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Trade Reforms and Technological Accumulation: the Case of the Industrial Sector in Argentina during the 1990s

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Abstract

The impacts of trade liberalisation on technological development are particularly important because of their dynamic long-term effects on the economy.

The paper pursues a comprehensive approach to technological change that relies on drawing a contrast between visible changes in performance and decision-making processes that stem from a behavioural dimension. Based on the Argentinean Innovation Survey (1997) the paper justifies the importance of a joint determination of these two dimensions for analysing macro-micro links of technological change as the most adequate way of assessing the impact of major macro-policy change on technology. It is organised in three parts.

The first part critically discusses the main theoretical arguments that relate trade liberalisation to technological accumulation. The second part claims that the ultimate impact of openness on technological performance is dependent on its incidence on the elements that guide firms' technological decisions. Therefore, a model for *micro technological behaviour* and trade liberalisation is developed in the light of the Schumpeterian literature and illustrated using techniques appropriate for non-parametric data. Part three emphasises the importance of *macro behaviour*. Based on empirical information for the Argentinean case it is claimed that the biological metaphor which states that an open market is sufficient to select the best performing firms is often invalid in the context of Argentinean macro behaviour during the 1990s. On the contrary, firms had higher probabilities of remaining in the market when they followed a survival attitude unrelated to productive activities, and this often hampered technological performance. Thus two distinct patterns emerged, one corresponding to technological performance and the other to economic performance.

Acknowledgements

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I must also express my gratitude for eighteen years of free, high-quality, public education in Argentina; especially to the UBA (University of Buenos Aires), which is responsible for the seeds of any piece of academic work I might do.

Introduction

In the context of structural adjustment reforms, developing countries have been challenged to liberalise and simplify their trade policies. The prevailing orthodoxy in economic theory has justified this switch in policies, claiming that it would foster growth and efficiency. The impacts of trade liberalisation on technological development are particularly important because of their dynamic long-term effects on the economy.

The relation between technology and import liberalisation is nevertheless quite controversial. There is no complete accord, even inside similar schools of thought. Here the arguments will be classified according to two main hypotheses. The first includes the new growth theory propositions, based primarily on world allocative efficiency and the broadening of access to international up-to-date sources of knowledge, which impact on technological change. The second hypothesis focuses on the need for developing countries' firms to achieve indigenous capabilities in order to adopt and benefit from available technology. According to this view, trade might threaten the development of those capabilities, because domestic efforts are undercut by foreign know-how or because the international division of labour imposes on developing countries the task of specialising in less dynamic technologies.

Therefore, both approaches imply that trade might influence technological change and would consequently agree that there exists a connection between the micro and the macro levels, though with opposite consequences.

Although this paper will discuss (and to some extent adopt) both sets of arguments, the line of reasoning is distinct from both of them. My contention is that, even though trade does enlarge the external sources of information available for trading *countries*, it does not imply that *firms* within these countries will upgrade their technological skills. Nor will they *necessarily* improve their technical or allocative efficiency. However, this does not use an "infant industry protection" type of explanation. My point is that *firm behaviour* needs to be openly considered within each particular *macro behaviour* in order to disentangle the extent to which firms benefit from the broader opportunities that openness creates.

The behavioural link between macro and micro spheres is of paramount importance. Firms' decisions are sensitive to a number of determinants (here distinguished as micro, sectoral and macro determinants), which are path-dependent. Therefore, micro behaviour is not given in the ways that the conventional approaches in economics have claimed; instead it changes across countries, sectors, and types of firms.

Two claims guide the discussion of the paper:

- *Importance of micro behaviour*: The ultimate impact of openness on technological performance will be dependent on its incidence on the *macro, sectoral* and *micro* elements that affect *OACK* conditions (opportunity, appropriability, cumulativeness and knowledge-based conditions) in the behavioural dimension, which is the abstract locus where decisions are shaped.
- *Importance of macro behaviour*: The macro behaviour that prevailed in Argentina at the time of liberalisation separated economic from technological performance as two distinct outcomes with different (sometimes opposite) characteristics. Firms that were successful at product and process innovation (i.e. *technological performance*) replicated the same patterns that characterised technological behaviour. However, patterns of successful *economic performance* diverged from them and did not necessarily amount to an efficiency criterion.

The paper is divided into three major parts and a conclusion. The first part critically discusses the main theoretical arguments that relate trade liberalisation to efficiency and long-term growth. The second part develops a model for technological behaviour and liberalisation in the light of the Schumpeterian literature and illustrates it with empirical information on the Argentinean case. Part three provides a broader picture of technological and economic performance based on the analysis of macro-micro behavioural links in Argentina after trade liberalisation. Finally, the conclusions summarise the results and formulate exploratory propositions on possible consequences of the changing macro environment after devaluation.

1. Trade: opportunities and challenges in the long-run

1.1 The case for free trade

Import liberalisation is usually thought of as a way of eliminating price distortions. This favours an optimal allocation of production factors and optimal distribution of commodities; therefore improvements in *inter-industry efficiency* can be expected. Furthermore, cost reduction tends to have a cumulative effect through its spillover effects via input/output relationships [Balassa, 1988].

In addition, it is widely argued that liberalisation increases industrial sector efficiency by preventing domestic producers enjoying monopoly rents, which usually result in excessive size and technical inefficiency. Trade reform not only generates competition that should discipline producers and improve technical efficiency, but also enlarges markets and thus opens up the possibility of reaping scale economies through making better use of the capacity. In other words, the elimination of monopoly rents through openness might bring *intra-industry efficiency*.

However, some caveats must be considered. First, the embodiment of technology in capital, skills and organisation of work implies that the reallocation of factors into more favoured activities is difficult and should not simply be assumed. This may create an unbalanced situation between creation and destruction after liberalisation, which might result in wasted resources. Secondly, in a context of information asymmetries and imperfect markets it is not necessarily true that the most inefficient firms quit the market while the efficient ones remain[1]. Finally, inter-industry efficiency could contradict the realisation of intra-industry efficiency in practical terms. Given that capacity utilization in developing countries relies on the availability of imports of inputs and capital assets, inter-industry reallocation could inhibit the achievement of intra-industry efficiency in a context of balance of payments constraints. As Helleiner [1993] argues, "liberalisation of imports is generally considered likely to *increase* allocative gains but, if it increases the proportion of free foreign exchange that is spent on non-critical inputs, as it probably will, it may *reduce* those relating to capacity utilization in a foreign exchange constrained economy". Within a culture of consumerism, the increase in imports of luxury goods could make this restriction especially relevant.

Having said this, there is not much controversy on these static approaches to trade questions, and it is largely agreed that liberalisation is beneficial for both inter- and intra-industry efficiency.

This research is mainly focused on a more controversial relationship. It will investigate whether trade reforms benefit or reduce technological accumulation. According to certain dynamic approaches, grounded in neoclassical views of economics, it could be argued that free trade is a positive incentive for technological change that would affect long-run growth. Some of the mechanisms are:

- *Communication*: International exchange opens channels of communication that facilitate the transmission of technical information [World Bank, 1992]. This faster accumulation of knowledge implies a more rapid reduction in the cost of production [Grossman and Helpman, 1991].
- *Replenishment*: International markets open access to up-to-date knowledge bases [Atiyas, Dutz and Frischtak, 1992] and enable entrepreneurs to introduce new varieties at a faster pace [Grossman and Helpman, 1991].

[1] I will return to this point, very much rooted in a behavioural approach, when analysing the Argentinean case in Section 3.

- *Competition*: International competition could encourage the use of new and distinctive ideas and technologies in production [Balassa, 1988]. It also reduces duplication [Grossman and Helpman, 1991].
- *Externalities*: Access to higher technology products creates spillover effects on knowledge [Barro and Sala-i-Martin, 1995].
- *Human capital*: Integration enlarges human capital resources that can be allocated to research. Given that the research sector exhibits increasing returns to scale, the rate of growth increases [Romer, 1990].
- *Source of imitation*: Most firms in developing countries innovate by imitating the innovations in products and processes made by other firms, usually located in the developed world. One of the main sources of this kind of innovation is importing capital goods that embody new technology [Barro and Sala-i-Martin, 1995; Obstfeld and Rogoff, 1996].

1.2 The criticism of free trade

The idea that openness is an unequivocally good means for technological development has been queried. There exists a whole array of critics who would actually find a rationale for protection or at least some kind of guidance in the process of liberalisation. These scholars, called the “heretics” by Dosi and Soete [1988], belong to different schools of thought and consequently their contributions are not necessarily integrated. This criticism has been classified here into two groups: one that emphasises the importance of indigenous capabilities, which could be threatened by early liberalisation, and another that objects to specialisation that relies merely on (existing) factor endowments.

Actually both would proclaim that only a *strategic* liberalisation is dynamically beneficial. Arguably, such a policy should commit itself to indigenous technological accumulation and must prioritise certain activities against others.

The *capability* approach criticises neoclassical views of innovation for being very weak in their conceptualisation of technology. It is now widely recognised that technological change is not a mechanical process where firms select what they need from a “technology shelf” or from an independent research sector. Therefore, even when trade does enlarge the external source of knowledge available for trading countries, it does not imply that they will upgrade their technology skills. Information might flow faster, but the “ability to produce or replicate innovative results is much more sticky” [Dosi, 1988].

One of the main reasons that justifies this type of argument is that imitation does not inevitably follow innovation, and even when it does it may not be immediate. The time element arises because indigenous knowledge needs to have been developed previously. Not only should imitators know how to select and to adapt the imported technology to local circumstances [Fransman, 1985], but also they should know how to decode the instructions and transform them into effective and efficient routines and processes [Nelson, 1987].

This capacity to innovate is intrinsically associated with the historic accumulation of knowledge inside the firm, and the allocative process that trade liberalisation is meant to generate could militate against that accumulation. A great part of the know-how might evaporate along with the disappearance of the firms that have produced it.

Moreover, the closure of firms also destroys backward and forward linkages that have been working hitherto. This, of course, further damages the accumulation of knowledge that is required to innovate [Katz, 2000]. Lall [1993] goes even further along this line of

argument in suggesting that the costs of protecting capital goods producers may well be offset in dynamic economies by the technological benefits yielded by a close interaction between users and producers.

Even some of those who openly support free trade as a way to increase technological accumulation become more cautious when referring to imitation. Grossman and Helpman [1991], for instance, make the point that in order for the imitation to be profitable, "the imitator must be able to earn positive profits in competition with the original inventor", and "the enforcement of any applicable patents must not be so strict as to make imitation prohibitively expensive". These conditions may be difficult to satisfy in a highly open economy.

Furthermore, the same authors in another study [Grossman and Helpman, 1993] note the case that, when technological spillovers are national in scope, the long-run growth would be faster in that country if it is allowed to "catch up before fully exposing itself to world competition".

To sum up, upgrading technologies requires time, especially in developing countries where innovative activities are characterised by imitation and incremental improvements. Thus, information flows are not enough to guarantee convergence in technological capabilities.

Related arguments have given rise to views favouring infant industry protection (e.g. List [1904]) and also the 'dependency school' in Latin America. Development according to these views was seen as a "chain of disequilibria" created by demand complementarity and external economies, mainly present in manufacturing production. Openness, in turn, was seen as offering a threat of becoming stuck in the production of primary products, in which developing countries had comparative advantages. Specialising in agriculture, despite being a "natural" international equilibrium, would mean withdrawing resources from manufacturing which, given its features (learning by doing, backward and forward linkages, etc.), constituted the real engine of growth. The role for policy makers was to struggle against this equilibrium: "growth sequences are likely to exhibit tendencies toward convergence or potentialities of divergence, and development policy is largely concerned with the prevention of too rapid convergence and with the promotion of the possibilities of divergence" [Hirschman, 1958].

These ideas link the discussion to the second theme used here to classify the "heretical" arguments on trade liberalisation. That is, the appropriateness of *specialisation* should be evaluated in dynamic terms. Or in other words, the "allocative patterns induced by international trade have dynamic implications which may yield either "virtuous" or "perverse" feedbacks in the long-term" [Dosi and Soete, 1988].

