Trade Liberalization and Industrial Response: The Case of Chile (1974-1987)*

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1. Introduction

Since 1974 Chile has undergone a radical and thorough process of restructuring. Two major crises had to be faced in 1975 and 1982, in an unfavourable international context that produced a terms of trade deterioration and was characterized by the oil crisis in the '70s, and by the debt crisis in the early '80s. The ensuing adjustment policies coexisted with the long-run structural reforms already being implemented under the military rule. Thus, the macroeconomic framework was modified substantially and subjected to frequent changes over the years, with trade liberalization as one of the changes in the policy environment. Firms had to adjust to an environment that provided them with varying incentives (*e.g.* as given by trade and exchange rate, monetary and fiscal policies) and a variable structural setting in which to operate (institutions, public administration, changing role of the State, ownership structure of firms and banks).

In this paper, we discuss the impact of the liberalization of international transactions on the industrial sector in Chile during the years from 1974 to 1987, and the way this affected firm-level re-

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sponses.[1] The structure of the paper is the following: in Section 2 we review the experience of trade liberalization in the context of a structural reform. Section 3 provides some evidence of the response of the industrial sector, and in Section 4 we propose an interpretation based on the concept of "Technological Capabilities" (TC) at the national level. Section 5 summarizes and concludes with some policy implications.

2. Liberalization of international transactions and structural reforms in Chile: 1974-87

Pre-1973 Chile was generally characterized by an active role of the State favouring industrialization.[2] During the Frei years (1963-70) the State often played a developmental and planning role, with a cautious outward-looking perspective, whereas the years of Allende's *Unidad Popular* government (1970-73) saw a further and thorough extension of the role of the State in the economy. The international insertion of Chilean manufacturing activities deteriorated dramatically with the latter government.

The macroeconomic framework changed substantially after 1973, and since then the efforts to stabilize the economy's high inflation rate coexisted with long-run structural reforms. Relevant to our present purpose, the specific form, sequence and intensity of policies had the greatest effect on the industrial sector, characterized during these years by stagnant production, substantial job losses, and poor investment performance.

Two sub-periods can be singled out to describe the dramatic policy changes: 1973-1981 and 1982-89. The first one corresponds to the implementation of the "pure" model (the true "experiment", see

[1] Many excellent studies of the broad macroeconomic framework and of the economic policies in Chile during these years exist in the literature, focusing on the many special dimensions of the Chilean "experiment", often reflecting different ideological approaches. Some of these are: Balassa 1985, CIEPLAN 1983, Corbo 1985, Corbo and Solimano 1991, De la Cuadra and Hachette 1991, Edwards and Cox-Edwards 1987, Ffrench-Davis 1983, Ffrench-Davis *et al.* 1992, Foxley 1983, Harberger 1985, Hojman 1985, Lüders 1991, Ramos 1986, Sjaastad 1983.

[2] On the pre-1973 Chilean economic history, and on the strategy of development and international insertion followed, see Ffrench-Davis 1973, Mamalakis 1976; on the Allende years, Larrain and Meller 1990.

note 1), when the most controversial, difficult and costly structural reforms were undertaken, and the strongest efforts were made to liberalize and de-regulate the economy, and restore the market as the central resource allocation mechanism. After the international debt crisis and the dramatic recession of 1982, the government's approach to economic policies became more flexible and realistic; some regulations were reintroduced, including some tariff barriers, and the external debt was re-negotiated and rescheduled. Let us see these two periods in sequence, referring specifically to trade liberalization.

2.1. *1974-81*

The character of Chilean economic policy after 1973 has been defined as a form of "orthodox structuralism" (Foxley 1983).[3] Free trade according to Comparative Advantage (CA) was the paradigm; this was to be achieved by liberalizing domestic and international transactions and financial markets. However, in spite of the clear ideological drive behind them, the implementation of the reforms was piecemeal and did not follow a pre-defined schedule (Sjaastad 1983, p. 7).

Major changes were in the following areas, with the aim of improving resource allocation,[4] and they implied achieving important structural changes:

- price deregulation, as prices had to reflect opportunity costs, and this had not been the case before in many areas;
- restrictive fiscal policies and a shrinking role of the State in the economy, to reflect the greater role of the private sector, that had to become the new dynamic force in the economy;
- liberalization of international trade, to enhance specialization according to CA, help reach static and dynamic efficiency and benefit from economies of scale;

[3] "Obviously the objectives and the instruments used differ radically from those proposed by the so-called Latin American structuralist school ... but its 'revolutionary' fervor is not less ambitious than the most radical attempts at structural change from the left, as during the Allende period" (Foxley 1983, p. 9).

[4] Whitehead (1987) gives a political economy interpretation of the objectives of the reforms, when he argues that the main target was to reduce inflation in order to regain the political support of the business *élites*.

– liberalization of the domestic financial market, previously repressed, to develop a new financial sector that would ease resource allocation guided by market forces;

– liberalization of the capital account, to benefit from external savings and capital inflows;

– liberalization of the labour market: following the idea that markets work, the interference of labour unions was banned, although a wage-floor existed for many years;

– administrative and infrastructural reforms, to facilitate the working of the markets and reduce the impediments of the public administration;

– continuation of some specific support policies for selected natural resources and manufacturing sectors.

Liberalization of international trade

A central feature of the reforms implemented since 1974 was the liberalization of international economic relations. In less than five years, the international exchange of goods was completely freed, and capital flows were to be liberalized later. According to the economic authorities, the opening would produce a more efficient resource allocation, following the country's pattern of comparative advantage.[5]

Synthetic indices of liberalization (Table 1, col. 5) show that the liberalization of international exchanges was at its minimum levels in 1973, and reached its maximum by 1979. After 1982 some new restrictions and the undervalued currency increased again the level of protection, but to a lesser extent, and through price rather than quantity measures.

The reduction in protection was drastic and the average tariff fell from 94% in 1973 to 10.1% in 1980 (Table 1). Official announcements by the economic authorities always gave great emphasis to policy measures in order to affect expectations, but *ex post* we can say that liberalization did not follow a pre-defined time path. Initially (1974), all quotas and compulsory import permits were eliminated, the highest nominal tariff levels were reduced, and the selectivity of

[5] On trade liberalization in these years useful references are: De la Cuadra and Hachette 1991, Ffrench-Davis 1987, Ffrench-Davis and Vial 1990, Ffrench-Davis *et al.* 1992, Meller 1991.

protection diminished. All remaining non-tariff barriers were eliminated by August 1976. By June 1979 a 10% flat rate was charged on all imports to Chile.[6]

The move away from the selectivity of import protection is clearly shown by the rates of effective protection (EPR), that decreased for all manufacturing sectors during the years of the military government. The average EPR fell from 151.4% in 1974 to 13.6% in 1979, and the EPRs also became more uniform (Table 2).

