. B. Franco (1988a).
[17] Ibid.

subsidiaries. Indeed, based on existing evidence on the very limited extent of technological search by multinational corporations before investment in developing countries[18] a case could be made that there was ample room for efficiency-improving technological adaptation of exogenously developed technologies to smaller market sizes, different input (including skills) specifications and demand characteristics by their foreign subsidiaries[19].

The influence of changing trade policy should not, however, be dismissed in explaining these "peculiarities" of Brazil's patterns of comparative advantage through dynamic efficiency gains. The observed low technological search before entry is not, of course, unrelated to the degree of protection from foreign competition - among other temporary favours - granted to import substituting investors in countries such as Brazil. Consequently, subsequent reductions in the "inwardness" of the host country's trade orientation - together with the natural phasing out of the other *ad hoc* locational incentives - could play an important role in inducing efficiency-enhancing adaptations over time. If that is accepted, the greater neutrality of incentives in Brazilian trade and exchange rate policies from the late sixties, following a wave of low-search import-substituting projects should also have contributed to spur local - ntional as well as foreign - firms to move faster down their learning curves[20].

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[18] Of the sample of seventy seven foreign investment projects in developing countries surveyed in G. Reuber et al. (1973) not less than fifty claimed not to have made any initial adaptation to local conditions.

[19] On this see, for instance, S. Teitel (1984) and J. M. Katz (1984).

[20] Whether this has in fact induced greater adaptation efforts by foreign firms is an empirical question and not very relevant for the present discussion. The weak evidence there is available, based on the estimation of VES production functions for ten Brazilian manufacturing sectors, concluded, however, that foreign firms displayed greater capacity of technological adaptation to changing factor prices than domestic firms in the seventies. See J. L. Máscolo & H. Braga (1985).

4)Industrial promotion and export upgrading in the 1980s: the key variables

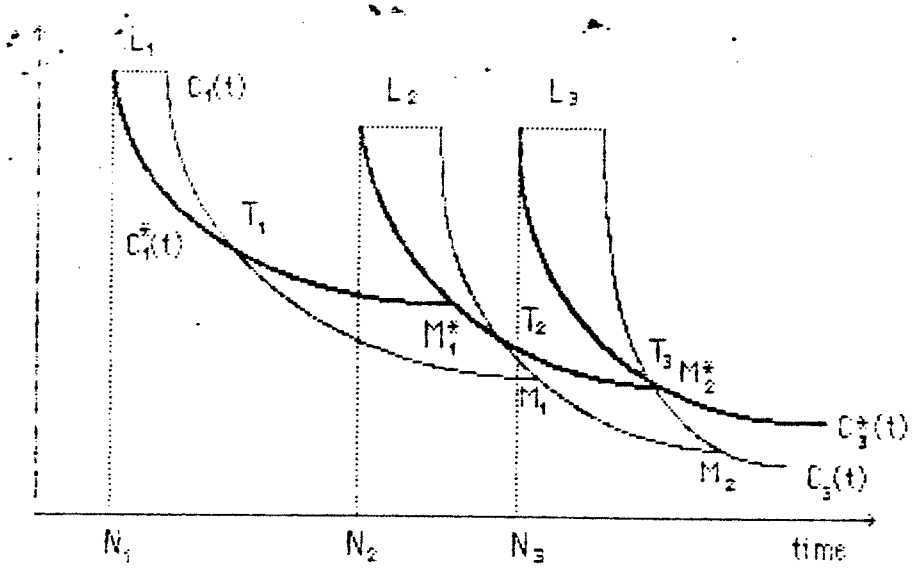
The stylized facts, summarized in the last section, on the record of strategies of industrial promotion in Brazil provide a good point of departure to examine future challenges to the formulation of industrial policies. The most crucial novelty for the years to come is the sharp acceleration in the rates of technological innovation in the North, which is due to have far reching implications to the prevailing patterns of comparative advantage worldwide. The consequences of these developments for technologically "dependent" countries, in the sense used in section 2, may result crucial for their efforts of export upgrading. As the technological frontier jumps ahead, an increasingly sophisticated set of industries - the lower end of the technological spectrum in the North - is liable to relocate the South, and this provides indeed a big challenge to be faced since it requires an increasingly sophisticated set of factor endowments and supporting policies. Success in industrial promotion in these new industries depend on being alert to the peculiarities of technologically dynamic industries. Yet, the appearance of new, high tech, industries should not be seen as a mere renewal of the import substitution agenda, but as an entirely new challenge requiring brand new solutions. This section addresses some key features of these new industries that should modify the nature of the calculations involved in the usual policies of industrial promotion in Brazil.