A structuralist approach would suggest that there are supply and demand attributes of certain sectors that make them more interesting than others. Any country, thus, should attempt to specialise in those if it is committed to increasing its catch-up potential. On the one hand, some sectors have higher income elasticities of demand. On the other hand, some sectors show higher elasticity of technology supply (i.e. more technological opportunities). Moreover, some sectors are more able to absorb technological spillovers than others[2]. Arguably, a country that favoured a group of industries that exhibited such advantages would be altering permanently the economy's comparative advantages and, in turn, raising its output.

[2] For instance, Rodrik [1992] argues that activities with scale economies are generally import-competing, and therefore intervention in these sectors could be justified when they generate spillover effects to other sectors (as long as its marginal costs are below the international marginal price).

These arguments are largely based on Kaldorian lines [Dalum, Laursen and Verspagen, 1999; Dixon and Thirlwall, 1975; Fagerberg, Verspagen and von Tunzelmann, 1994; McCombie and Thirlwall, 1995] and Pasinetti's [1981] theory of growth. Particularly in Pasinetti, the more similar the country's sectoral structure is to the sectoral structure of the leaders, the higher will be the degree of catching up. If we reverse the causation, we will find the structuralist approach: a country that wants to develop continuously should copy the sectoral structure of the leaders.

However, the findings of economic history suggest that the best possible sectoral structure was not always the same as that of the leaders. (e.g. Gerschenkron [1962]). Given that latecomers could concentrate their production in the most dynamic sectors (without the sacrifices that such resolution would have created in more advanced countries), the situation that emerged from the process of development was one where followers did not look like their models, either in speed of growth or in sectoral structure.

Nevertheless, due to the larger gap between the advanced nations and the developing countries during most recent industrialisations, and the reinforcement of new technological barriers, it has not been possible for the newest latecomers to access the most dynamic technologies.

To sum up, according to these views current market prices as for instance generated by free trade do not necessarily provide the right incentives for resource allocation in the long-run. Therefore if a country attempts to improve its dynamic competitiveness it might be worth guiding the liberalisation process towards the enhancement of more dynamic activities.

However the issue is more complex than simply favouring or distrusting free trade as a pathway to growth as suggested above.

2. Technological Micro Behaviour and Liberalisation

2.1 The theoretical model

2.1.1 Diversity in micro responses: OACK conditions

It could be argued that the attitudes of firms towards technological upgrading stem from *models of behaviour* that depend on conditions of *opportunity, appropriability, cumulativeness* and *knowledge base* (hereafter referred to as *OACK conditions*) [Breschi, Malerba and Orsenigo, 2000], which largely guide the search activities that firms pursue in order to improve their current technology.

Technological *opportunity* refers, on the one hand, to the *technological* potential of improving production and the effectiveness of R+D spending in promoting such potential. On the other hand, the technological aspect of opportunity has to be reflected in some *market* opportunity, in the sense that demand for such a rise in technical performance must exist.

The *knowledge base* refers to both the degree of progress in understanding the specific technology, and the characteristics of knowledge (e.g. tacit or codified, simple or complex, generic or specific, etc.).

Conditions of *appropriability* are derived from the public or private good attributes of technology. Technology is generally regarded as non-rival and only partially excludable (depending on the institutional system). It follows that a price-taker firm will not be able to reward technology of this nature and, therefore, innovative activities become threatened. For this reason, only when innovation is rewarded by quasi-rents (the appropriability condition) do innovators have the incentive to take on these activities. In a developed context, this is coupled with the possibility of effectively protecting innovation from imitation. In a development context, by contrast, high appropriability conditions are associated with the possibility for local innovators to appropriate the returns of “good ideas” in the production sphere that enable them to compete against (usually) more advanced foreign producers of technology. On the one hand, this goes together with the existence of some (only) locally appropriable advantage. On the other hand, any local innovative potential will be fully exploited only when barriers to access to financial resources are not too important. Therefore, we could argue that appropriability conditions in developing countries are enhanced for firms that rely for their production on resources that are mainly locally available, or for firms that enjoy the necessary micro determinants to have smooth access to capital markets.

Conditions of *cumulativeness* of past experience are given when there exist advantages for those who have already innovated; or, in other words, when innovations today generate a stream of new innovations in the future. This has to do with market and technological characteristics of the industry (e.g. increasing returns, ease of search, routinisation opportunities, possibility of improving technology incrementally, technological complexity, etc.), and with learning dynamics (past experience builds up knowledge for future developments).

It is my contention that these conditions constitute the *stick and carrot* in technological behaviour. There are enough reasons to assume that the stronger the OACK conditions the greater will be the chance to develop technological strategies:

Firstly, conditions of technological opportunities and large knowledge bases constitute a necessary starting point to develop any strategy towards technological upgrading

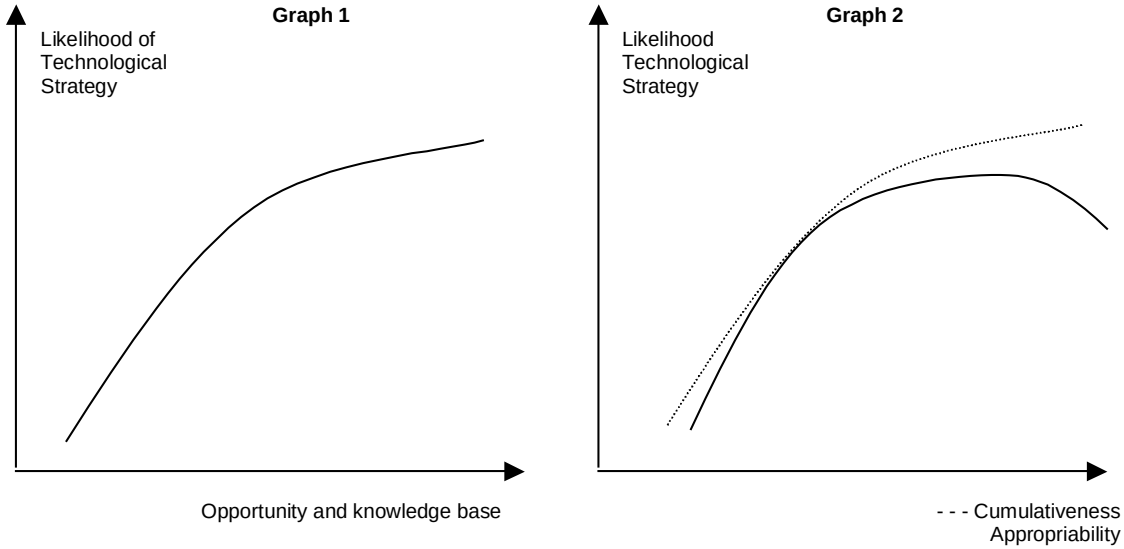
(Graph 1).

Secondly, as argued above, the principal patterns of innovation in developing countries are imitation and incremental improvements on available technology, which are positively related to the historic accumulation of knowledge inside the firm.

Furthermore, accumulation of knowledge is in part the result of production experience (i.e. cumulativeness), but this passive learning explains only a small part of the ability to incorporate new technology effectively. Deliberate capability-building efforts are necessary, but costly and risky. Therefore, a firm's financial capacity is important and sometimes determinant to pursuing innovative activities through creative imitation. In order to pursue internal efforts in technology, imitators must expect profits that exceed those they would get when relying on external sources.

Thus, to follow an indigenous technological strategy the development context imposes a minimum level of *appropriability*, which is perhaps larger than in advanced countries (Graph 2).

To sum up, as shown in Graph 1 and 2, conditions of opportunity, knowledge base and cumulativeness would continuously increase the likelihood of pursuing technological strategies across the industrial structure as a whole. Conditions of appropriability would also have a positive impact on technological behaviour, though it could be argued that there would be a turning point when excessive appropriability conditions make monopolies or oligopolies choose a "quiet life" over innovative activity, which entails risk and uncertainty[3].



2.1.2 Impact of liberalisation on OACK conditions

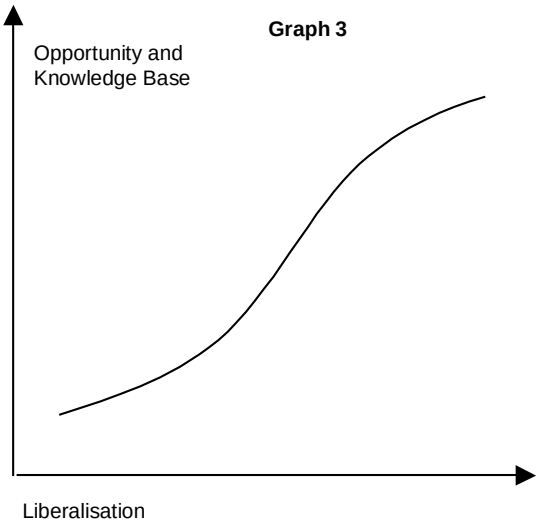
In this section the effect of different degrees of liberalisation on OACK conditions will be hypothesised, which, as argued just above, will in turn directly influence the likelihood of a firm pursuing a technological strategy. Arguments will be borrowed from the two main approaches to the relation between trade and technology identified in Part 1. As will be seen below, within this framework, arguments from both supporters and critics of free trade could hold true

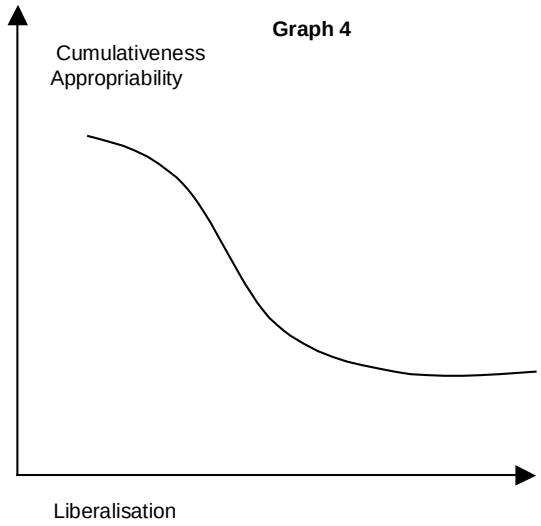
[3] Indeed, as seen in Part 1, this is one of the arguments in favour of liberalisation.

When an economy is opened to trade, new technological opportunities that were once lacking become available and arguably the knowledge base expands. This could have a positive impact on the technological potential of *users of technology*. However, sectors that suffered especial contraction after liberalisation were usually those that *produce technology,* and given the importance of technological spillovers that could be generated due to the user-producer relation, liberalisation could also imply a decrease in technological opportunity and a contraction of the knowledge base.

Moreover, market opportunity does not necessarily increase as a consequence of liberalisation. On the one hand, import liberalisation does not imply a better performance in exports, as is usually assumed. In point of fact, import restrictions do not necessarily mean preventing the taking advantage of exports[4]. On the other hand, the process of creative destruction should not simply be assumed either. Usually protected sectors will contract before those that are advantaged after the reforms are established and expanded.

However, for the interim, I will take as valid the arguments from free trade supporters and predict a positive effect of trade liberalisation on conditions of opportunity and knowledge base (Graph 3). Nevertheless, a negative impact of liberalisation will be predicted on conditions of cumulativeness and appropriability in a development context (Graph 4).





Firstly, in a context where technological and industrial policies are weak and capital markets are very imperfect, local firms are unable to perform costly indigenous efforts. They have to compete against the original innovators, or against highly competitive multinational companies, or against imports in general. Thus, they might prefer to adopt disembodied technology transferred from abroad, rather than encouraging the risk of spending on innovation inside the firm. This militates against national *appropriability*, given that foreign suppliers of technology will capitalise on the benefits that its use generates.

Secondly, the reallocation process after trade liberalisation usually involves the closure of firms and thus backward and forward linkages necessarily deteriorate. Thus, given the absence of complementary technological safeguards, it may be stated that the *accumulation* of knowledge also declines with liberalisation.

[4] As is well documented, most export booms in developing countries were experienced before trade liberalisation had been attempted (Korea and Taiwan in the 1960s, Brazil in the late 1960s, and Turkey in the 1980s) ([Rodrik, 1992].