The exchange rate was considered important for guiding resource allocation, and was managed according to various targets in different years. Balance of payments equilibrium was the guiding principle until June 1978, whereas the reduction of inflation was the rationale of the policy until June 1982. Only after 1982 has the exchange rate gradually and consistently depreciated in real terms.

The active crawling peg implemented on the basis of a predefined *tablita* (and fixed at 39.00 pesos per US$ in June 1979) aimed at affecting expectations, in the belief that the "law of one price" would apply in an economy open to the international market,[7] but instead it brought about a substantial real appreciation. This happened when foreign capital was flowing into the country, allowing the financing of the trade deficit, and when the wage indexation mechanism in existence did not make possible a downward price adjustment.[8]

[6] The only (temporary) exception was "automobiles and other vehicles".

[7] "... the government is providing the foundations so that 1979 will mark the start of a period of unprecedented price stability" (Speech of the Minister of Finance, 3 February 1978 quoted by Ffrench-Davis 1983).

[8] There has been an extensive debate in the literature on the causes of the 1982 crisis. For example, Edwards and Cox Edwards 1987, and Harberger 1985 argue that the liberalization of the capital account was the main cause of the crisis: the large capital inflows would have induced a real appreciation anyway, incompatible with the simultaneous wage indexation. On the contrary, Meller 1991 supports the hypothesis that the current account deficit was induced mainly by a wealth effect on consumption and by the liberalization of imports, and that the capital inflows only provided the means to finance the deficit. Balassa 1985 explains the crisis with the reintroduction of price distortions after 1979 discriminating against the production of tradable goods. Saieh and Sjaastad 1986 attribute the crisis mainly to external factors (*i.e.* the sharp fluctuations of the US dollar in the late 70s). Others provide stronger criticisms of the whole approach, and underline its internal inconsistencies (CIEPLAN 1983, Ffrench-Davis 1983, Foxley 1983, Moran 1989, Vergara 1985).

TABLE 1

LIBERALIZATION OF INTERNATIONAL TRANSACTIONS, CHILE 1960-1988

	1	2	3	4	5	6	7	8
Year	Average tariff on imports	Max tariff on imports	% items subject to 2	Real exchange rate	Liberalization index	Real protection index	X/GDP %	M/GDP %
1960					8		15.5	15.6
1970					5			
1973	94.0	220	8.0	40.6	2	411.6	19.1	21.1
1974	75.6	161	17.1	48.1	12	393.6	20.4	19.7
1975	50.3	108	8.2	62.2	12	340.1	25.5	27.4
1976	35.7	66	0.5	102.4	12	400.7	25.1	20.8
1977	21.8	43	0.5	95.3	15	231.9	20.6	22.4
1978	14.7	20	22.0	115.9	17	193.4	20.6	23.4
1979	11.7	12	99.5	115.9	20	156.8	23.3	26.1
1980	10.1	10	99.5	100.0	20	118.4	22.8	27.0
1981	10.1	10	99.5	84.5	20	100.0	16.4	26.8
1982	10.1	10	99.5	95.9	20	113.5	19.4	21.3
1983	21.0	18		114.3	18	268.2	24.0	21.3
1984	24.4	25		116.2	16	314.8	24.3	25.3
1985	27.3	26		146.2	16	441.4	29.1	26.3
1986	20.8	20		174.6	17	405.9	30.6	26.8
1987	20.0	20		206.5		462.5	33.5	
1988	20.0	15		200.8		342.7		

Notes to columns:

[1] Simple mean of nominal import tariffs. 1973 refers to 31.12.1973; 1987 and 1988: base tariff.

[3] Percentage of items subject to maximum tariff.

[4] Real effective exchange rate indices (1980=100). Total trade share weights and CPI are used, as in Pietrobelli 1991. An increase implies real depreciation. For 1987 and 1988 (September) nominal exchange rates are simply deflated by CPI in the US.

[5] "... an ordinal arrangement of the intensity of liberalization", as defined in De la Cuadra and Hachette 1991. It combines indicators on quantitative restrictions on imports, official and black market effective exchange rate, export quotas and implicit tariff rates. MAX is 20.

[6] Indicator of Real Protection: Real effective exchange rate times one plus average nominal tariff. 1981=100

Sources: Banco Central de Chile. Column 5 : De la Cuadra and Hachette 1991.

TABLE 2

EFFECTIVE RATES OF PROTECTION
IN SELECTED MANUFACTURING SECTORS (%)

ISIC		1967	1974	1979	1982	1984
311-2	Food	374	161	12	10	25
313	Beverages	23	203	13	10	25
314	Tobacco	–13	114	11	10	25
321	Textiles	492	239	14	10	25
323	Leather & products	18	181	13	10	25
324	Footwear	–2	264	14	10	25
331	Timber products	–4	157	15	10	25
332	Furniture	–5	95	11	10	25
341	Paper & products	95	184	17	10	25
342	Printing & publishing	–15	140	12	10	25
351	Industrial chemicals	136	80	13	10	25
353-4	Petroleum and coal	1140	265	13	10	25
355	Rubber products	304	49	15	10	25
361-9	Non-metallic minerals	1200	128	14	10	25
371-2	Basic metals	35	127	17	10	25
381	Metal products	68	147	15	10	25
382	Non-metallic machinery	437	96	13	10	25
383-5	Electrical & transport machinery	102	96	13	10	25
	Average	243,6	151,4	13,6	10	25
	Standard deviation	549,3	60,4	1,7		

Source: Agacino *et al.* 1992.

Liberalization of the capital account

The liberalization of international capital flows started later and proceeded more slowly and gradually than trade liberalization. Initially the authorities feared capital flight. Thus, until 1977 the capital account was still virtually closed, after which the limits to foreign borrowing began to be eased gradually. From June 1979 medium-term capital movements were only subjected to the maximum allowed debt/capital ratio (20:1). However, constraints on short-term movements were not lifted, and banks were permitted to borrow abroad at short-term (less than two years) only for a brief period between 1981 and 1982. Moreover, banks could not arbitrage, as a result of the prohibition of taking a net position in foreign currency-denominated assets and liabilities.