4.1) Infant industries and the product cycle

The stylized picture of successful maturing examined in the last section considered industries with a "stable" technological frontier, in which efficiency obtained after a long period of undisturbed - except for

domestically generated cyclical factors - learning and technological search. This is, however, no longer to be seen, once one of the most clear features of new high tech industries is that innovations take the form of the introduction of new higher quality products that very often represent a lethal demand shock to the existing products. Newer industries not only experience such marked product cycles but it happens that these cycles are shown to be short and shortening. The precise implications of these phenomena to the logic of industrial promotion in "follower" countries are best seen with the help of Graph 3.

Graph 3: Infant industries over product cycles



The graph shows the evolution of cost functions over time for a succession of three related product cycles. Each product is first introduced in the North at instants N_1, N_2 and N_3, and their production in the South starts after lags L_1, L_2 and L_3 respectively. Producers in the South face significant cost disavantages at the moment production starts* but "catching-up" eventually takes place at times T_1, T_2 and T_3. The crucial question regarding industrial promotion in this context is whether the Mill-Bastable "viability"

* For simplicity, it is assumed that initial costs in the South are equal to initial costs in the North which, evidently assures that - given an introduction lag - at the moment the new product starts to be manufactured in the South there exist a cost differential favourable to the North.

condition expressed by equation (4) is fullfilled before the termination of the product cycle. It is important to note that the product cycle does not terminate with the introduction of the next generation of products, namely at N_1, N_2 and N_3. The innovation does represent an adverse demand shock that results in excess capacity but, at this point there generally persists a significant price differential favouring the old product. This, however, tends to dwindle over time until the two prices - of the new and of the old product - are sufficiently close and the demand for the old product actually disappears[21]. Instants M^*_1 and M^*_2 signal the moments when respective product cycles terminate considering the industry in the North.

The product cycle in the South starts later and does not have the same length, as easily seen from the graph. Note that, in the South the first cycle starts after the introduction lag L_1 namely at N_1+L_1. At N_2 the introduction of new product in the North may be a serious shock to domestic producers of the old product if foreign products are allowed to penetrate in the country's market. Protection may certainly restrict the exposition of consumers to the new product, still only manufactured in the North, thus extending the old product's cycle a bit more. This is effective, however, just for a while, actually corresponding to the second introduction lag L_2, since it would be entirely senseless to prevent the introduction of domestically manufactured versions of the new product. At this point, established producer of the first generation products have no defense against competition from the new product, though the product cycle will only terminate in the South at M_1, when the price of the domestic version of the new product is close enough to the old one's price. In these conditions, and

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[21] It might be that some residual demand persists while downstream users are slow to switch to the new product. That varies from case to case.

considering for simplicity that $M_i = N_{i+1}+L_{i+1}$ - i. e. that the old product's demand disappears when the new one starts to be manufactured domestically[22] - the condition for the desireability of industrial promotion becomes:

$$\int_{N_i+L_i}^{N_{i+1}+L_{i+1}} \exp(-\delta.t) \cdot [C(t) - C^*(t)]\, dt \geq 0 \qquad (5)$$