Therefore, while liberalisation may be expected to have a positive effect on conditions of *opportunity* and *knowledge base*, it may have a negative one on conditions of *cumulativeness* and *appropriability*.

Arguably, the former relation is stronger at early stages of liberalisation when the local market is flooded with new technologically advanced varieties of inputs and capital goods that may not require much adaptation. Thus, adoption of technology opportunities is fairly easy and therefore opportunities on the demand side are also high. By contrast, as the country gets closer to a situation of complete free trade, easily adaptable technological opportunities become exhausted and further complexity prevents a rapid adoption of remaining technological opportunities; therefore the rate of growth decreases accordingly.

On the other hand, long-lasting effects of past technological accumulation and past routinisation of activities flatten the decrease of cumulativeness and appropriability conditions at early stages of liberalisation, while technologically specific factors slow down the process once close to a situation of free trade.

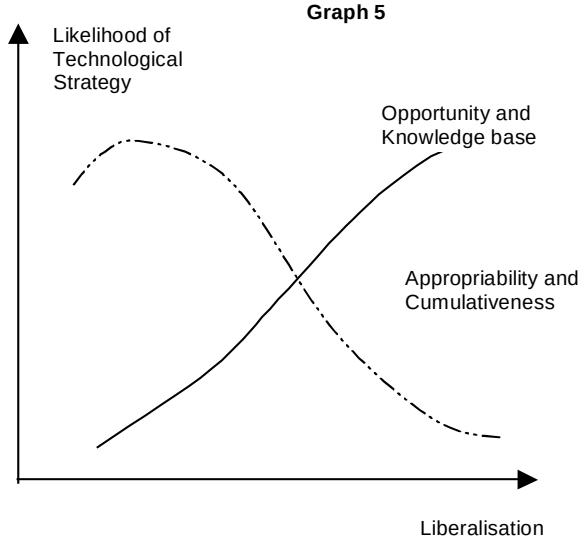
2.1.3 Impact of liberalisation on technological decisions

At this stage, the above lines of reasoning could be linked to analyse the overall impact of liberalisation on the likelihood of pursuing a technological strategy. Graph 5 charts separately the positive and negative effects of opportunity and knowledge base on the one hand, and appropriability and cumulativeness on the other. These two effects could be thought of as a re-interpretation of the main hypotheses that classify arguments for and against trade liberalisation from a dynamic perspective. On the one hand, the supporters of free trade propositions are summarised in the positive impact that liberalisation has on technological behaviour through new technological opportunities that widen the knowledge base. On the other, the adverse perspective is shown in the downward sloping curve that sketches the negative effect caused by sacrificing cumulativeness and indigenous appropriability, which has been the main justification for infant industry protection.

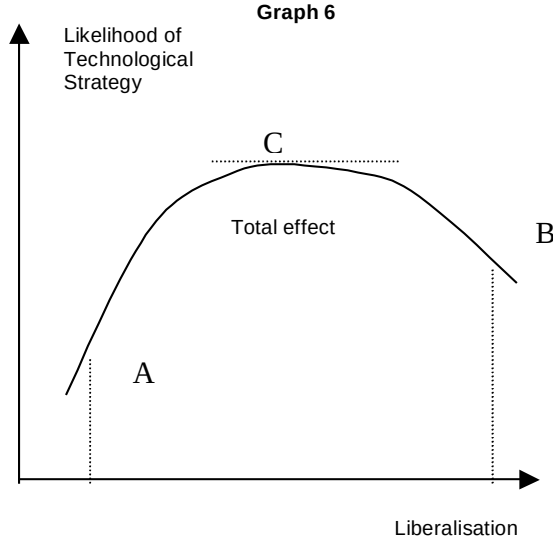
Graph 6 draws the total outcome assuming that both effects are weighted equally[5] in technological behaviour. As is clear in the graph, liberalisation in the early stages has marked positive effects on technological decisions, given by both the new technological opportunities and the response induced by competition. However, as liberalisation proceeds, this positive effect is overtaken by the negative effect on appropriability and cumulativeness.

[5] The actual form of this curve will depend, of course, not only on the weights of the two curves presented in Graph 5, but also on their slopes, which will in turn depend on the institutions that characterise the country under analysis.

Graph 5



Graph 6



The empirical evidence on the performance dimension[6] that links trade policy with productivity gains in developing countries reviewed by Havrylyshyn [1990] seems to validate this argument, given that it shows that neither extreme in trade liberality is good for productivity growth. Actually, the countries with better outcomes in productivity are those with intermediate degrees of liberalisation.

2.2 Empirical illustration

Optimally, I would need to assess the impact of trade on those conditions in order to draw conclusions about behavioural patterns. However, there are methodological problems that rule out this possibility. Firstly, those conditions are primarily theoretical entities that are very difficult to proxy with empirical indicators. Secondly, although one could attempt to measure behaviour directly using innovation surveys, which address motivational aspects of the process of innovation, these surveys do not allow longitudinal analysis given that in Argentina they were carried out only once (1997) and the coverage period starts after liberalisation. Thirdly, liberalisation was completed suddenly in 1991; consequently, the country passed from protection towards (almost) free trade without pause, which leaves no option to look for the existence of a point like C in Graph 6.

Therefore, instead of analysing empirically the effect of liberalisation on OACK conditions (that will in turn impact on innovative behaviour), the problem will be approached from the opposite direction, by looking deeply into innovative strategies after liberalisation in an attempt to disentangle the main patterns that could enable reconstruction of the initial causes.

This methodology requires a set of assumptions. Firstly, it will be assumed that the endogenous growth theory premises on the positive impact of liberalisation on technological opportunity and knowledge base are valid (Graph 3). Secondly, it will be assumed that large and foreign firms necessarily enjoyed appropriability conditions. Thirdly, it will also be assumed that mature firms and those that largely invest in R&D

[6] Despite the empirical support of this evidence, it should be recalled that the model presented here is based on the behavioural dimension whose translation to performance is neither deterministic (i.e the whole process is imbued with uncertainty and randomness) nor unidirectional (i.e. there is no single causality in the relation of behaviour to performance).

enjoyed a greater degree of cumulativeness conditions than otherwise. Finally, the commodity sector is assumed to be technologically less dynamic than the other sectors, whereas the durable good sector and the diffuser of technological progress sector are technologically more dynamic[7].

The organisation of this empirical part proceeds at follows. First, using latent class analysis, innovative strategies will be identified on the basis of information on behaviour provided by the National Survey of Technological Behaviour ('The Survey')[8]. The second sub-section will analyse what factors have originated those strategies, with an explicit emphasis on trade determinants.

2.2.1 Identification of strategies

i) Data, definitions and methodology

The Survey includes information on innovative strategies: firms were asked (question 220) to stipulate the importance of eight types of innovative activities using a 1-3 scale:

A. Product innovation
B. Process innovation
C. Renewal of machinery
D. Labour reorganisation
E. Production process reorganisation
F. Continuous improvements
G. Costs rationalisation
H. Training

These eight ordinal variables involve firms' perceptions and arguably should be highly interrelated. However, there is no reason to suggest any particular causality among them; rather the underlying relationship is likely to state some unobserved characteristics of firms' *strategies*.

Arguably, we could think of two different innovative strategies in the aftermath of liberalisation for those firms that actually react proactively to the change in the environment[9].

On the one hand, being concerned about the increase in competition, firms might have targeted their technical efficiency by restructuring their production organisation. These are the static once-for-all gains that are usually associated with the increase in competition imposed by trade liberalisation that would induce them to adopt techniques in concomitance with factor endowments and improve their efficiency. This strategy will be called here the *organisational strategy*.

On the other hand, firms might have benefited from technological spillovers (of the type suggested by endogenous growth theory) and could have attempted to develop a *technological strategy*. This strategy, on the contrary, pursues long-term efficiency.

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[7] See Appendix 1 for definition of different sectors, based on Ferraz, Rush and Miles [1992].

[8] The Survey includes 1639 firms. It was produced jointly by the National Institute of Statistics and Censuses (INDEC) and the Secretary of Science and Technology (SECyT) for Argentina, with the fieldwork carried out during 1997. Due to the methodology used and the size of the sample, the data, once extrapolated, depict the Argentinean industrial sector as a whole.

[9] However, as will be argued in Part 3 of this paper, the average behaviour after liberalisation was not focused on productive activities but on shorter term activities aiming at survival. These firms could actually take their resources out of the productive system and devote them to managerial, commercial or even speculative activities. Firms belonging to that group were very likely to be among those that inflated to 60% the proportion of non-respondents to at least one of the items included in question 220 from The Survey.

Table 2a: Descriptive Statistics on the Importance of Different Innovative Activities

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
m220a: product innovation	997	1.00	3.00	1.9829	.7175
m220b: process innovation	968	1.00	3.00	1.9928	.7140
m220c: renewal of machinery	1088	1.00	3.00	1.9963	.7589
m220d: labour reorganisation	919	1.00	3.00	1.8303	.6808
m220e: production process reorganisation	786	1.00	3.00	1.6298	.7024
m220f: continuous improvement	880	1.00	3.00	1.8557	.7097
m220g: costs rationalisation	1048	1.00	3.00	2.0458	.6798
m220h: training	919	1.00	3.00	1.7704	.7160
Valid N (listwise)	668				

Source: Author's calculation based on The Survey.

Factor analysis could be used to discover those underlying dimensions. However, the data here are categorical and therefore do not meet the properties of parametric data to use such techniques. Instead, latent class analysis, which is used for categorical data as an analogue to factor analysis [McCutcheon and Mills, 1998], is adopted. A latent class model is like a log-linear model that estimates an n-way contingency table, but with that table including latent (unobserved) variables.

Thus, a log-linear model on a three-way table could be defined as:

$$\ln(F_{ijk}) = \mu + \lambda_i^A + \lambda_j^B + \lambda_k^C + \lambda_{ij}^{AB} + \lambda_{ik}^{AC} + \lambda_{jk}^{BC} + \lambda_{ijk}^{ABC}$$

where F is the three-way (observed) frequency table. The natural logarithm of F could be described as a linear combination of a grand mean, three marginal effects, three two-way association effects, and one three-way association effect. This is the unrestricted model, which could be used as a starting point for testing restrictions stemming from the research hypothesis.

In this case, my hypothesis is that the eight indicators mentioned above actually represent some other more encompassing factors, namely two latent variables that define either a low/high organisational strategy or a low/high technological strategy.

A latent variable model then adds one or more latent variables to the log-linear model. These latent variables are hypothesised to control for the association between the indicators, and therefore once they are included, the remaining relations among indicators could only originate by chance. Therefore, the latent class model imposes the restriction of independent classification errors, which implies that all higher-order terms that combine indicator variables are set to zero. The above model with one latent variable can be defined as:

$$\ln(F_{ijkt}) = \mu + \lambda_i^A + \lambda_j^B + \lambda_k^C + \lambda_t^X + \lambda_{it}^{AX} + \lambda_{jt}^{BX} + \lambda_{kt}^{CX}$$

Here there are eight indicator variables, each of them of dimension 4 (recall that firms have to grade the importance of each of them using a scale from 1-3, but one extra category needs to be included for missing information: 1 for missing values, 2 for scores 1, 3 for scores 2, and 4 for scores 3). How many latent variables could be extracted from them? This is something that should be decided a-priori based on the research hypothesis. Of course, different models can be contrasted using the evaluation criteria that will be mentioned below, but the main motivation to perform latent class analysis is the idea that some common dimension must have guided similar

response patterns.

My hypothesis is that two different behaviours characterised the post-liberalisation period: one based on an organisational innovation strategy and another based on a technological innovation strategy. There are still two more things to decide before estimating the model. First is the distribution of the indicator variables between the two latent variables. While this draws mainly on the preceding discussion, alternatives using evaluation criteria will also be considered. Secondly, it is necessary to define beforehand how many classes (the analogue of categories in indicators) the latent variables have. In the absence of an a-priori alternative, the most parsimonious alternative will be chosen, as usually recommended [McCutcheon and Mills, 1998]. That is, I will hypothesise that firms are either low-innovative or high-innovative (in both technological and organisational terms).

ii) Estimation and evaluation procedures

LEM software, based on the EM (expectation maximisation) algorithm, which is a two-step procedure, is used for the estimation. In the first step (E), it calculates the expected value of the log-likelihood, based on initial values for the parameters. In the second step (M) the log-likelihood is maximised and the obtained parameters are used as initial values for a new round of the E step. The model is therefore solved by iteration.