A substantial domestic-international (expected devaluation-adjusted) interest rate spread persisted, in spite of the increasing relaxation of capital controls and of the low devaluation risk in 1979 and 1980 (Sjaastad 1983). The spread and the opening of the capital account made it extremely convenient to borrow abroad, an alternative available only to large firms already connected to the international markets. This created very unfavourable conditions for most local manufacturers, especially small and medium-sized enterprises,[9] desperately needing good financing to face the domestic recession (1975-76) and undertake the necessary investments to adjust and resist import competition.

Another dimension of the liberalization process were the substantial administrative and infrastructural reforms that eased and made more efficient the slow and bureaucratic functioning of the structures administering the export process, such as the National Customs Service (SNA), the plane and the shipping systems. Within this context of general liberalization and shrinking of the role of the state in the economy however, some public policies towards the natural resources available, that had been started decades earlier, remained in place during these years. These policies were especially effective for the forestry and the agricultural sectors (Pietrobelli 1993).

2.2. *1982-88*

In 1982 GDP and industrial production were falling and unemployment rising, and in the previous year exports had fallen and the current account deficit worsened to 14.5% of GDP (Table 3). A shift in macroeconomic management was considered necessary. A more flexible and realistic approach to economic policies was adopted thereafter. However, the basic structural reforms were not reversed, and the economy was still open and market-driven.

As far as trade liberalization is concerned, in order to cope rapidly with the balance of payments crisis, the government increased tariffs to 20% in June 1983, and 35% in September 1984. This gave some temporary protection to domestic activities. Further controls on

[9] The excellent sectoral and microeconomic analysis in Mizala (1984) shows that the financial liberalization and the high real interest rates have been a major cause of crisis and bankruptcy of Chilean manufacturing firms in the years 1977-82.

TABLE 3

INTERNATIONAL PERFORMANCE INDICATORS, CHILE 1960-1988

	1	2	3	4	5	6	7
Year	Exports	Imports	Manuf. X[a]	Exports	Imports	Current Account	
	US$ million			Growth Rates		US$ million	% GDP
1970	1112	786	106,1	2.1	0.9	-81	
1973	1309	864	105,1	2.8	-5.4	-294	
1974	2151	1257	275,8	45.9	3.4	-211	2.5
1975	1590	1033	361,1	2.4	-38.7	-491	5.6
1976	2116	1103	483,3	24.4	4.3	148	1.5
1977	2186	1479	535,0	11.9	35.5	-551	4.5
1978	2460	1848	646,9	11.2	17.6	-1088	7.1
1979	3835	2748	961,8	14.1	22.7	-1189	5.7
1980	4705	3661	1220,5	14.3	18.7	-1971	7.7
1981	3836	4914	985,1	-9.0	15.7	-4733	14.5
1982	3706	2789	935,7	4.7	-36.3	-2304	9.5
1983	3831	2005	951,0	0.6	-15.1	1117	5.7
1984	3651	2399	1003,1	6.8	16.5	-2111	10.7
1985	3804	2103	917,8	6.9	-11.0	-1329	8.3
1986	4199	2443	1159,8	9.8	9,7	-1137	6.5
1987	5223	3156	1461,5	8.8	17.0	-808	4.3
1988				6.1	12.1	167	

[a] Non-copper industrial exports = ISIC 300 – ISIC 372.
Sources: Banco Central de Chile. Column 3: CEPAL.

the capital account were reintroduced, especially on short-term capital movements. However, the flat rate of tariff protection was reduced again to 30% in March 1985, and to 20% in June of the same year. Later (beginning of 1988), it was further reduced to 15%, and finally to 11%, to maintain the essence of the trade liberalization once the economy had partly recovered from the recession.

Exchange rate policy changed substantially relative to the past, to provide export support. The exchange rate was devalued by 19% in June 1982, and in the following years a passive crawling peg was adopted, sliding in line with international inflation. Between 1982 and 1988 there was a real depreciation of about 100% (Table 1). It was increasingly realized that the economy had become more dependent on exports to generate large surpluses to serve the huge foreign debt.

Exports were necessarily given a central role in the design of the post-1982 macroeconomic policies. Thus, in addition to the now consistent and credible exchange rate management, that reduced uncertainty and allowed investments in more complex manufactured export activities, some explicit export support mechanisms were also designed and implemented after 1984. Most of them simply refunded duties and taxes to exporters in order to grant them an *equal footing* with home market-oriented producers, but others actually represented selective and temporary incentives. This is especially the case of the draw-back of 5% or 10% of the export value (Law No. 18653/1987), explicitly geared toward non-traditional, emerging exports (selectivity), only until the export item reached a pre-defined value (temporariness).

The impact of these policies on non-traditional exports is hard to evaluate: it was probably not substantial due to the small funding, but played a role in promoting some newly emerging exports. The percentage of export goods potentially benefiting from the draw back rose from 5.6% of total exports in 1985 to 9.6% in 1987, and the draw-back amounted to US$ million 4.7, 8.04 and 8.16 respectively in 1986, 1987 and 1988.[10,11]

Another interesting feature of the post-1982 period has also been a new co-operative attitude of private and public agents in the design and management of economic policies. An example of this was the creation of the "National Commission for Foreign Trade" in 1986, that met on a regular basis to act as assessor to the government on international trade policies. The economic ministries, the Sociedad Nacional de Agricultura (SNA), ProChile (the export promotion board), the Central Bank, and various enterprise associations (*e.g.* ASEXMA), participated in the Commission.

[10] Data from Central Bank of Chile, Technical Department of International Trade, and General Treasury of the Republic.

[11] Draw-back schemes are not new in Chile. Already during the Frei government the Law No. 16528/1966 had established a system of duty repayments with rates up to 30% of the export value. However, these schemes are considered to have been not very effective in promoting emerging exports (Ffrench-Davis 1973, p. 101).

3. The industrial response

The structural reforms consistently implemented since 1974 together with the short-term anti-inflationary policies have had remarkable "real" effects: they affected the performance of the productive sector and modified its structure.

As far as the long-run evolution of GDP and manufacturing GDP is concerned, Chile does not compare well with other Latin American countries. Taking 1950 as the initial benchmark, by 1987 Chile had a manufacturing GDP index of 313.1, well behind the average for Latin America (699). Looking at the period of interest, the figures show a characteristic instability, with recoveries after deep recessions: by 1985 manufacturing GDP was still roughly at the same level as in 1974 and in 1979 (Diagram 1 and Table A.2).