Note that the fullfillment of condition (5) depends crucially on the timing of innovations, namely the speed of innovation, $(N_{i+1} - N_i)$ and the behavior over time of lags in the introduction of new products in the South, $(L_{i+1} - L_i)$. It is interesting to note that (5) is less likely to be fullfilled the shorter the interval between innovations, and the shorter become the introduction lags. If we define the left hand side of (5) as function $H_i(N_{i+1}\ L_{i+1})$ it is rather trivial that $\partial H_i/\partial N_{i+1}$ and $\partial H_i/\partial L_{i+1}$ are both positive, expressing the fact that the longer the delay in the appearance of new products and their introduction in the South the easier it becomes to fullfill (5). Correspondingly, under an accelerating rythm of innovation and ever shorter introduction lags, the viability of industrial promotion in follower countries is very clearly endangered. Note, however, that $\partial H_{i+1}/\partial L_{i+1}$ is negative, which represents an advantage to the South as far as the next cycle is concerned provided that L_{i+2} is not further shrunk.

A lively example of these considerations is provided by the Brazilian experience with the manufacturing of computers of the Apple II type. Local manufacturing started in July 1982, thus substantially later than the product's appearance in the US. At this time the cost differential between the local clone (considering only the CPU) and the original US model was estimated to be 215%[23]. In May 1984 the cost differential was virtually eliminated, but at this time the Apple II was an obsolete machine.

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[22] That means to terminate the cycle before M1, as easily seen from the graph.
[23] W. Fritsch & G. H. B. Franco (1988b, p. 156).

Domestically manufactured IBM PCs clones were taking over the domestic market at this point, despite their incredibly high price(cost) differentials, estimated at 319% in July 1986[24], damaging Apple II clones' sales very badly.

Several issues are important to allow a judgement on whether the Apple II experience was worthwhile. It may surely have been that efficiency was reached too late, though it is difficult to assess the extent of residual demand, especially when firms begin the leave the industry to participate in the next product cycle. In this connection an interesting case is the one of the semiconductor manufacturing in Korea. The crucial point there was that in the later phases of the product cycle industry leaders left to enjoy the early - and allegedly more profitable - phase of the next generation of chips' manufacturing thus leaving the residual demand to be fullfilled by the late entrants, the Koreans, which thus managed to grab significant market shares in semiconductors[25]. The Korean experience also points out to the feasibilty of a lesss ambitious world marketing strategy for technologically "dependent" countries, based on targeting the position of a "second supplier" for the residual demand for obsolencing products left by the upgrading of products by market leaders.

It is difficult also to assess the extent to which the accumulation of human capital during the Apple II experience may be of usefulness in the next product cycle. This issue is related to one of the dangers of technological dependence, what has been called technological protectionism. As Apple next product, the Macintosh, adopted a closed architecture concept, clone manufacturers could not upgrade their plants accordingly. Attempts to build

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[24] Idem, ibid.
[25] C. H. Yoon (1988).

a local Macintosh clone have been technically successful, though this raised a complex issue of the treatment of intelectual property in Brazil. Pressures from the US government would eventually prevent the product from obtaining permission for commercialization. In these conditions, only a few of the original producers of Apple II clones could reconvert to IBM PC clones.

In sum, in industries subject to marked product cycles, the viability of policies of industrial promotion should be assessed from calculations cutting accross many product cycles, and are crucially affected by variables such as the introduction lag L - which is in fact a measure of lags in technology transfers or spillovers - and the length of the product cycle, being especially relevant for "follower" firms the behavior of industry demand in the later phases of the product cycle. Very clearly under shortening product cycles and large introduction lags the promotion of "infants" becomes a rather risky exercise.

4.2) Industrial promotion and openess

Many structural features account for the initial cost disavantages plaguing infant industries in semi-industrialised economies and a crucial one is the degree of vertical integration with other relatively inefficient domestic producers or, alternatively, the lack of access to imported inputs. The reason can be clearly seen by considering the limit situation where the country's industry is entirely formed by "infants": the more it relies on itself as a source of inputs - as opposed to importing competitively priced inputs - the less competitive it becomes.