There are different evaluation methods, all of which compare the expected with the observed frequencies. Four of them are widely used: the Pearson Chi-Square (χ^2), the likelihood ratio chi square (L^2), the Akaike information criterion (AIC), and the Bayesian information criterion (BIC). The first two have an asymptotic chi-square distribution with respect to the degrees of freedom, thus a good fit will exist when the p-value approaches 1. The AIC criterion penalises the number of parameters to be estimated (because more parameters yield a greater likelihood regardless of the quality of the model), while the BIC criterion also penalises sample size, because the first two criteria are usually quite conservative when sample sizes are large (modest models appear to be valid ones: [McCutcheon and Mills, 1998].

$AIC=L^2-2df$
$BIC=L^2-df*[\ln(N)]$

The rule is thus to choose models with lower AIC and BIC criteria.

iii) Model estimation for innovative strategies

As stated above, the latent class model that will be estimated here has two latent variables and eight indicators. One latent variable represents a technological innovation strategy and the other an organisational innovation strategy. The next step is to define which are the best indicators to measure each of them. Basically, indicators A, B and C should be in one of them (technological strategy) and D and E in the other (organisational strategy). With regard to the rest, arguments could be found to locate them in one or the other. The following options groups are what I consider sensible alternatives:

Table 2b: Models for Latent Variables

Model	Indicators for Technological strategy	Indicators for Organisational strategy
1	A, B, C, F	D, E, G, H
2	A, B, C, F, H	D, E, G
3	A, B, C, G	D, E, F
4	A, B, C	D, E, F, G, H
5	A, B, C, F, G	D, E, H

Initially these five models were estimated, all of them with 2 latent variables (X and Y) with 2 classes each (t=r=2). None of the models showed a good fit to the data and an analysis of the residuals (not shown here) suggested that all the above models underestimate the number of missing values, especially when none of the indicator variables were answered (A=B=C=D=E=F=G=H=I=1).

Therefore, the model was re-estimated using three-dimensional latent variables. However, one of these dimensions is needed to state the absence of strategy, therefore the probability that class 1 of both latent variables belongs to positive (no missing) responses was set to 0%. Therefore, there will be one class that absorbs the systematic missing responses and only those. The other two classes of each latent variable will be interpreted as low or high strategy.

Table 2c: Information Criteria for the Models

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Model	Indicators for Technological strategy	Indicators for Organisational strategy	BIC criteria	AIC criteria
1	A, B, C, F	D, E, G, H	-482572	-128783
2	A, B, C, F, H	D, E, G	-482519	-128723
3	A, B, C, G	D, E, F	-482558	-128765
4	A, B, C	D, E, F, G, H	-482618	-128825
5	A, B, C, F, G	D, E, H	-482552	-128758

Source: Author's calculation based on The Survey

The five models fit the data, thus their information criteria need to be compared to evaluate their relative performance, as in Table 2c. As can be seen, both criteria point to model 4 as the most suitable for these data. Actually, the distribution of indicators in model 4 is the same as would have been discriminated using factor analysis. The first thing to notice is that by means of latent class analysis, the information data are reduced from eight four-dimensional variables into two three-dimensional ones, in a meaningful way. Furthermore, contrary to factor analysis I could also use non-responses as valuable information.

2.2.2 The determinants of innovative strategies

The previous identification of innovative strategies will be used here to estimate an ordered probit model that defines their salient determinants. Technological strategy is measured as the sum of scores a firm assigned to product innovation, process innovation and renewal of machinery (activities A, B & C); while organisational strategy is measured as the sum of scores assigned to training, cost rationalisation, labour re-

organisation, production process re-organisation and continuous improvements (activities D, E, F, G & H)[10].

Tables 2d and 2e present the results of an ordered probit regression on both strategies.

Table 2d: Ordered Probit Regression on Technological Strategy

Dep. Variable: Technological Strategy		N	1607
		Pseudo R2	0.0513
Ind. Variables	Coef.	Sig. .	z
Commodities	-0.339392***		-4.17
Food Commodities	-0.069240		-0.57
Diffuser	-0.081920		-0.88
Durable Goods	0.181974*		1.79
RD Avg. 92-96	0.000410*		1.68
Other Inn. Activities (production) Avg. 92-96	0.000540*		1.73
Other Inn. Activities (management) Avg. 92-96	0.000651		1.31
Transfer of Technology Avg. 92-96	0.000085		1.46
Expo Avg. 92-96	-0.000004**		-2.05
Import of Capital Goods Avg. 92-96	0.000068***		2.72
Import of Inputs Avg. 92-96	-0.000005		-1.15
Imports of Final Products Avg. 92-96	-0.000009		-1.64
Imports of Services Avg 92-96	-0.000113		-0.94
Decentralised Information	0.113189***		7.75
Centralised Information	0.043057***		3.77
Size	0.273293		1.6
Age	0.003275***		2.6
Foreign	0.261973***		3.54
Sales 96	0.000002**		2.5

*** Significant at 99%, ** Significant at 95%, *Significant at 90%
Source: Author's calculation based on The Survey.

[10] Given that firms were asked to grade each activity with a score from 1 to 3, technological strategy grades from 0 to 9 and organisational strategy grades from 0 to 15. Score 0 corresponds to non-respondents, which amounts to 49% for technological strategy and 58% for organisational strategy.

Table 2e: Ordered Probit Regression on Organisational Strategy

Dep. Variable: Organisational Strategy		N	1607
		Pseudo R2	0.0555
Ind. Variables	Coef.	Sig. .	z
Commodities	-0.211216	**	-2.51
Food Commodities	-0.344013	**	-2.54
Diffuser	0.153081		1.61
Durable Goods	0.318091	***	3.06
RD Avg. 92-96	0.000522	**	2.16
Other Inn. Activities (production) Avg. 92-96	0.000395	**	2.05
Other Inn. Activities (management) Avg. 92-96	-0.000056		-0.11
Transfer of Technology Avg. 92-96	0.000056		1.05
Expo Avg. 92-96	-0.000003		-1.54
Import of Capital Goods Avg. 92-96	0.000015		0.66
Import of Inputs Avg. 92-96	-0.000003		-0.82
Imports of Final Products Avg. 92-96	-0.000005		-1.01
Imports of Services Avg 92-96	-0.000565	***	-2.81
Decentralised Information	0.096925	***	6.4
Centralised Information	0.033122	***	2.83
Size	0.284025		1.62
Age	0.003096	**	2.35
Foreign	0.470414	***	6.22
Sales 96	0.000003	***	3.79

*** Significant at 99%, ** Significant at 95%, *Significant at 90%
Source: Author's calculation based on The Survey.

Variable definition

RD Avg. 92-96: includes expenditures on Basic Research, Applied Research and Development of New Products and Processes measured in thousands of pesos➔ 1peso=1US$
Other Inn. Activities (production) Avg. 92-96: includes expenditures on Adaptation of Products and Processes, Technical Assistance to Production and Project Engineering. It is measured in thousands of pesos ➔ 1peso=1US$
Other Inn. Activities (management) Avg. 92-96: includes expenditures on Administrative Reorganisation, General Organisation, and Commercialisation of new products. It is measured in thousands of pesos ➔ 1peso=1US$
Transfers of technology Avg. 92-96: Includes expenditures on licences, patents and technical assistance paid to private firms inside or outside the country. It is measured in thousands of pesos ➔ 1peso=1US$
Exports Avg. 92_96: firm exports. Average 1992-1996. Measured in thousands of US$ FOB.
Import of Capital Goods Avg. 92_96: firm imports of capital goods. Average 1992-1996. Measured in thousands of US$ CIF.
Import of Inputs Avg. 92_96: firm imports of inputs. Average 1992-1996. Measured in thousands of US$ CIF.
Import of Final Products Avg. 92_96: firm imports of final products. Average 1992-1996. Measured in thousands of US$ CIF.
Import of Services Avg. 92_96: firm imports of services. Average 1992-1996. Measured in thousands of US$ CIF.
Decentralised information: The three most important (ranking from 1 to 3) sources of information available in the market: a) from competitors; b) from clients; c) from suppliers; d) from reverse engineering ➔ Ordinal variable 0-6
Centralised information: The three most important (ranking from 1 to 3) sources of information available from research institutions: a) from universities; b) public research organisations; c) private research organisations; d) seminars, conferences and expositions; e) publications; f) technology centres ➔ Ordinal variable 0-6
Size: firm sales over industry sales (5 digit ISIC)
Age: 1997-year of foundation of the firm
Foreign: Dummy variable that equals 1 when the firm has foreign participation and 0 otherwise
Sales 96: firm sales measured in thousands of pesos➔ 1peso=1US$

These empirical results will be discussed in the light of the theoretical discussion in Part 2.1. Although results on technological strategy and organisational strategy are quite similar, I will concentrate the discussion mainly on the former given that the goal of the paper is to analyse the impact of trade liberalisation on *long-term* efficiency.

i) Trade as an incentive for technological dynamism: the endogenous growth theory claim

Imports of inputs apparently did not encourage innovative behaviour; however an appropriate assessment of the importance of inputs for the creation of externalities in technology should consider only new (or highly technological) inputs, which is not the case here.

More encouraging results for free-trade supporters are found in relation to capital goods and market information flows, both arguably favoured by liberalisation policies and significant for explaining technological strategy. Thus, it seems to be the case that openness did create new opportunities, either embodied in capital goods or in newly available technological information, which induced a renewed interest in technology.

Unfortunately, only the supply side is analysed here because those imports were actually ordered directly by the industrial firms. That is, there is no analysis of the fact that these new imports also displaced local production of those inputs and capital goods elsewhere, which (especially the latter) had historically led technological production in the country.

Actually, sectoral dummies support a structuralist approach. Once sources of micro diversity and sales are controlled for, industrial sectors that were openly supported during ISI (Industrialisation by Substitution of Imports), and subsequently punished as a consequence of trade liberalisation, were, technologically speaking, the most dynamic sectors. Thus, in comparison to the traditional sector, firms from the Durable Goods sector were significantly more concerned about innovation. On the other hand, the Commodity and the Food Commodity sectors, which based their competitiveness on natural resources and were winning sectors during the 1990s[11], were, as usual, not very interested in innovation.

Moreover, rather than encouraging a technological attitude that could increase national competitiveness, exports seem to affect negatively the likelihood of pursuing a technological strategy, which could be interpreted as an excessive emphasis on static, rather than dynamic, comparative advantage. This is plausibly the result of some omitted variable related to international specialisation in products (across different sectors) that were not particularly dynamic in technological terms. This, in turn, could be a consequence of a policy emphasis on static advantages.

However, the ambiguity of effects of variables related to liberalisation does not prevent some firms from being positively affected by liberalisation, even in technological terms. For instance, liberalisation induced technological dynamism in the form of newly available information and capital goods, at least for some firms. My hypothesis, however, is that behavioural diversity hampered an overall positive effect. This diversity was given by the different degree of conditions of cumulativeness and appropriability that different typologies of firms could enjoy.

ii) Importance of appropriability and cumulativeness conditions: the heretic claim

Oldness and nationality seem to be advantageous for following either an organisational strategy or a technological strategy. Bigness, in turn, is highly correlated with nationality; when this latter variable is not included in the model, size becomes highly significant to explain both strategies.

[11] Empirical evidence on 'winners and losers' of trade liberalisation will be presented in Part 3.

Therefore, firms with many years' experience and with foreign participation were more likely to undertake technological efforts. Years of experience could be easily associated with a natural advantage in cumulativeness. Size and foreign participation, in turn, were micro determinants that paved the way to capital markets. Therefore, the case could be advanced that firms that shared these attributes could afford the inherent costs and risks associated with innovative activities, and therefore they were more likely to be more competitive in technological terms.