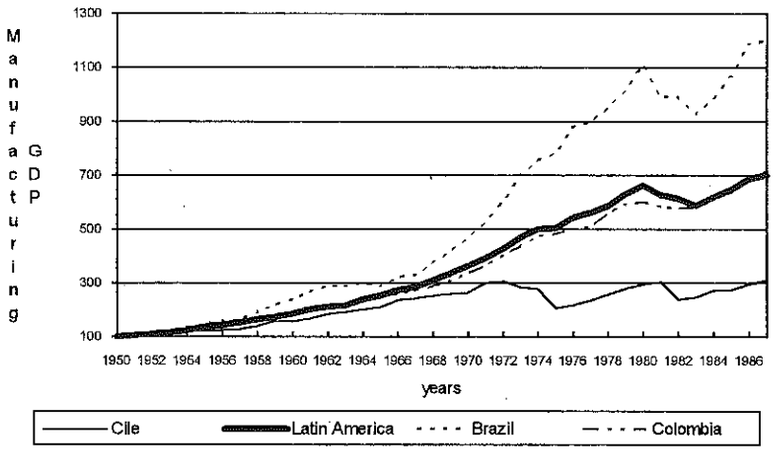
Gatica estimated the loss in industrial output relative to what could have been produced if industry had maintained the average annual "historical" rate of growth of the '60s (and under various other assumptions). According to his figures, US$ 10 billion of industrial output (almost three times the value of industrial GDP for an average year) were lost from 1970 to 1982 (Gatica 1989, p. 27). Using a different methodology (the "trend through peaks" or Wharton method), he measured the evolution of industrial productive capacity: the results show that from 1969-73 to 1982-83 maximum productive capacity in total manufacturing fell by 9.5% (Table 4).[12]

If one excludes "Non-ferrous Metal Basic Industries" (ISIC 372, mainly basic copper products), the deterioration reached 19.2%. The picture moderately improves when considering the "boom" years 1978-81. Disaggregated evidence confirms the main conclusion: maximum capacity output deteriorated for 23 out of 29 industrial groups, and the only increases were concentrated in the natural resource-intensive exporting groups (*e.g.* Food, Paper, Wood). The sectors where productive capacity fell the most were Machinery (–76.7%), Ceramics (–70.7%) and Scientific Equipment (–63.1%).

[12] Given that he uses figures on industrial gross output and not on industrial value added, his results might conceal the fact that the value added-gross output ratio decreased during those years (Gatica 1989, p. 32). In response to the abrupt opening of the domestic market, many producers actually reacted by replacing domestic intermediate goods with imported ones. Hence, the share of value added generated locally decreased.

DIAGRAM 1

LATIN AMERICA, MANUFACTURING GDP, 1950-1987



Sources: Joint Industry and Technology Division, ECLAC-UNIDO, and Table A.3.

In addition to the drop in gross manufacturing production, other typical features of these years have been rising industrial unemployment, a high number of bankruptcies, and the shrinking number of productive establishments, reflecting dramatic changes in industrial organization (Tables 4 and 5).

The liberalization policies certainly form an important part of the explanation of the losses in industrial output and employment, but this might be justified if the survivors of the selection process were more competitive and efficient, and the economy-level efficiency in resource allocation increased. In theory, the main reason for liberalization is its positive effect on productivity, via a reallocation of resources according to CA, economies of scale, and the spur of foreign competitors. On this issue, the evidence is not conclusive. Measurement difficulties are well known (Tybout 1991), and even if this were not a problem, the Chilean experience of a coincidence of different policies makes it hard to identify unequivocal causal relationships.

De la Cuadra and Hachette (1991, p. 257) strongly argue that trade liberalization had a significant positive impact on manufacturing productivity. On the contrary, Tybout *et al.* 1990, using plant-level evidence, obtain results that suggest an unequivocal fall in total factor productivity (TFP), in the presence of reductions in EPR. They

explain these as a product of the decline in demand for manufactured products in 1974-79, and of the change in the mix of products and the nature of technology. Industry-level analysis suggests a very low productivity improvement overall (Tybout 1991), contradicting the results of the plant-level studies.

The most recent analysis on this issue (Agacino *et al.* 1992) reveals that TFP had a different dynamics depending on the sub-periods considered. Thus, in 1976-81 TFP increased at 3.9% per year, and in 1984-88 (thereby excluding the recession years 1982-83) fell at a rate of −1.0% per year. In both sub-periods, gross industrial production grew at rates above 7% per year. The interest of their study lays in the explanation of this pattern they provide. Using figures on the utilization of labour and capital, and on the number of plants, they explain the initial rise in TFP indices with the improvements in the organization and rationalization of production, in the presence of shedding of both labour and capital. Average plant-size rose, together with capital-labour ratio, as a result of a greater firing of labour and not of new investments in capital equipment. In the latter period (1984-88), the growth of gross industrial production is explained by a more extensive employment of labour, and to a smaller extent of capital, in response to the following conditions: diminishing real wages in the period, and high indebtedness that prevented firms from investing in new equipment. TFP fell during these years to reveal that the potential rise in efficiency after trade liberalization had been fully exploited by 1981 through rationalization of production processes, and could not proceed further without new investments and greater efforts to incorporate technical changes. These limited efforts also explain why the pattern of specialization took the form described in the rest of this section.

Trade liberalization had a strong impact on the *composition* of manufacturing production: the importable subsectors suffered very large cuts in production (De la Cuadra and Hachette 1991, p. 256), and de-substitution of imports was often observed (Agacino *et al.* 1992, Gatica 1989, Vergara 1980).[13] Industry did not have a satisfactory performance overall, but some sectors fared better than others (Diagram 2 and Table A.3). The industrial restructuring was directed by the open-economy policies adopted, that forced a specialization in

[13] We can define "de-substitution of imports" as drops of production in those sectors that had increasingly replaced imported goods in the past.