The history of Brazilian industrialization provides a good example of how something quite near to such a vertically integrated infant industrial structure comes to be formed as an almost necessary consequence of the

sectoral sequencing of an extensive process of import substitution resulting from the use of trade restrictions as a central instrument of adjustment to recurrent balance of payments stringencies. In an early phase, which in Brazil spans from the thirties to the early fifties, trade restrictions - mostly quantitative restrictions associated to foreign exchange allocations - discriminate against "non-essential" consumer goods leading to a progressive and spontaneous process of import substitution in these sectors. However, as this process evolves over time, the import bill comes to be dominated by producer goods. In the situation of almost perennial balance of payments difficulties and meagre flows of foreign finance then prevailing, this created a new twofold problem which became acute by the mid-fifties: while the greater sensitivity of domestic activity levels and inflation rates to import restrictions affecting intermediate goods introduced a strong constraint on the continued use of QRs, market inducements for import substitution in the more capital intensive and technologically sophisticated producer goods sectors were not generally present. The response to this problem came during the second half of the fifties, when the first fully fledged industrial plan was launched, signalling the beginning of government efforts towards industrial promotion aimed at import substitution in intermediate and, later, capital goods which, reinforced by a similar industrial policy response following the first oil shock, lasted to the end of the past decade. The result was a dramatic compression of the economy's propensity to import industrial inputs.

This forcible and relatively rapid build up of a highly vertically integrated industrial structure where many of the new input producing sectors were created by stimuli generated by the domestic market reserve and minimum import content requirements in downstream sectors must

perforce have given rise to a large number of infants, at least temporarily producing at a cost disvantage. However, as severe external disequilibria following the debt crisis recurred, import controls protecting them were not relaxed, leading to an import structure which can be described in a stylised way as having basically non-competitive imports, most of which are subject to QRs stemming from administrative allocations of foreign exchange to importers.

It is interesting to see how, given the presence of a large number of infants in the intermediate goods sectors, such structure of protection affects the attainment of industrial efficiency. This can be easily done with reference to the analytical framework presented in section 3 slightly adapted to capture the peculiarities of the Brazilian trade regime. Thus, considering an economy in which interindustrial relations are described by a matrix $A_{ij} = [a_{ij}]$ of fixed technical coefficients and ignoring differences between prices and costs, according to equation (2) the costs of a domestic producer can be writen as:

$$C_i(t) = a_{iw}.w + \sum_{j\epsilon V} a_{ij}P_j + \sum_{j\epsilon\Gamma(V)} e.a_{ij}P^*_j(1+t_j) - [\beta_0 + \beta_1.\phi].t \qquad (6)$$

where V stands for the set of domestically produced inputs and $\Gamma(V)$ the complement of V. The other inputs are the non-competitive imported ones used in the production of i, where tariffs or tariff equivalents are designated by t_j, and e stands for the relevant exchange rate. It can easily be seen that the enlargement of V through import bans based on industrial policy regulations concerning national content requirements, or simply the use of "similarity laws", produces a reduction in competitiveness in downstream sectors which is exactly equal to $a_{ij}[P_j - e.P^*_j(1+t_j)]$. Thus, when V is extended in this fashion as import substitution is pushed towards

inputs, inspection of equation (6) shows that there should be an upward shift in C(t) which might have pervasive negative effects on industrial efficiency in other sectors through its interindustrial effects and retard, *coeteris paribus*, the maturation of infant industries.