The importance of cumulativeness could also be highlighted by looking at variables related to the development of indigenous capabilities inside the firm. Technological efforts inside the firms, particularly R&D and innovative activities related to production, were fundamental to pursuing both strategies. However, innovative activities related to management, which have grown steadily during the period as will be discussed in Part 3, were not significant to explain either of the two strategies.

To sum up, firms that took advantage of the newly available technological opportunities and carried out technological strategies enjoyed conditions of cumulativeness and appropriability. This was facilitated by certain micro (age, nationality and size) and sectoral attributes[12]. The important point to stress here is that a technological strategy was not generally adopted because only a certain typology of firms enjoyed all OACK conditions. Had conditions of cumulativeness and appropriability been equally enhanced across firms' typologies, a broader adoption of technological strategies would have been induced by the new technological opportunities and the broadened knowledge base that trade liberalisation triggered.

In point of fact, the second claim of this paper is that the macro environment not only did not enhance OACK conditions in a way that could have increased the proportion of firms willing to commit to a technological strategy, but also encouraged a behaviour that discriminated against the long-term. Therefore, firms committed to technological strategies (which enjoy higher probability of being successful in technological performance) were not necessarily among the most successful in economic performance in this macroeconomic environment that rewarded short-term strategies. This proposition will be discussed in Part 3.

[12] The Commodity sector excluded. Besides, given the path dependent characteristic of technological innovation, it could be argued (though it was not tested here) that some *other* firms that have been historically technologically committed continued to be so. Actually, the significant importance of efforts in R&D could suggest this.

3. Technological and Economic Performance after Liberalisation: Analysis based on Macro Behaviour

Following the empirical findings of the previous section, it could be argued that opportunities embodied in newly available capital goods and freer market information encouraged the adoption of innovative strategies. However, it was also shown that firms would benefit from those opportunities especially when they enjoyed conditions of appropriability and cumulativeness, otherwise the risks and costs attached to a technological strategy were too difficult to meet.

A further step in this line of reasoning could be to analyse what happened to those firms that did not enjoy one or other condition (especially appropriability).

One possible answer, grounded in biological evolution and natural selection [Alchian, 1950], would be that the (now freer) market would select the more efficient firms, and therefore nothing of importance would be lost in the process. This conventional conclusion relies exclusively on the performance dimension and does not tackle the behavioural side[13].

However, it is my contention that, in order to assess the effects of any macro policy on aggregate performance, it is necessary to analyse the historical pattern of behaviour across sectors and types of firms in the country under analysis. The literature emphasises path-dependency at the firm level, but past performance is also important at the macro level. In other words, national economic and social history will shape specific patterns of macro behaviour that are reluctant to change even though a current economic situation signals different attitudes. In point of fact, these mismatches between current (path-dependent) behaviour and the one that should have prevailed to sustain the new macro environment, could induce the system to a new (macro) economic crisis.

Based on analysis on macro behaviour I will argue that the biological metaphor that claims that an open market will suffice to select the best performing firms by making inefficiency a terminal disadvantage is not always valid. In a context of high degrees of structural uncertainty, information asymmetry and imperfect markets (especially capital markets) it is not necessarily the case that the most inefficient firms leave the market while the efficient ones remain. Quite the contrary, firms will have higher probabilities of remaining in the market if they follow a survival attitude unrelated to productive activities that therefore hampers technological performance. In other words, this paper claims that there was a divorce between technological and economic performance which could be largely explained when analysing different patterns of behaviour at micro, sectoral and macro level.

Section 3.1 will analyse macro patterns of behaviour which are necessary to contextualise trade reforms historically. The outcome of section 3.1 will be an identification of different patterns of behaviour across firms' typologies interacting within that macro environment. In section 3.2, I will evaluate to what extent and in what direction those patterns of behaviour affect technological and economic performance.

[13] Therefore, heterogeneity either is considered random or does not exist (all agents are rational and follow strategies that maximise profits).

3.1 Identification of macro behaviour

3.1.1 Contextualising the reforms

The economic policies carried out in 1978[14] plus the debt crisis during the early 1980s created such damage in all the macro aggregates that they marked the beginning of a new mentality in Argentina. At the policy level it was clear that the main priority was to stabilise the economy. At the micro level, though, there was a general disbelief that stabilisation was possible. The external and fiscal maladjustments together with unfavourable micro expectations ended up in the 1989 hyperinflation.

Therefore, by the time of trade reforms, Argentina had passed through more than one decade (called the "lost decade") of serious economic problems, only (apparently) stabilised by the Convertibility Programme. It is not surprising, therefore, that the micro behaviour has been characterised as guided by an absolute preference for flexibility [Fanelli and Frenkel, 1996].

Accordingly, at a policy level it was thought that only a dramatic change in policy could change micro expectations, and trade liberalisation was carried out almost in one effort during 1991, the same year that the Convertibility stabilisation programme was launched.

Overvaluation of the local currency implied that firms suddenly had to face the competitive pressures of new imports without enjoying the benefits of either price or non-price competitiveness. Consequently exports were virtually unchanged while imports almost tripled during the first years of the programme's implementation[15].

Time and liquidity (in American dollars) were especially precious. There were some firms that, regardless of how efficient they managed to be in their productive activities, were 'a-priori' in a stronger position to survive given their easier access to capital markets and foreign currency (e.g. big firms, foreign firms, or those that based production on natural resources). These are referred to as the *a-priori chosen firms*.

All these macro elements only accentuated a general tendency in behaviour. There were limited opportunities for proactive strategies: the aim was much less to grow than to survive. In such an uncertain macro environment selection will not necessarily be based on efficiency but on the likelihood of surviving the selection process. This is as circular as it seems.

To make it simpler, in the aftermath of liberalisation firms had two options. The first one was to react proactively taking advantage of the newly available technological opportunities. However, not every firm fully enjoyed appropriability and cumulativeness conditions, which, as discussed in Part 2 are necessary to draw technological strategies. Besides, the dogmatism in policy design, which reduced to a minimum the direct incidence of the public sector in the private domain[16], openly avoided the creation of incentives that might have helped to conserve the capabilities acquired during the import substitution period[17]. Thus, among firms that decided to react proactively, *only*

[14] Which implied a sharp decrease in industrial activities, so serious that in the 1980s the participation of the manufacturing sector in total GDP was less than it was in the 1940s. According to statistics of the Central Bank the participation rate of the manufacturing sector was: 1900-1909 = 15.35%; 1940-1949 = 24.22%; 1960-1969 = 28.18%; 1980-1990 = 23.6% [Kosacoff, 1996].

[15] This tendency was reversed in 1995, in part as a result of the recession caused by the Mexican crisis at the end of 1994.

[16] Public expenditures nevertheless increased rather than reduced through the 1990s.

[17] Except for the automobile sector, that enjoyed special treatment [Katz, 2000b].

those that enjoyed OACK conditions[18] were to be successful. The *a-priori chosen* firms mentioned above clearly enjoyed conditions of appropriability before but especially after reforms, and therefore they were in a better condition to benefit from the new environment. The rest, which were made up of heterogeneous firms (e.g. small firms, firms producing non-traditional products, firms located in remote places, etc.), would very likely die in their attempts to be proactive[19].

Therefore, rational firms that did not especially enjoy OACK conditions would do better if they opted for the second option, that is, following a survival strategy that enabled them to react faster to changing situations.

The faster the reaction, the more likely it would be to remain in the market queuing to be chosen. Thus, flexibility and rapid reaction were rewarded. This created a series of short-term strategies that were distinct from innovative strategies, and were usually even beyond the industrial sphere. Even though they remained conservative in production techniques, they were nevertheless flexible to survive in changing markets. They would not risk their survival by adopting innovative strategies that might hamper their speed of changing activities, because what constituted an advantage at the present time could be a disadvantage in the near future. I will refer to this behaviour as an inclination towards *malleability.* Thus, short-range focused attitudes pre-empted Schumpeterian responses.

The main point here is, on the one hand, that firms that did better in economic terms either survived on the basis of short-term strategies that prioritised *malleability* with strong emphasis on the ability to adapt quickly to a different macro environment, or were *a-priori chosen*. On the other hand, those that did better in technological terms were firms that did not prioritise malleability and were largely committed to proactive (innovative) activities. As argued in Part 2, firms that enjoyed appropriability and cumulativeness are in a better situation to pursue this kind of strategy. Given that *a-priori chosen* firms naturally enjoyed appropriability condition, it will be shown below that they were more able to benefit from the new technological opportunities created after liberalisation (especially in dynamic sectors).

3.1.2 The Micro Behaviour triggered by Macro Behaviour

In tune with prevailing macro behaviour that prioritised malleability, the principal strategic reorientation inside the firm after liberalisation was the adoption of a new managerial model. Financial and administration skills prevailed over technological skills across management and there was an extraordinary concern for demand-side activities.

This strategy gave firms the capacity to adapt rapidly to the changing environment, and most importantly, it avoided more expensive, deeper and more permanent restructuring, such as is commonly necessary in indigenous technological innovation.

As suggested before, this was in part due to a lack of concern by public institutions to take care of the know-how that had been achieved during the years of ISI. However, the main point here is that the turnabout in national concerns was especially the consequence of a dominant behaviour born and fostered under many years of serious macro uncertainty. Consequently malleability was rewarded at the same time that policy changes were distrusted.

[18] Assuming that trade liberalisation created new technological opportunities and broadened the knowledge base for *all* firms, conditions of appropriability and cumulativeness were to be the ones that drew a dividing line between successful and unsuccessful firms in technological terms.
[19] Of course this is a stylised categorisation and there were exceptions in both directions (see below).

Survival rather than growth was the aim. Most of the firms that were not *a-priori chosen* and therefore found it too difficult to adopt proactive strategies engaged in this malleability culture. Besides, there were still many of the *a-priori chosen* that, although having the choice of acting proactively, opted for the rewards of malleability.

Unfortunately, it is very difficult to delimit theoretically what constitutes a malleable activity, particularly because, by definition, the wide variety of its manifestations was permanently changing. Furthermore, malleability strategies, which were sometimes quite creative, were usually far away from the production sphere. Therefore, it is even harder to assess malleability empirically given that its manifestations were not strictly covered by innovation surveys.

Despite these intrinsic limitations, I identified two interrelated patterns of behaviour that can be associated with a strong commitment to the malleability culture:

i) Strong reliance on domestic markets

During the ISI period, efforts were predominantly towards imitation and adaptation of products and process, and therefore internal sources of knowledge were of paramount importance. Although goods were predominately produced for domestic markets, firms did not need to perform extraordinary efforts on the demand side because most markets were captive.

Liberalisation brought specialisation. However, even when firms reduced their production mix, they did not gain enough competitiveness to compete in international markets. Most of them continued to rely on domestic demand, and therefore reduced their production mix without reducing the product mix they marketed. Instead they complemented their sales with imported products[20]. Final products imported by firms included in The Survey increased by 72%, much more than the 55% of the total increase of imports (Table 3a). This pattern is also manifested in firms' sales disaggregated by producers. Sales of goods that were not produced inside the industrial firms increased as a share of total sales.

[20] Katz [2000a] argued that these commercial activities constituted one of the outstanding strategies followed by manufacturing local subsidiaries of MNC (Multinational Companies) after liberalisation. Data from The Survey show that this could be extrapolated easily also to national firms.