TABLE 4

SELECTED INDICATORS OF INDUSTRIAL PERFORMANCE

ISIC		Evolution of max capacity output		No. of establishments				Total employment (persons employed)			
		82-83/ 69-73	78-81/ 69-73	1967	1979	1982	1984	1967	1979	1982	1984
311	Food	109.5	117.4	1374	1610	1383		100.0	126.3	104.6	
313	Beverages	111.6	126.2	375	211	151		100.0	105.5	81.5	
314	Tobacco	n.a.	n.a.	4	3	4		100.0	66.7	52.8	
321	Textiles	77.1	79.8	567	503	350	336	100.0	78.8	40.6	59.7
322	Wearing apparel	57.2	80.5	385	441	305	294	100.0	117.5	77.3	67.1
323	Leather & products	49.6	79.4	106	90	59	51	100.0	72.0	53.2	66.7
324	Footwear	46.0	64.1	222	185	127	133	100.0	71.5	52.7	88.5
331	Wood and cork	110.9	141.5	1068	524	354		100.0	100.7	57.0	
332	Furniture	90.6	158.7	213	211	143		100.0	84.5	65.9	
341	Paper & products	114.6	120.4	73	70	56		100.0	123.3	103.1	
342	Printing & publ.	61.7	75.4	204	243	196		100.0	117.3	97.8	
351	Industrial chemicals	38.8	61.7	78	65	56		100.0	63.8	42.8	
352	Oth. chem.	98.8	105.7	176	171	148		100.0	111.9	98.9	
353	Petroleum ref.	79.1	100.2	12	10	9		100.0	99.6	73.2	
354	Petr. & coal	65.3	73.3	5	8	9		100.0	128.2	145.1	
355	Rubber products	64.1	79.4	40	63	53		100.0	124.7	83.3	
356	Plastic products	80.7	98.6	93	170	142		100.0	136.9	107.2	
361	Ceramic products	29.3	89.0	15	13	15		100.0	87.6	35.6	
362	Glass	90.1	126.5	40	33	24		100.0	66.3	29.0	
369	Oth. non-metal. miner.	63.7	104.0	148	135	110		100.0	89.1	69.5	
371	Iron & steel	80.9	93.6	53	64	35		100.0	94.2	62.1	
372	Non-ferr. metal ind.	153.6	151.6	26	34	27		100.0	130.7	138.1	
380	Machinery	23.3	100.3				133	100.0	62.2	54.7	95.8
381	Metal products	58.5	89.0	462	459	365	358	100.0	90.4	70.5	77.7
383	Electrical machin.	110.3	219.0	86	87	57	59	100.0	95.7	46.8	48.5
384	Transport equipment	51.6	99.2	172	150	94	83	100.0	46.5	22.6	44.1
385	Prof. & scientif. equip.	36.9	54.2	22	15	15	14	100.0	50.6	50.3	91.7
390	Other industries	129.8	130.0	93	77	55		100.0	72.2	36.8	
300	Total industry	90.5	109.3	6112	5645	4342	4378	100.0	94.8	68.2	77.7
	Tot. excluding 372	80.8	102.9	100.0	92.4	71.0	71.6	327026	310115	223138	240885

Sources: No. of establishments and Total employment: 1969 and 1979: INE, IV and V Censo Nacional Manufacturero. 1982: INE, Encuestas Manufactureras Anuales, Santiago.
Evolution of max capacity output: Gatica 1990, Table 2.4: [(1982-83)/(1969-73)]%, using Wharton method estimates refer to industrial gross output and not to industrial value added, that reasonably decreased in years of abrupt opening to international markets.

TABLE 5

BANKRUPTCIES BY SECTOR OF ECONOMIC ACTIVITY, CHILE 1965-82
(yearly averages)

	1965-69	1970-73	1974-76	1977-82	1982
Total	214.0	141.0	79.7	422.5	810
Agriculture	4.2	3.3	1.0	22.8	50
Wholesale & retail trade	184.0	102.7	21.3	158.0	295
Restaurant & hotels	0.2	0.5	0.7	18.7	69
Manufacturing	17.2	12.3	21.0	91.8	150
of which:					
Food, bev. tobacco	1.6	1.3	3.0	14.8	19
Textile, wearing & leather	3.2	3.3	10.7	32.3	53
Wood & furniture	3.8	2.5	2.3	7.8	8
Paper, printing & publishing	0.2	0.8	0.0	5.0	14
Chemicals, petroleum, rubber & plastic	0.6	0.3	0.7	9.2	25
Non-metallic min. products	0.2	0.0	0.0	3.3	10
Basic metal industries	1.4	0.3	0.7	4.5	1
Metal products, machinery & equipment	1.2	2.5	3.7	13.8	19
Other manufacturing	5.0	1.5	0.0	1.0	1

Source: Fiscalia Nacional de Quiebras, Santiago, Chile.

sectors enjoying CA, and that affected the cost and the availability of imported and domestic inputs. Those sectors that could gain CA easily on the basis of the existing endowments of natural resources were favoured, whereas those embodying more complex technologies were heavily and negatively affected (Diagram 2). This evidence is reinforced by the figures on manufacturing export performance, a good proxy for overall industrial performance at an international level.

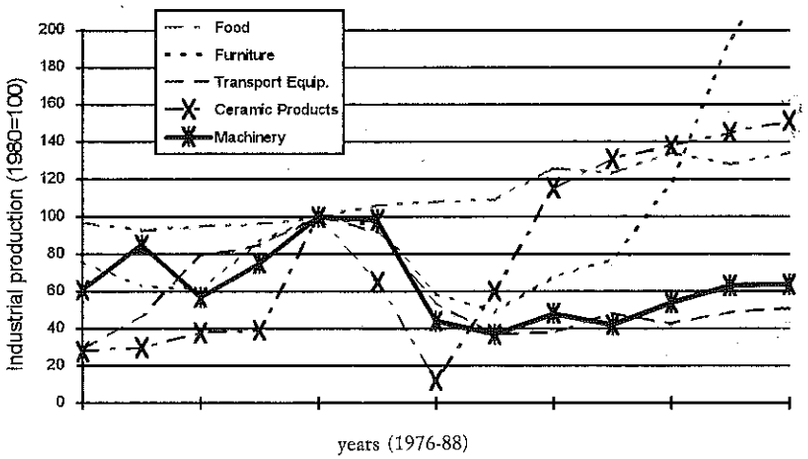
Overall the country experienced a marked export diversification,[14] and also industrial exports (ISIC 300) grew at high rates (Table 6). However, this positive performance is crucially related to the definition of "industry" used, and we need to take a more disaggregated view. Thus, if "Simply refined copper" (ISIC 3720 and

[14] After 1974 the export diversification experienced has had three dimensions; diversification in products, markets and producers (Pietrobelli 1993 and 1994a).