The above shows that to obtain a high degree of vertical integration may be especially troublesome for new industries now being established in Brazil especially in view of the change in emphasis from import substitution to manufactured export growth as the adjustment strategy to the foreign exchange constraint in the eighties leading to renewed emphasis on industrial efficiency and competitiveness. Moreover, under shortening product cycles, as argued in the last section, there are much less degrees of freedom as regards the viability of industrial promotion: too much importance being given to vertical integration might push cost curves upward to a point that the "catching up" obtains too late, or that the economic desireability of infant industry promotion is simply destroyed. In these conditions, the levels of vertical integration become an important policy variable to adjust for the need of economic viability in the sense of equation (4) for a given, and presumably short, product's life. This is why, in cheap labour countries even high tech "infants" can be <u>born</u> competitive in the assembly stage if its reliance on imports is sufficiently unrestricted, as typically found in EPZ. Yet, in a meaningful industrial promotion policies the challenge is to increase vertical integration gradually, without damaging competitiveness. Thus, in promoting entirely new industries as, for instance, those created by the recent advances in microelectronics, care should be taken not to move too fast from assembly towards the protected manufacture of components, and then the move should be based of efficiency criteria.

The Apple II experience mentioned above provides an interesting illustration for these considerations. In Brazil computers are manufactured with indexes of "nationalization" (value of imports/sales) around 90%, which obviously does not help the cause of fullfulling the Mill Bastable criteria; it puts initial cost differentials too high even considering the large wage differentials favourable to Brazil. Yet, the Apple II case was an exception: it was the only product whose plants were allowed to be established in the Manaus Free Zone (MFZ) where import restrictions are very mild. The move to the MFZ was equivalent to a liberalization: it increased import content in the product's manufacturing and thus represented a significant downward shift the C(t) line that allowed competitiveness to be achieved shortly after.

The importance now attributed to competitiveness has naturally brought the liberalization issue to be considered also in connection with old established vertically integrated sectors. Two main political obstacles must be faced here. The first is need to counteract the inevitable resistances to the costs of structural adjustment which will accompany the process of industrial restructuring produced by trade liberalization as observed worldwide. The other is the fear that depending on the nature and speed of the liberalization it may generate import surges and destabilising payments disequilibria. An interesting alternative cutting accross these problems was provided by the Brazilian BEFIEX program, under which a firm is granted free access to inputs and even exemption from "similarity" examinations for processing for sale either in foreign or domestic markets, in exchange for export commitments far in excess of the value of allowed imports. Its effectivenss in terms of increased efficiency can be gauged by the fact that exports under the program - which comprises only about 60 firms - accounted for nearly

40% of Brazilian exports of manufactures in 1986, a US$ 7.1 billion worth[26]. A quite similar posture prevails in Korea, where, according to an account, "exporters were placed under a virtual free trade regime such that they faced world (or border) prices for both tradable inputs and exported utputs"[27]. The success of these programs coupled with the ease with which they were enforced, does provide a promising avenue for achieving greater outwrad orientation, and eventually a fully fledged trade liberalization in NICs in the years to come.

4.3) Industrial promotion and technical progress

The preceding discussion of the influence of the trade regime and the feasibility of infant industry promotion emphazised only the role of once and for all effects associated to increased access to competitively priced inputs. Nowhere it was suggested that the trade regime has a direct bearing on productivity growth and other dynamic factors affecting the slope of C(t). Although it is admitted that trade restrictions introduce static allocative inefficiencies, the notion that trade liberalization leads to a greter technical efficiency is not tenable. As noted by an extensive survey of exercises attempting to relate the trade regime with total factor productivity growth: "there is no clear cut confirmation of the hypothesis that countries with an external orientation benefit from greater growth in technical efficiency in the component sectors of manufacturing; combined with the relatively small static costs of protection, this finding leaves those with a predilection towards a neutral regime in a quandary"[28]. Indeed, the fact that the

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[26] W. Fritsch & G. H. B. Franco (1988b, p. 116).
[27] H. Pack & L. Westphal (1986, p. 93).
[28] H. Pack (1986, p. 38). An enlightening discussion of the issue is offerred by D. Rodrik (1988).

empirical arguments for defending export promotion *vis-à-vis* import substitution on the grounds of technical efficiency are simply not there, was even admitted by Bhagwati[29] . Thus, the importance normally attributed to the trade regime as a determinant of industrial efficiency should not be overemphasized. Many other factors - most notably those related with market structure such as size and nationality of ownership of leading firms in the industry - are relevant in this respect.