Table 3a: Sales, Imports and Exports between 1992 and 1996

N firms / Millions $	1992							
	big		medium		small		TOTAL	
Sales	**100**	**17,816**	**266**	**9,641**	**1,191**	**7,358**	**1,557**	**34,814**
Sales of own production	99	15,664	262	9,072	1,145	6,964	1,506	31,701
Sales of others' production	48	2,152	93	568	307	393	448	3,114
Imports	**100**	**2,711**	**266**	**1,228**	**1,191**	**693**	**1,557**	**4,632**
Imports of capital goods	67	192	146	120	283	127	496	439
Imports of inputs	76	1,798	178	840	439	427	693	3,065
Imports of final products	42	704	59	267	119	136	220	1,107
Imports of services (inc. techno)	6	17	11	1	10	4	27	22
Exports	**100**	**3,071**	**266**	**895**	**1,191**	**461**	**1,557**	**4,427**

N firms / Millions $	1996							
	big		medium		small		TOTAL	
Sales	**100**	**26,643**	**266**	**12,984**	**1,191**	**7,978**	**1,557**	**47,605**
Sales of own production	100	23,169	264	11,952	1,161	7,408	1,525	42,529
Sales of others' production	62	3,474	121	1,032	360	570	543	5,076
Imports	**100**	**4,441**	**266**	**1,843**	**1,191**	**907**	**1,557**	**7,191**
Imports of capital goods	84	454	184	237	329	168	597	860
Imports of inputs	85	2,615	211	1,195	530	578	826	4,388
Imports of final products	51	1,344	89	403	165	158	305	1,904
Imports of services (inc. techno)	12	27	19	8	27	3	58	39
Exports	**100**	**5,770**	**266**	**1,804**	**1,191**	**786**	**1,557**	**8,360**

%	GROWTH							
	big		medium		small		TOTAL	
Sales		**49.5**		**34.7**		**8.4**		**36.7**
Sales of own production	1.0	47.9	0.8	31.7	1.4	6.4	1.3	34.2
Sales of others' production	29.2	61.4	30.1	81.6	17.3	45.0	21.2	63.0
Imports		**63.8**		**50.0**		**30.9**		**55.2**
Imports of capital goods	25.4	136.8	26.0	97.6	16.3	32.4	20.4	95.9
Imports of inputs	11.8	45.4	18.5	42.3	20.7	35.5	19.2	43.2
Imports of final products	21.4	91.0	50.8	50.6	38.7	16.2	38.6	72.1
Imports of services (inc. techno)	100.0	58.6	72.7	543.0	170.0	-15.6	114.8	75.5
Exports		**87.9**		**101.5**		**70.4**		**88.8**

Source: Author's calculation based on The Survey.
Note: size was defined in terms of the amount of sales, where big firms sold more than $100 million, medium firms sold more than $25 million but less than $100 million, and small firms sold less than $25 million.

ii) Innovation related to management

Among indigenous capability efforts, strictly innovative activities, rather than research and development, gained predominance. Table 3b shows that the rates of growth of activities related to *administration (84%), organisation (86%) and commercialisation (98%)* were well above the average growth rate of innovative efforts inside the firm (47.5%).

The very low starting point in terms of managerial activities from the ISI period makes the high growth rate of these activities during the 1990s understandable. However, the

new strategy might also imply a collapse of the indigenous potential for creating new knowledge.

Table 3b Innovative Efforts: Structure and growth rate in innovative activities

%	big		medium		small		TOTAL	
	Share in Total 96	Growth rate 96/92	Share in Total 96	Growth rate 96/92	Share in Total 96	Growth rate 96/92	Share in Total 96	Growth rate 96/92
TOTAL INNOVATIVE EFFORTS	**100%**	**69.1**	**100%**	**65.1**	**100%**	**17.9**	**100%**	**58.0**
INSIDE THE FIRM	**7%**	**57.8**	**18%**	**29.5**	**18%**	**68.9**	**12%**	**47.5**
Total R+D	**51%**	**53.7**	**45%**	**30.3**	**42%**	**67.0**	**47%**	**46.3**
Basic research	28%	31.5	16%	15.9	10%	146.8	20%	32.6
Applied research	26%	277.6	21%	66.1	9%	58.2	20%	133.7
Products and process development	46%	25.4	63%	25.5	81%	61.6	60%	33.9
Total Other innovative activities	**49%**	**62.4**	**55%**	**28.8**	**58%**	**70.2**	**53%**	**48.6**
Products and process adaptation	27%	35.5	14%	48.5	16%	37.3	19%	39.5
Technical assistance to production	25%	14.0	21%	12.8	20%	50.2	22%	20.2
Project engineering	25%	102.4	19%	29.7	15%	53.6	20%	59.3
Administration reorganisation	5%	1,274.0	7%	21.4	6%	103.7	6%	83.7
General organisation	2%	295.1	7%	50.1	20%	97.6	9%	85.6
Commercialisation	9%	116.6	9%	31.4	14%	258.8	11%	97.8
Other innovative activities	7%	230.9	22%	29.8	8%	24.2	13%	44.6
OUTSIDE THE FIRM	**93%**	**70.1**	**82%**	**75.4**	**82%**	**10.5**	**88%**	**59.4**
Total Transfer	**15%**	**48.0**	**15%**	**38.1**	**8%**	**59.6**	**14%**	**46.3**
Transfer technology new brands	18%	37.2	25%	94.1	42%	127.9	22%	61.1
Other transfer of technology	82%	50.5	75%	26.0	58%	30.9	78%	42.7
Local	5%	83.7	15%	41.9	33%	93.5	10%	67.8
External	95%	46.5	85%	37.5	67%	46.9	90%	44.3
Embodied technology	**81%**	**73.3**	**77%**	**83.2**	**85%**	**2.7**	**80%**	**59.4**
Investment in national capital goods	51%	41.0	39%	51.5	51%	0.6	48%	34.5
Investment in imported capital goods	49%	128.2	61%	111.1	49%	4.8	52%	92.8
Consultancy	**4%**	**108.5**	**9%**	**90.5**	**7%**	**161.0**	**6%**	**108.1**

Source: Author's calculation based on The Survey.

To sum up, given serious methodological limitations to delimit what conforms with the malleability culture, the empirical analysis relies on *specialisation oriented to national markets* and an *increasing importance of managerial activities* as proxies for firms' commitment to the malleability culture. These tendencies were empirically manifested in an increased importance of industrial firms' imports of final goods (Table 3a); a bigger share in total sales of goods produced by third parties (Table 3a); and an augmented importance of innovative spending related to management (Table 3b).

Although these highlight the spirit of what was defined as malleability, they are neither complete nor totally accurate. Expenditures in management could be strictly related to production and demand-side activities were artificially repressed before liberalisation. Therefore, the empirical results concerning malleability should be considered just as an illustration that calls attention to the importance of macroeconomic environment in shaping firm behaviour.

3.2 Empirical illustration

In what follows, the determinants of technological and economic performance will be evaluated. Two distinct patterns will then emerge, one corresponding to technological performance and another to economic performance.

Following the above discussion, there are three main propositions on *technological performance* that require empirical verification. First, is that technological behaviour actually advances technological performance. Secondly, we should also be able to demonstrate that micro and sectoral attributes that enhanced appropriability and cumulativeness (largely important to encouraging technological behaviour) are beneficial to technological performance. Finally, there is the question of whether the malleability culture that characterised survival during the 1990s, was harmful for technological development for those that were not *a-priori chosen*.

However, it will be shown that these propositions are not valid for explaining *economic performance.* Furthermore, some determinants that hampered technological performance did encourage economic performance.

3.2.1 Technological performance

i) Dependent variables

There are two questions included in The Survey that explore actual innovations (defined in this case as the introduction of "new" products or processes[21]) rather than perceptions. Strictly speaking, they are still subjective indicators (firms themselves evaluate what an innovation is), however they could be considered a closer measurement of performance.

In question 413 firms were asked to inform whether they had introduced new products due to the introduction of novel inputs, the introduction of a new process, or a frontier movement in scientific knowledge. They are also asked whether they had improved old products or introduced some product differentiation. The variable takes on values of 0 to 5 as shown in Table 3c.

Table 3c: Measurements of Product and Process Innovation

Variable	**Five possible types of product innovation:**
413	➢ Due to the introduction of novel inputs ➢ Due to the introduction of new processes ➢ Due to a frontier movement in the scientific knowledge ➢ Improvement of existent products ➢ Product differentiation
Value	**When**
0	None of them were informed
1	At least one
2	At least two of them
3	At least three of them
4	At least four of them
5	The five of types of product innovation were informed

Variable	**Four possible types of process innovation:**
414	➢ Due to the introduction of new products ➢ Due to a frontier movement in the scientific knowledge ➢ Improvement of existent processes ➢ Introduction of machinery or equipment associated to new processes
Value	**When**
0	None of them were informed
1	At least one
2	At least two of them
3	At least three of them
4	The four types of process innovation were informed

[21]The answers, though, are subject to the firm's ideas of what is new (e.g. new for the firm?, new for the local market? new for the world?).

On the other hand, question 414 asked whether firms had introduced new processes due to either the introduction of a new product or some movement in the scientific frontier. This question also asked whether there were improvements in existing products and whether machinery and equipment associated with new processes were introduced. The variable ranges between 0 and 4 as shown in Table 3c.

ii) Model estimation

The aim is to analyse the determinants of technological performance in order to corroborate the above propositions. Therefore, in Table 3d, I present an ordered probit model to estimate the relationship of these dependent variables and a set of independent variables that are related to these hypotheses[22].

Table 3d: Ordered Probit Regression on Product and Process Innovation

	Dep. Variable: 413 product innovation			**Dep. Variable: 414 process innovation**		
	N		1414	N		1414
	Pseudo R2		0.1114	Pseudo R2		0.1369
Ind. Variables	Coef.	Sig.	z	Coef.	Sig.	z
Ln Investment in Fixed Assets Avg. 92-96	0.063350	***	4.27	0.115013	***	7.57
Commodities	-0.198989	**	-2.46	-0.013557		-0.17
Food Commodities	-0.210807	*	-1.67	-0.272411	**	-2.11
Diffuser	0.022175		0.23	-0.051361		-0.53
Durable Goods	-0.130504		-1.24	0.094564		0.88
RD Avg. 92-96	0.000782	***	2.71	0.000478	*	1.66
Other Inn. Activities (production) Avg. 92-96	-0.000368	*	-1.92	-0.000148		-0.77
Other Inn. Activities (management) Avg. 92-96	0.000925		1.59	0.000228		0.45
Transfer of Technology Avg. 92-96	0.000127	*	1.88	0.000077		1.4
Expo Avg. 92-96	-0.000002		-1.11	-0.000001		-0.98
Import of Capital Goods Avg. 92-96	0.000004		0.18	0.000011		0.55
Import of Inputs Avg. 92-96	0.000004		0.99	0.000000		-0.07
Imports of Final Products Avg. 92-96	-0.000003		-0.56	-0.000011	**	-2.1
Imports of Services Avg 92-96	0.000176	**	2.01	-0.000027		-0.27
Decentralised Information	0.099864	***	6.69	0.094375	***	6.25
Centralised Information	0.037687	***	3.21	0.034302	***	2.91
Size	0.257280		1.5	0.423578	**	2.44
Age	0.001444		1.13	0.001220		0.94
Foreign	0.190083	**	2.49	0.158885	**	2.06
Technological Strategy	0.120884	***	9.77	0.148191	***	11.73
Organisational Strategy	0.013537	*	1.67	0.002788		0.34

*** Significant at 99%, ** Significant at 95%, *Significant at 90%

Source: Author's calculation based on The Survey.

Variable definition: same as above except:

Investment in Fixed Assets Avg. 92-96: includes national and imported capital goods, buildings, reparation and maintenance and other fixed assets, measured in thousands of pesos➔ 1peso=1US$

[22] I also included total investments in physical assets as a control variable.

- *First proposition: innovative behaviour positively influenced technological performance*

Both sets of results show that technological performance was greatly influenced by a commitment towards a technological strategy (behavioural dimension), which is an important result to show that both dimensions are related.

On the other hand, a strategy that attempted to improve organisational matters did not seem to have such a definite effect on technological performance. Organisational strategy was not significant to explain process innovation and was only marginally significant for product innovation[23]. Therefore, the argument that says that organisational capabilities are necessary to improve technological capabilities was only partially true in Argentina[24].

Technological efforts inside the firms in the form of Research and Development, even after controlling for both innovative strategies, were important for explaining product and process innovation (recall that they were also significant for increasing the likelihood of these strategies).

- *Second proposition: micro and sectoral attributes that characterise appropriability and cumulativeness foster technological performance*

Large and foreign firms enjoyed high degrees of appropriability conditions and consequently they performed better in process and product innovation. This micro attributes are also the ones used to define the *a-priori chosen* firms.