3721) and Fishmeal (ISIC 3198), both substantially natural resources with very little manufacturing, are excluded, the positive assessment of Chile's industrial export performance has to be moderated. In fact, using this more restrictive definition, industrial exports only accounted for 9.4% of total exports in 1970 (11.6% with the broader definition) and rose to 22.9% in 1987, instead of 31.6%, again according to the broader definition (Table 6).[15]

DIAGRAM 2

INDUSTRIAL PRODUCTION, SELECTED SECTORS CHILE 1976-88
(1980 = 100)



However, the diversification away from copper is remarkable, but it reflects a special pattern. The figures show that the most dynamic Chilean exports have been the most natural resource-intensive and those employing the simplest technologies. Chilean manufactured exports have been disaggregated according to the technology required to produce them, and different groups have been identified following two criteria: labour skill intensity and technology intensity, based on the fact that more complex technologies require a

[15] Furthermore, changes in the criteria of export classification followed by the Central Bank may mislead in the interpretation of the figures on "industrial exports"; for example, in 1985 "Fresh fish" was moved from "Agriculture, livestock and seafood" to "Industrial" without apparent reasons.

TABLE 6

STRUCTURE OF TOTAL EXPORTS, CHILE 1970-87
(percentages, from current million US$)

ISIC		1970	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1000	Mining	85.5	91.2	84.3	69.3	69.3	64.0	60.2	61.2	59.3	57.9	59.3	59.9	54.2	61.3	54.9	53.8
1100	Copper	75.5	78.6	77.1	57.4	59.9	54.2	51.3	48.8	46.1	43.9	45.3	47.9	43.3	46.1	41.9	41.2
2000	Agriculture, seafood	3.0	1.9	2.6	5.5	5.7	7.3	8.2	6.8	7.3	9.4	9.8	8.5	11.7	13.1	15.3	14.6
3000	Industrial goods	11.6	6.9	13.2	25.2	25.0	28.6	31.6	32.0	33.4	32.8	30.8	31.6	34.1	25.5	29.8	31.6
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
3198	Fishmeal	n.a.	0.9	1.5	1.9	2.9	3.9	4.3	3.9	5.0	5.2	6.7	8.0	7.5	8.2	7.9	7.0
3600	Basic metal manuf.	2.2	0.5	1.0	3.8	4.6	4.7	5.8	7.9	6.0	5.9	6.4	7.4	6.7	1.6	1.8	1.7
	Industrial less Fishmeal and basic copper prod.	9.4	5.4	10.7	19.5	17.5	20.0	21.5	20.2	22.4	21.7	17.7	16.2	19.9	15.7	20.1	22.9
	Total exports (US$)	1111.7	1305.5	2144.3	1552.1	2082.6	2190.9	2477.7	3894.2	4670.7	3906.3	3821.5	3835.5	3657.2	3823.0	4222.4	5102.0

Note: Data are classified according to a modified version of the ISIC, followed by the Central Bank.
Source: Banco Central de Chile.

more intense use of scientists and engineers, labour paid higher wages, and stronger R&D efforts (Table 7 and Appendix 2).

The Chilean performance in more complex manufactured exports is not satisfactory, and does not compare favourably with other fast developing countries (Pietrobelli 1994c). In 1986, low-skill- and low-R&D-exports accounted for a larger share of manufactured exports than two decades before, and the composition of industrial exports moved towards a pattern intensive in simple technologies.[16]

These results do not hinge on the special methodology employed: even using the classification proposed by the OECD (Table 8) the share of "differentiated" and "science-based" exports stay at very low levels throughout the period, and that of resource-based exports has diminished only slightly: from 96% in 1970 to 90% in 1987. The restructuring of Chilean industry has followed a process of "regressive transformation" (Ominami 1991). Both the shares of intermediate goods (and machinery therein) and transportation equipment have declined steeply in Chile, and industry has become more traditional.

This evidence on international specialization confirms the idea that the considerable increase in specialization and contribution of the manufacturing sector to total exports, has occurred simultaneously with a steep fall in industrial development and technological complexity of the industrial sector. This is contrary to the evolution of the industrial sector of the most dynamic developing countries (Pietrobelli 1994c).[17]

4. Explanations of the industrial response

Different explanations of this poor industrial performance have been given in the literature, and all try to assess the impact on aggregate and sectoral output and employment of a variety of phenomena, including the trade and financial liberalization, the anti-inflationary policies, and international factors.[18] The difficulty they all

[16] This is confirmed by econometric evidence (Pietrobelli 1994b).

[17] Another important structural change that has been noted is the *increase in concentration* during these years (see Section 4 below).

[18] See for example De la Cuadra and Hachette 1991, Gatica 1989, Tybout 1991, Tybout *et al.* 1990, Vergara 1980.

TABLE 7

MANUFACTURED EXPORTS BY TECHNOLOGICAL INTENSITY, CHILE 1966-86
(current US$ million and %)

			1966	1975	1986
	Total X (US$)		4,166	1,649	875
	Manuf. X (US$)		342	142	38
	% of Total X		8.2	8.6	4.3
Percentages of total exports					
	AWG	High	4.2	5.8	3.8
Human		Intermediate	2.7	1.3	0.4
Skill		Low	1.4	1.5	0.2
Intensive	SKR	High	3.6	3.9	2.9
		Intermediate	3.4	3.6	1.3
		Low	1.2	1.1	0.2
R&D	S&ENG Ratio	High	4.0	3.7	3.0
Intensive		Intermediate	2.2	3.6	1.1
		Low	2.1	1.3	0.3
Percentages of manufactured exports					
	AWG	High	50.7	66.9	87.7
Human		Intermediate	32.8	15.2	8.1
Skill		Low	16.5	17.8	4.2
Intensive	SKR	High	43.6	45.6	66.2
		Intermediate	41.6	41.2	29.8
		Low	14.7	13.3	4.0
R&D	S&ENG Ratio	High	48.6	43.2	68.8
Intensive		Intermediate	26.2	41.8	24.3
		Low	25.2	14.9	6.9

Definitions: See Appendix 2. "Manufactures" = ISIC 300 less 311-2 (Food), 353-54 (Petroleum Refinery and Products) and 371-2 (Iron and steel and Non-ferrous metals).

Source: Elaboration from United Nations data.