The literature on infant industry promotion stresses that the crucial elements for successful maturation are exactly those relating to the growth of technical efficiency over time. As a recent survey of the record of infant industries aptly put it: "maturation is not automatic or instant: reaching and maintaining international competitiveness is not simply a matter of developing the right industry or industries given the existing (aggregate) relative factor endowment. It takes more than effortless learning by doing and requires capability to manage continuous technological change. Maturation takes conscious efforts to develop a technological strategy, to invest in resources for technlogical changes, and progressively to accumulate technological capability"[30].

Increasing technical efficiency can result from the operation of two distint causes. On the one hand, they are likely to be generated by positive externalities created along the time span of the industry's maturation. On the other, they stem from the existence of increasing returns due to economies internal to the firm, especially those resulting from the attainment of economies of scale - when they happen to be significant - and, especially in technologically dynamic sectors, from the firm's capacity to master the

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[29] J. Bhagwati (1988, pp. 39-40).
[30] M. Bell et al. (1984, p. 124).

process of technological choice either through the development of R & D capability or through technology acquisition.

Dealing with these two different causes have different implications for public policy. The former quite clearly relates to circumventing market failures in generating public goods such as technical training, support to basic R & D and the like which, although still facing low priority in the allocation of public resources in the vast majority of developing countries, present little ambiguities as to their causal effect on the level of domestic technologicall capability. However, devising government stimuli to innovation and technical efficiency at the firm level implies in the administration of instruments of competition policy to foster technical efficiency, which begs the much more complex issue of the relation between market struture and innovative behavior. In fact, although the traditional presumption is that high entry barriers stiffles the stimulus to innovation and thus are conductive to technological stagnation, the neo-Schumpeterian notion that R & D investments are part of the strategic behavior of firms in concentrated market structures aimed at generating technical progress and innovation, leads to altogether different conclusions.

Empirical findings are inconclusive in this respect. Innovative activity is commonly related to perceived market opportunities[31], which are often associated to market size and growth - and, especially in developing countries, to firm ownership - and far less clearly to other elements of the competitive environment, such as for example intra-firm rivalry and ease of entry and exit, as noted by H. Ergas (1984) in the context of contrasts in innovative activity in the OECD area, and by S. Teitel (1984); J. M. Katz

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[31] See K. Pavitt (1988).

(1984) and C. Dahlman et al. (1987) in the context of a discussion of infant industries and technology acquisition in the Third World. It should be noted in this connection that protection could in itself hardly be taken as a powerful inducement towards efficiency and innovation, as one could *a priori* expect, though it has been difficult, on the other hand, to prove its negative implication to the innovation effort, as suggested by the inconclusive results of studies relating total factor productivity growth and measures of protection or openess mentioned above.

In this regard, it is interesting to note that the assertions to be found in some "new trade theory" models which associate trade restrictions (or distortions) with eventual high export performance through the attainment of increasing returns internal to the firm, crucially depend on behavioral hypotheses explaining increasing technical efficiency as resulting from R & D or other efficiency improving investments made out of rents generated by protection to firms operating in non-competitive environments[32]. However, until we improve our understanding of the relation between market structure and innovation in developing countries[33] it will be unwise to make normative generalizations as to the use of barriers to competition as a source of increasing efficiency over time.

In the meantime, the debate around the role of competition policies for the faster maturation of "infants" is everything but settled in Brazil, the positions ranging from the idea of forming the domestic equivalents of the Korean *chaebols* to orthodox liberalizers arguing for less industrial policies and restrictions to foreign capital. No doubt there is ample room to increase

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[32] For a popular model in this class, see P. R. Krugman (1984). For lucid caveats related to the activist prescriptions of this class of models see G. Carliner (1986, pp. 164-167).
[33] On the state of the art regarding this issue see M. Kamien & Schwartz (1982).