Moreover, as could be expected, firms that systematically enhanced their technological capability and invest in R&D enjoyed greater degree of cumulativeness and also performed better in technology.

On the other hand, those sectors that are traditionally considered to be technologically more dynamic did not show here an outstanding technological performance, once expenditures in R&D were controlled for[25]. However, dummy variables for those sectors that are meant to be less dynamic did affect negatively product and process innovations. The commodity sector was one of the winning sectors after liberalisation (see below) and consequently many of the *a-priori chosen* firms belonged to it. This confirms the structuralist view which claimed that, in the absence of counterbalancing policies, trade liberalisation could drive specialisation towards non-technologically dynamic areas.

- *Third proposition: commitment towards a malleability culture deters technological performance*

Other innovative efforts related to production seem to be negatively correlated with product innovation, but not with process innovation. Among the three possible activities within this category (i.e. adaptation, technical assistance to production, and project

[23] Nick von Tunzelmann [1995] argued that process innovation is more likely to be advanced by knowledge and product innovation is advanced by market competition. Given that an organisational strategy is also more likely to be induced by market competition, it is not very surprising that it shows a tiny association with product innovation but not with process innovation. By the same token, if process innovation was advanced by knowledge it should be more sensitive to cumulativeness (and given the costs of capability building also to appropriability) than product innovation. Actually, as is shown in Table 3d, despite the strategic movement of each firm (i.e. after controlling for both innovative strategies), size appeared as positively affecting process but not product innovation.

[24] Organisational strategy in Argentina was largely based on cost rationalisation (especially labour costs).

[25] Dummy variables for both the durable goods sector and the diffuser of technical progress sector were significant when expenditure in R&D was dropped from the regression.

engineering), adaptation of products may be one that affected product innovation. Apparently, adaptation deterred actual innovation in products. Given the general concern for demand-side activities, it could likely be the case that adaptation means here a light transformation (e.g. packaging) either of former production or of imported products, rather than major changes. If that were the case, such activity could be considered closer to management than to production.

Actually, those variables related to the malleability culture were either insignificant in explaining technological performance (innovative activities related to management) or affected it negatively (imports of final products).

Thus, firms that were more committed to a survival strategy and imported more final products to widen their mix of products for sale were less committed to a long-term strategy and therefore less successful in process innovation. This also shows that specialisation in Argentina was not oriented to international markets. Consequently, it did not constitute a competitive improvement in domestic production but only a reduction in the production mix.

3.2.2 Economic performance

i) Dependent variables

Having confirmed the three hypotheses for technological performance, I next attempt to test empirically whether the same could be said for economic performance. However, The Survey does not provide information on firms' value added. Therefore, measurement of either a production function or productivity needs to rely on information on sales, which is obviously far from ideal.

I therefore took two different indicators of economic performance (natural logarithm of sales and natural logarithm of the ratio of sales over labour) during two different periods (the last period available –1996, and an average of the whole period covered by The Survey – from 1992 to 1996) to enhance the robustness of the results.

ii) Model estimation

Tables 3e and 3f present simple regression models that estimate the relationship of these dependent variables using a set of independent variables related to the above-mentioned propositions[26]. The hypothesis in this case is that the determinants of economic performance are different and sometimes opposite to what explained technological performance.

[26] A variable that measured total investments in fixed assets was used as a control variable for regressions on the ratio sales/labour, while the same variable plus labour were used as control variables for regressions on sales.

Table 3e: Determinants of Productivity measured by Sales 92-96

	Dep. Variable: Ln Productivity (Sales/Labour)Avg. 92-96			**Dep. Variable: Ln Sales Avg. 92-96**		
		N	1347		N	1336
		Adjusted R2	0.2319		Adjusted R2	0.8197
Ind. Variables	Coef.	Sig.	t	Coef.	Sig.	t
Ln Investment in Fixed Assets Avg. 92-96	0.096642	***	9.91	0.125046	***	11.51
Ln Total Labour Avg. 92-96				0.873223	***	39.05
Commodities	0.031525		0.59	0.043314		0.82
Food Commodities	0.253979	***	3	0.248815	***	2.97
Diffuser	-0.106295	*	-1.67	-0.152858	**	-2.41
Durable Goods	0.043663		0.62	0.056080		0.81
RD Avg. 92-96	-0.000112		-0.7	-0.000049		-0.31
Other Inn. Activities (production) Avg. 92-96	0.000062		0.46	0.000084		0.63
Other Inn. Activities (management) Avg. 92-96	0.000560	*	1.7	0.000588	*	1.81
Transfer of Technology Avg. 92-96	-0.000022		-0.57	-0.000011		-0.28
Expo Avg. 92-96	0.000004	***	4.42	0.000004	***	4.8
Import of Capital Goods Avg. 92-96	-0.000072	***	-4.26	-0.000067	***	-4.02
Import of Inputs Avg. 92-96	0.000009	***	3.49	0.000010	***	3.78
Imports of Final Products Avg. 92-96	0.000008	**	2.3	0.000008	**	2.14
Imports of Services Avg 92-96	0.000045		0.82	0.000049		0.89
Decentralised Information	0.009924		0.99	0.009526		0.96
Centralised Information	-0.007458		-0.95	-0.005134		-0.66
Size	0.424848	***	3.63	0.523930	***	4.48
Age	-0.001469	*	-1.69	-0.000024		-0.03
Foreign	0.288951	***	5.6	0.326163	***	6.34
Technological Strategy	-0.002298		-0.28	0.000302		0.04
Organisational Strategy	0.008028		1.46	0.010572	*	1.94

*** Significant at 99%, ** Significant at 95%, *Significant at 90%

Source: Author's calculation based on The Survey.

Variable definition: same as above except

Total Labour Avg. 92-96: includes total employees: production, management, R&D and others

Table 3f: Determinants of Productivity measured by Sales 96

	Dep. Variable: Ln Productivity (Sales/Labour) 96			Dep. Variable: Ln Sales 96		
	N		1347	N		1347
	Adjusted R2		0.2319	Adjusted R2		0.804
Ind. Variables	Coef.	Sig.	t	Coef.	Sig.	z
Ln Investment in Fixed Assets 96	0.093292	***	9.14	0.111409	***	9.85
Ln Total Labour 96				0.913545	***	38.54
Commodities	0.101915	*	1.81	0.105998	*	1.89
Food Commodities	0.330959	***	3.74	0.333132	***	3.78
Diffuser	-0.063714		-0.92	-0.099743		-1.43
Durable Goods	-0.017935		-0.23	-0.011521		-0.15
RD Avg. 92-96	-0.000116		-0.67	-0.000074		-0.43
Other Inn. Activities (production) Avg. 92-96	0.000063		0.44	0.000078		0.55
Other Inn. Activities (management) Avg. 92-96	0.000570		1.61	0.000608	*	1.72
Transfer of Technology Avg. 92-96	-0.000045		-1.25	-0.000037		-1.03
Expo Avg. 92-96	0.000004	***	4.47	0.000005	***	4.71
Import of Capital Goods Avg. 92-96	-0.000067	***	-4.88	-0.000064	***	-4.69
Import of Inputs Avg. 92-96	0.000009	***	3.24	0.000009	***	3.43
Imports of Final Products Avg. 92-96	0.000010	***	2.85	0.000009	***	2.69
Imports of Services Avg 92-96	0.000035		0.59	0.000039		0.65
Decentralised Information	0.005092		0.48	0.005135		0.48
Centralised Information	-0.008232		-0.98	-0.006133		-0.73
Size	0.483218	***	3.83	0.562407	***	4.41
Age	-0.000120		-0.13	0.000661		0.71
Foreign	0.325802	***	6.03	0.354067	***	6.51
Technological Strategy	0.002494		0.29	0.004980		0.57
Organisational Strategy	0.006943		1.19	0.008534		1.47

*** Significant at 99%, ** Significant at 95%, *Significant at 90%

Source: Author's calculation based on The Survey.

Variable definition: same as above

- *First proposition: did innovative behaviour positively influence economic performance?*

Although Table 3d showed that technological behaviour fostered technological performance, it is not possible to extrapolate this result to economic performance. Neither technological strategy nor investments in research and development were significant for explaining economic performance. Sales and productivity were detached from technological commitment, which is not too surprising when one looks deeply into the behavioural dimension.

As was largely described in section 3.1.1, trade liberalisation did not encourage efficiency because it did not break with the predominant macro behaviour. Many years of macro uncertainty plus inconsistent policy design had rewarded strategies that prioritised malleability. In such a context, any long-term strategy militates against mere survival unless the firm's micro and sectoral attributes make it *a-priori chosen* to survive.

- *Second proposition: did micro and sectoral attributes that characterise appropriability and cumulativeness foster economic performance*

As discussed above, micro attributes that characterise appropriability and cumulativeness conditions were very similar to those that help a firm being *a-priori chosen* by the macro environment. Therefore, those attributes should be (and they were) positively related to economic performance.

On the other hand, contrary to what was found for technological performance, the commodity sector, especially food commodities, did significantly better than the other sectors in economic terms.

In point of fact, these *a-priori chosen* firms pursued aggressive investments in capital-intensive state-of-the-art techniques, especially in the commodity sector [Katz, 2000b]. Again, this result in economic performance is not surprising under the Argentinean macro environment during the 1990s. On the one hand, credit markets were fragmented; on the other hand uncertainty brought an absolute preference for liquidity in dollars. These firms were those with easier access to capital markets and to foreign markets. On top of that, they benefited from other policies, like privatisation, which are beyond the scope of this analysis. They were definitely among the winners of the liberalisation period in economic terms.

- *Third proposition: did commitment towards a malleability culture deter economic performance?*

The malleability culture existed because it was rewarded in such a macro environment. As stressed before, it is very difficult to assess its existence, especially with this type of information based on industrial activities.

However, it could be still seen that those activities that were identified in section 3.1.2 as characteristic of the new managerial model inside the firm orientated towards domestic demand were successful determinants of economic performance. Thus, while imports of final products had a negative effect on process innovation they had a strong positive effect in the four different ways used here to measure economic performance. Moreover, expenditures on innovative activities related to management that were not significant in explaining technological performance had a positive, though weak, impact on economic performance.

Thus, although its relation to economic efficiency can be queried, these results illustrate that malleability was economically rewarded in this new macro economic environment. Probably, the biological metaphor may work under different (usually quite restricted) behavioural assumptions.

Conclusions

Among the large variety of macro policies, the most careful attention in relation to technology has been paid to *trade policy*. Within this topic it is possible to find studies that belong to endogenous growth theory which argue that openness broadens the technological knowledge base and enlarges the technological opportunities available for the country that liberalises trade. Therefore, they predict a positive impact of trade liberalisation on technological and economic performance. On the other hand, there is a whole array of studies belonging to different theoretical approaches which are critical about early liberalisation. Their arguments rely on the importance of developing indigenous capabilities (that early liberalisation may hamper) and the need to drive specialisation towards technologically dynamic activities instead of relying on static comparative advantages.

This paper, on the contrary, has argued that the final impact of trade liberalisation on technological and economic performance was dependent on its impact on the firms' decision-making process. Empirical results were drawn from the Argentinean Innovation Survey carried out in 1997.

Two main claims guided the discussion, one emphasising the importance of micro behaviour, the other the importance of macro behaviour.

Firstly, the ultimate impact of openness on technological performance will be dependent on its incidence on the *macro, sectoral* and *micro* elements that affect OACK conditions in the behavioural dimension, which is the abstract locus where decisions are shaped.

Although the literature on technological change recognises that firms differ in their strategies towards technological acquisition, when coming down to empirical evidence or even when developing formalised theoretical models, most seem to overlook the behavioural dimension and only assess the performance dimension.

This paper has in fact shown that introducing the behavioural dimension *narrows* the differences between the two approaches mentioned above in regard to the relation between trade and technological performance (Part 2.1).

In Part 2.2.1, using latent class analysis, I identified two types of innovative strategies. There was one strategy more oriented to technological innovation, and another more oriented towards production re-organisation. The latter could be interpreted as strategy aiming at a once-for-all gain in efficiency, while the former could be interpreted as a longer-term scheme.