TABLE 8

PATTERN OF INDUSTRIAL EXPORTS, OECD CLASSIFICATION, CHILE 1970-87
(percentages from current million US $)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1. Resource intensive	96.4	95.1	94.7	96.5	96.3	90.8	90.6	89.7	89.8	92.1	90.2	91.0	91.7	92.7	91.9	92.6	90.2	90.1
2. Labour intensive	0.5	0.4	0.4	0.4	0.5	1.1	2.0	2.1	1.5	1.2	1.1	1.0	0.5	0.4	0.8	0.6	1.4	2.3
3. Scale intensive	2.7	3.8	4.3	2.8	3.0	7.2	6.4	6.9	7.2	5.3	7.8	6.9	6.3	6.3	6.1	6.2	7.7	6.9
4. Differentiated	0.3	0.5	0.4	0.3	0.2	0.8	1.0	1.0	1.1	0.8	0.7	0.7	1.0	0.4	0.4	0.3	0.4	0.5
5. Science-based	0.1	0.2	0.1	0.0	0.1	0.1	0.1	0.4	0.3	0.5	0.2	0.3	0.6	0.2	0.7	0.3	0.2	0.3
Tot. ind. exports	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Note: Definitions given by OECD 1988
1. includes ISIC 31, 323, 331, 3411, 353-4, 369, 372.
2. includes ISIC 321-2, 324, 332, 380-81, 39.
3. includes ISIC 342, 351, 355-6, 361-2, 371, 384.
4. includes ISIC 3821-4, 3829, 383, 3852-3.
5. includes ISIC 352, 3825, 3851, 3845.

Source: CEPAL, Centro de Computos, Santiago, Chile

acknowledge is how to separate the effects of the liberalization from those of the simultaneous recession and anti-inflationary policies.

Another approach, that will be briefly sketched here, emphasizes the role of "Technological Capabilities" (TC) at the firm-level and at the national level to affect industrial performance.[19] TC is *the complex set of human skills and organizational structures required to efficiently utilize a given technology and improve it over time.* Together with entrepreneurial and managerial capabilities, it is the *sine qua non* of efficient and dynamic industrial development. It implies not only the achievement of productive efficiency, but also a deeper understanding of the technological process, its mastery, and the capability of adapting and improving upon it. TCs have a relevance also at a national level.

The attainment of static and dynamic efficiency at the firm-level is the building block of industrial success (Lall 1990 and 1992), but it has received little attention in the debate on the determinants of industrial performance in the Less Developed Countries (LDCs). This is not surprising, given the traditional neo-classical assumptions of small and homogeneous firms, all having equally easy, free and instantaneous access to information, skills and technology.

When industries are started, many of the TCs necessary at the firm-level are absent. These missing TCs may be temporarily obtained at home or imported in an "unbundled" form, but some "core" capabilities have to be developed by firms and expanded over time, especially if the technology is new to the economy. Technology has several "tacit" elements which necessarily involve local effort even when knowledge is transferred from abroad (Nelson and Winter 1982, Pack and Westphal 1986). Moreover, like all skills, TC acquisition involves a process of *learning.* It involves a variety of specialized capabilities, and is partly endogenous to the productive units, so that the effort that each firm puts in creating such TC largely explains persisting differences. This is especially true among LDCs, where the available skills and knowledge are limited, and market failures are widespread.

Although TC is clearly a firm-level concept, it also has a *macro-economic dimension,* and differences in National Technological Capa-

[19] Main references are: Bell and Pavitt 1992, Enos 1991, Katz 1987, Lall 1992 and 1993, Pack and Westphal 1986.

bilities (NTC) contribute to explain divergent economic performances internationally. NTC is *not simply the sum* of individual capabilities developed independently, due to the characteristics of technological knowledge, such as its imperfect appropriability, non-rivalry and its being embodied in human capital, the inter-industry linkages that can help creating new TCs by overcoming uncertainties, scale constraints, lack of external economies, and the policies and institutions that at a national level can enlarge the national endowments of educated manpower and the physical and science and technology (S&T) infrastructures. The interaction between the firms' TCs and all these variables generates NTC, that conditions a country's technological and industrial performance.

What determines *the acquisition of TC* at the firm and at the national level? This process is partly stochastic and partly depends on a host of factors. In an attempt to summarize, three building blocks of NTC can be identified: *incentives, capabilities* and *institutions* (Lall 1992). Importantly, none of these factors operates in isolation. The *interplay* of the incentive structure with the capabilities generated by investments in physical and human capital, and with the institutions supporting the process of firm-level TC creation, is crucial.[20] The *institutional environment* is especially important for this dynamic process of learning and development of TCs. It has to adapt to the needs of industrialization; thus, specific institutions that are especially interesting to us are those related to the provision of training, education, and technical education in particular: these are the markets that more often fail, and where intervention is most necessary. Technology infrastructures and policies are crucial in order to facilitate the creation of the necessary network of information flows between firms and institutions supplying services like the setting of technical standards, quality assurance, testing, information on markets, R&D, etc. Institutions are also needed to remedy the failures of the financial system, the meeting of input and product suppliers and buyers, the inefficiencies of the administration.[21]

[20] The available literature on LDCs' industrialization has emphasized the relevance of the structure of incentives, namely trade regimes (Balassa 1989). Yet, *the response to those incentives has often been implicitly taken for granted.*

[21] Enos (1991) also emphasizes the function that institutions play in pulling together individual skills, and instilling them with a "common purpose".

Firstly, the "effort" dimension referred above is justified by the existence of adequate *incentives*. At the national level, the incentives that are deemed most important to boost the creation of NTC are those arising from external policy (trade strategy) and from internal policy (resource mobilization and industrial policy). Market prices sometimes do not produce correct incentives for investments in physical capital or TCs. Such market failures occur because of externalities, "learning to learn", capital market failures, risk and uncertainty (OED 1992). In these circumstances, the setting of "correct" incentives as given by free market prices may not be a sufficient condition for effective and competitive industrialization, and require interventions.