the slope of C(t) through increases in β_0 - i. e., by enhancing domestic firms' R & D capabilities - or through increases in β_1 - i. e., by raising the rate of technological transfer. The former is, however, far from easy, especially if the technology frontier is moving fast for, in this case, increases in domestic technological capability must be defined as something beyond simple learning by doing, since returns from mastering the use of given techniques fall over time. Alternatively, acquiring capablity to master technology so as eventually being able to overcome major technical discontinuites with the firm's own resources is an altogether different proposition, implying investment outlays which can be very high and in most sectors unattainable within a reasonable time span in Brazil if current very low rates of R & D expenditures by national as well as foreign subsidiaries as taken as guidance of future behavior[34]. Of course, government incentives could play an important role in reducing entrpreneurial risk, but leap frogging to the technological frontier with the present huge R & D expenditure gaps cannot be taken as a serious proposition.

Normative discussions on how to increase the rate of technological transfer in LDCs either boils down to the same issue of how to foster the technological capability of domestic firms discussed above, or raises the question of how to increase the rate of transfer by MNCs. No doubt the latter's role is of a crucial importance in the context of the Brazilian debate in view of the heavy presence of MNCs in the most technologically dynamic sectors of industry. There can be little doubt that the development of competitiveness and technology acquisition is related to policies affecting MNCs behavior in several instances. First, technological search by local

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[34] For evidence on the dismal low rates of R & D expenditures in Brazil as compared to some OECD countries, see H. C. Braga & V. Matesco (1986).

affiliates[35] were usually addressed to comply with stringent "local content" requirements. In fact such requirements tend to make local affiliates behave as "infants", having to undertake sometimes extensive technology adaptation efforts. Second, pressures for technology transfer, usually within joint ventures, have been actively exercised by the government with the precise aim of maximizing technology acquisition, although a vast number of joint ventures where the local partner exclusively aims at at accessing the foreign partner's know-how were formed without any government intervenction. Third, competitive threats to MNC affiliates posed by domestic policies biased towards national firms, such as for example, preferences by government procurement, previledged access to subsidized credits. Fourth, concerns with industrial "enclaves" led government policies to force vertical links between national and foreign firms with important effects on the technological upgrading of upstream national firms. In fact, the presence of MNCs in the Brazilian industrial structure was by and large positive to local innovation for their relation with local suppliers and competitors tended to enhance the technological and market complementarities prone to generate innovations or to enlarge technology transfer channels.

5) Conclusions

The Brazilian tradition of activist industrial policy, its past success and the recent emulation created by the success stories of Japan and Korea, will continue to generate pressures for government guidance and support for infant industry promotion. The crucial change in current discussions in Brazil on how to devise a new industrial policy strategy in relation to past

35 See H. Braga (1988) for example.

approaches based on import substitution is the generalised perception that the need to strive for efficiency. The reason for this change is simple: if export growth is an imperative to overcome the foreign debt constraint on growth and if fast rising real wages is a requisite of the consolidation of the democratic regime, compatibility between these two central long term policy objectives requires fast productivity growth.

However, as the review presented in this paper shows, when all is said and done about infant industry promotion in developing countries one is left with very little policy guidance except for the simple truth that decisions regarding industrial promotion are fundamentally of a nature similar to that of investment decisions and, therefore, surrounded by uncertainty about the future. As such, in the present environment of rapid technological change in the innovating countries, industrial promotion policies in technologically "dependent "economies should be carried out with caution for, as once observed by Keynes, between the cup and the lips there may be many surprises. Nevertheless, one is on the safe side who says that public policy to foster industrial efficiency in these countries should (i) avoid going into new industries with high degrees of technical obsolescence, unless one is prepared to follow a marketing strategy of residual supplier of "dying", past generation products, and even that may only be possible if backward integration in domestic production of parts and components is not pushed too fast, (ii) continue to strive towards reducing the competitive burden placed on domestic producers by overly restrictive import regimes and, last but not least, (iii) urgently correct the market failures and generate the positive externalities associated with investments in human capital and basic R & D.

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