Part 2.2.2 showed that firms that imported capital goods and were active in absorbing (technological) information from the environment were also more likely to commit themselves to innovative strategies. Therefore, one could agree with the endogenous growth theory that opportunities embodied in capital goods and (arguably) more accessible information pushed a technological interest among firms that had imported those goods or absorbed that information.

However, more often than otherwise, these firms relied on conditions of cumulativeness and appropriability to take advantage of the newly available opportunities and the broadened knowledge base. Therefore, it could not be taken as representative of the whole industrial sector that came out of the 1990s.

It was shown in the same section that size and nationality on the one hand, and age and capability-building efforts inside the firms (basically investment in R&D and in other

innovative activities related to production) on the other hand, were significant in explaining both a technological and an organisational strategy. Whereas the former variables could be considered as a proxy for appropriability, the latter variables show that cumulativeness was also fundamental to commitment to innovation. By the same token, the commodity sector was significantly less dynamic and the durable goods sector significantly more dynamic than the control group (the traditional sector). Both findings give credit to the importance of indigenous capability building and sectoral specialisation when developing a technological strategy, as the critics of free trade have insisted.

Therefore, the policy prescription that stems from this analysis is not a claim for more government intervention in trade. Rather, the argument here is for a different type of intervention towards the enhancement of OACK conditions at a national level.

This drives us to the second claim of this paper: **the macro behaviour that prevailed in Argentina at the time of liberalisation separated economic from technological performance as two distinct outcomes with different (sometimes opposite) characteristics. Firms that were successful at product and process innovation (i.e. *technological performance*) replicated the same patterns that characterised technological behaviour. However, patterns of successful *economic performance* diverged from them and did not necessarily amount to an efficiency criterion.**

In Argentina reforms were carried out in a macro context characterised by structural macro uncertainty, a long history of inconsistent and changing macro policies and imperfect markets (especially capital markets). Most of the firms were therefore conservative and distrusted the sustainability of national policies. This, on the one hand, favoured policy overshooting and liberal dogmatism, and on the other hand prioritised short-term strategies aiming at survival over long-term ones aiming at growth.

However, among survivors two markedly different groups could be identified.

There were some firms whose micro and sectoral attributes make them ‘a-priori’ in a stronger position to survive, regardless of their efficiency (e.g. big firms, foreign firms, or those that based production on natural resources). The reason for this is that in this macro environment, which showed different features from what is usually assumed in the conventional wisdom, an easier access to capital markets and foreign currency was rewarded. Section 3 showed that while these firms did better in economic performance, their sectoral attributes deterred technological accumulation.

The rest (e.g. small firms, firms producing non-traditional products, firms located in remote places, etc.) needed to follow a *survival strategy* that would enable them to react faster to changing situations. This created a series of short-term strategies that were distinct from innovative strategies, and usually even beyond the industrial sphere.

The macro environment rewarded *malleability*, and therefore it was more effective for this group of industrial firms to maximise sales by investing in management rather than in R&D, and to commit themselves to short-run strategies orientated to domestic markets rather than long-term strategies aimed at gaining competitiveness. Even though they remained conservative in production techniques, they were nevertheless flexible to survive in changing markets. Thus, the best possible decision for each firm did not drive the economy as a whole to a point closer to the production possibility frontier.

Despite the intrinsic limitations to assess malleability quantitatively, I considered two activities as proxies for firms' commitment to the malleability culture: investment in management and imports of final products. Section 3.2 showed that whereas these two activities enhanced economic performance they discouraged technological performance.

To sum up, years of uncertainty and inconsistent policies have brought about a national preference for malleability. Firms were conservative and distrusted the sustainability of national policies. Given the absence of technological or other complementary policies that could have enhanced appropriability and cumulativeness for all firms and the fragmentation of capital markets, liberalisation favoured firms that shared certain characteristics while discriminating against the rest. Especially for the latter group, the predominant macro behaviour made economic success dependent on strategies different from innovative ones. Thus, they did not advance a technological strategy despite the new technological opportunities created after trade liberalisation Accordingly, the situation militated against the acquisition of technological capabilities and therefore against national technological accumulation, exacerbating the risk of creating a *technological trap*.

In any case, the point here is not to blame liberalisation for this entire situation, but to argue that unexpected consequences in performance could eventuate when behaviour is overlooked in policy design. The same may be applied to the current crisis and the potential blessings that could be expected from devaluation.

Although devaluation enhances price competitiveness of national products, exports will not take off automatically, neither will they constitute a generalised consequence of current macro environment. Again, a diversity of behaviour will prevail.

This paper has shown that the post-liberalisation environment, which was characterised by an overvaluation of the peso, encouraged a deeper integration with external providers, both inside and outside the malleability culture. Outside this culture, links with external providers of general services and producers of technology were tightened, and imported products were introduced as part of a technological strategy (imports of inputs and capital goods that were incorporated into national production). On the other hand, trade liberalisation also enhanced practices grounded in the malleability culture, like the possibility of importing cheap final goods to widen the mix of final products for sale.

Given that it is by definition easier to abandon a strategy grounded on malleability than a more proactive one, conservative firms that did not pursue structural changes in production after liberalisation and relied mainly on a survival strategy are at the present time in a better situation to survive the crisis because they do not need further restructuring to replace the now expensive imports. Malleability is once again rewarded. On the other hand, big firms, multinational firms and those that rely on static comparative advantage also enjoy larger margins for manoeuvring.

Therefore, unless OACK conditions are enhanced at a national level, which, among other things, requires not only commitment towards technology policies but also an urgent transformation of financial institutions (rather than just restoration of previous credit opportunities), the new survivors will again be either the *a-priori chosen firms*, or *the speculative-conservative ones*, or both.

Appendix 1

Categories	ISIC	Description
Automobile Sector	3410	Manufacture of motor vehicles
	3420	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers
	3430	Manufacture of parts and accessories for motor vehicles and their engines
Commodities	1711	Preparation and spinning of textile fibres; weaving of textiles
	1712	Finishing of textiles
	1911	Tanning and dressing of leather
	2010	Sawmilling and planing of wood
	2021	Manufacture of veneer sheets; manufacture of plywood, laminboard, particle board and other panels and boards
	2101	Manufacture of pulp, paper and paperboard
	2102	Manufacture of corrugated paper and paperboard and of containers of paper and paperboard
	2109	Manufacture of other articles of paper and paperboard
	2310	Manufacture of coke oven products
	2320	Manufacture of refined petroleum products
	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
	2412	Manufacture of fertilizers and nitrogen compounds
	2413	Manufacture of plastics in primary forms and of synthetic rubber
	2422	Manufacture of paints, varnishes and similar coatings, printing ink and mastics
	2511	Manufacture of rubber tyres and tubes; retreading and rebuilding of rubber tyres
	2694	Manufacture of cement, lime and plaster
	2696	Cutting, shaping and finishing of stone
	2710	Manufacture of basic iron and steel
	2720	Manufacture of basic precious and non-ferrous metals
	3130	Manufacture of insulated wire and cable
	3150	Manufacture of electric lamps and lighting equipment
Diffuser of Technical Progress	2421	Manufacture of pesticides and other agro-chemical products
	2911	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines
	2912	Manufacture of pumps, compressors, taps and valves
	2913	Manufacture of bearings, gears, gearing and driving elements
	2914	Manufacture of ovens, furnaces and furnace burners
	2915	Manufacture of lifting and handling equipment
	2919	Manufacture of other general purpose machinery
	2921	Manufacture of agricultural and forestry machinery
	2922	Manufacture of machine-tools
	2923	Manufacture of machinery for metallurgy
	2924	Manufacture of machinery for mining, quarrying and construction
	2925	Manufacture of machinery for food, beverage and tobacco processing
	2926	Manufacture of machinery for textile, apparel and leather production
	2927	Manufacture of weapons and ammunition
	2929	Manufacture of other special purpose machinery
	3000	Manufacture of office, accounting and computing machinery
	3110	Manufacture of electric motors, generators and transformers
	3120	Manufacture of electricity distribution and control apparatus
	3210	Manufacture of electronic valves and tubes and other electronic components

Categories	ISIC	Description
Diffuser of Technical Progress	3220	Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy
	3311	Manufacture of medical and surgical equipment and orthopaedic appliances
	3312	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment
	3313	Manufacture of industrial process control equipment
	3511	Building and repairing of ships
	3520	Manufacture of railway and tramway locomotives and rolling stock
	3530	Manufacture of aircraft and spacecraft
Durable Goods	2930	Manufacture of domestic appliances n.e.c.
	3230	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus, and associated goods
	3320	Manufacture of optical instruments and photographic equipment
	3330	Manufacture of watches and clocks
	3512	Building and repairing of pleasure and sporting boats
	3591	Manufacture of motorcycles
	3592	Manufacture of bicycles and invalid carriages
	3599	Manufacture of other transport equipment n.e.c.
Food Commodities	1513	Processing and preserving of fruit and vegetables
	1514	Manufacture of vegetable and animal oils and fats
	1531	Manufacture of grain mill products
	1532	Manufacture of starches and starch products
	1533	Manufacture of prepared animal feeds
	1542	Manufacture of sugar
Traditional	1511	Production, processing and preserving of meat and meat products
	1512	Processing and preserving of fish and fish products
	1520	Manufacture of dairy products
	1541	Manufacture of bakery products
	1543	Manufacture of cocoa, chocolate and sugar confectionery
	1544	Manufacture of macaroni, noodles, couscous and similar farinaceous products
	1549	Manufacture of other food products n.e.c.
	1551	Distilling, rectifying and blending of spirits; ethyl alcohol production from fermented materials
	1552	Manufacture of wines
	1553	Manufacture of malt liquors and malt
	1554	Manufacture of soft drinks; production of mineral waters
	1600	Manufacture of tobacco products
	1721	Manufacture of made-up textile articles, except apparel
	1722	Manufacture of carpets and rugs
	1723	Manufacture of cordage, rope, twine and netting
	1729	Manufacture of other textiles n.e.c.
	1730	Manufacture of knitted and crocheted fabrics and articles
	1810	Manufacture of wearing apparel, except fur apparel
	1820	Dressing and dyeing of fur; manufacture of articles of fur
	1912	Manufacture of luggage, handbags and the like, saddlery and harness
	1920	Manufacture of footwear
	2022	Manufacture of builders' carpentry and joinery
	2023	Manufacture of wooden containers
	2029	Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials
	2211	Publishing of books, brochures, musical books and other publications
	2212	Publishing of newspapers, journals and periodicals

	2213	Publishing of recorded media
Categories	**ISIC**	**Description**
Traditional	2219	Other publishing
	2221	Printing
	2222	Service activities related to printing
	2230	Reproduction of recorded media
	2423	Manufacture of pharmaceuticals, medicinal chemicals and botanical products
	2424	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations
	2429	Manufacture of other chemical products n.e.c.
	2430	Manufacture of man-made fibres
	2519	Manufacture of other rubber products
	2520	Manufacture of plastics products
	2610	Manufacture of glass and glass products
	2691	Manufacture of non-structural non-refractory ceramic ware
	2692	Manufacture of refractory ceramic products
	2693	Manufacture of structural non-refractory clay and ceramic products
	2695	Manufacture of articles of concrete, cement and plaster
	2699	Manufacture of other non-metallic mineral products n.e.c.
	2731	Casting of iron and steel
	2732	Casting of non-ferrous metals
	2811	Manufacture of structural metal products
	2812	Manufacture of tanks, reservoirs and containers of metal
	2813	Manufacture of steam generators, except central heating hot water boilers
	2891	Forging, pressing, stamping and roll-forming of metal; powder metallurgy
	2893	Manufacture of cutlery, hand tools and general hardware
	2899	Manufacture of other fabricated metal products n.e.c.
	3140	Manufacture of accumulators, primary cells and primary batteries
	3190	Manufacture of other electrical equipment n.e.c.
	3610	Manufacture of furniture
	3691	Manufacture of jewellery and related articles
	3692	Manufacture of musical instruments
	3693	Manufacture of sports goods
	3694	Manufacture of games and toys
	3699	Other manufacturing n.e.c.

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