There is widespread consensus that, *ceteris paribus*, outward orientation and competition, both domestically and on international markets, provide more effective incentives for industrial development than the opposite alternatives of inward oriented and strongly protectionist policies (Balassa 1989). However, competition is a double-edged sword, and may be potentially harmful to weak and incipient manufacturing sectors, requiring a longer activity to reach efficient production. As far as *trade policy* is concerned, export orientation does not imply *laissez faire* and absence of intervention. On the contrary, because of the failure of the markets of knowledge and information, especially frequent in LDCs (Stiglitz 1989), functional and selective interventions may have to go *together with* a necessary competition policy.[22]

In Section 2 we have outlined how Chile was discriminating heavily in favour of its domestic market in the '60s. After 1974 its trade policy provided strong macroeconomic incentives for readjustments, but these were not constant over time. Thus, confusing signals came from the exchange rate appreciation in 1979-82 (Table 1) and the sky-rocketing real interest rates in the same years. Unlike other Newly Industrializing Countries (NICs), Chile's export-led strategy, at least until 1984, did not imply any selective support, and was based only on liberalization and the elimination of the bias in favour of domestic activities. These conflicting signals and the general uncertainty confused and misled the entrepreneurs during these years, and

[22] "Functional" government intervention does not discriminate between activities, whereas "selective" intervention explicitly provides support to selected activities (OED 1992).

prevented new export-oriented investments for some time. They clearly hindered the development of more complex manufactured exports.[23]

Industrial policies provide the other major source of macro-incentives to NTC creation.[24]

In Chile, the extent of state intervention in the economy decreased significantly in the first years after 1973. Resources were to be assigned according to the market, and competitive markets would replace protection and regulations. Only after the 1981-82 productive and financial crisis did the state increase its role in the economy, especially in the banking sector, when the Central Bank intervened to rescue many banks near to bankruptcy (Muñoz 1986, p. 285). But in the manufacturing sector nothing similar happened.

After 1973, widespread privatization further strengthened the traditional feature of the Chilean economy of a segmented, highly concentrated and oligopolistic structure. A handful of *grupos económicos* acquired large ownership shares at bargain prices, mainly because of their access to foreign credit, and raised inter and intra-industry concentration rates (Yotopoulos 1989, Galvez and Tybout 1985). By the end of 1978, five economic conglomerates controlled 53% of total assets of Chile's 250 largest private enterprises. Nine conglomerates, including those five, controlled 82% of the assets in the Chilean banking system (Dahse 1979). This rising concentration of ownership of industrial and financial assets was fostered by government policies in many ways (Foxley 1983). Differential access to foreign credit ensured large financial profits, the auction of state enterprises had an implicit subsidy equivalent to 30% of the firms' net worth, and relative prices (real wages net of social security and physical productivity, sale and export prices) moved in a direction favourable to large productive enterprises. Nevertheless, the government did not provide the *grupos económicos* with incentives and regulatory mechanisms to deepen and upgrade their industrial activities. Only the incentive of aggressive import competition was present, without support for the restructuring (relearning) process and

[23] This is confirmed by microeconomic evidence (chapter 5 in Pietrobelli 1994a, and Corbo and Sanchez, 1985).

[24] If completely free trade were realized, and transport costs were uniform across industries, domestic competition would cease to be an independent incentive to NTC building investments. However, to the extent that some degree of protection remains, and transport costs differ significantly, domestic competition is expected to be of autonomous policy significance for LDCs.

without schemes to direct the conglomerates to invest in TC creation. In other words, the internalization of markets by *grupos* did not remedy market failures, but may have exacerbated them.

Technology policy has been fragmented or lacking totally, with the exception of an institution, set up as a result of the interaction between a US corporation and the Chilean government, with the aim of transferring foreign advanced technology to the country (*Fundación Chile*, see Pietrobelli 1994a, ch. 5 and Meissner 1988).

Summarizing, during the years of the conservative "experiment" the major source of competitive pressure came from the international competitors more than from the local ones, and the former was introduced too quickly and forcefully to let local producers restructure, relearn and survive. The strengthening of the *grupos económicos* did not lead to healthy competition in the domestic market. Nor were the *grupos* given the necessary incentives or the domestic learning base and access to capabilities to invest in TC creation. The large Korean *chaebol* played a very different role under this respect: these large conglomerates were all new and selected on the basis of export performance, and worked as agents of the government industrial policy.

We can summarize on incentives by saying that in these years in Chile the strongest incentives were provided by the thorough trade liberalization, but due to some misleading (and temporary) changes, they tended to give conflicting and misleading signals. Industrial policy was nearly absent, with the large *grupos* that were not forced to exploit the same opportunities to learn and overcome market failures as in other NICs, where more complex manufacturing activities developed. Thus, important dimensions of the NTC building incentives were missing.

Investment in *capabilities* to increase physical and human capital, create specialized skills, improve the organization of production and marketing, including the establishment of an effective network of industrial suppliers, consultants and service firms, is also a crucial factor for TC acquisition. Market failures here arise from externalities, imperfect foresight, missing markets, lumpiness, inappropriability, etc. The human capital needed for industrialization can be created in several ways. The higher and the more advanced the education is, the more likely is its relevance to more technically complex industries. Thus, higher levels of technical education, science and engineering and vocational training are needed to cope with more complex and changing technologies.

TABLE 9

HUMAN CAPITAL AND TECHNOLOGY INVESTMENT AND STOCKS

	Year	Chile	Comparators Colombia	Korea
Education (% age group enrolled in):				
primary education	1965	124	84	101
	1986	110	114	94
secondary education	1965	34	17	35
	1986	70	56	95
tertiary education	1965	6	3	6
	1986	16	13	33
Orientation of education				
Scientific students ratio	1975	49	36	49
	1985	53[d]	39	42
Vocational education	1975	1,15	0,71	12,37
(per million population)	1986	10,30	15,23	19,2[g]
(% manuf. empl. 1987)	1986	20,9	54,1	18,3
University students	1986	132254[d]	320371	1080483[g]
(% of population)		1,09	1,10	2,60
Engineering students only	1986	54412[d]	95280	227640
(% of population)		0,45	0,33	0,55
Educational effort				
Public exp. education	1975	4,1	2,2	2,2
(% GNP)	1986	4,5[e]	2,9	4,5
Private Exp. in Education	1980-85	6	5	9
(% of house-holds consumption)				
Formal technological effort				
Total R&D	1975	0,1	0,1[a]	0,5[b]
(% GNP)	1986	0,5	0,1[c]	1,8
R&D in prod. sector (% GNP)	1986	0,002	0	1,4
R&D financed by productive enterprises (% GNP 1985)	1986	0,001	0	1,7
Scientists & eng. in R&D	1975	575	50[a]	291
(per million population)	1985	422*	40[c]	1120[f]
Technicians in R&D	1975		28[e]	257
(per million population)	1984		38[c]	725[f]
Patents to nationals	1986	455[e]	169	2581
(% of total patents)		(9,7)	(8,3)	(69,0)

Notes: [a] 1971 [b] 1976 [c] 1982 [d] 1984 [e] 1985 [f] 1986 [g] 1987 *(S&ENG + Technicians).

Definitions: Scientific students' ratio = (students in natural science, maths and computer sciences, medical and health-related sciences, engineering, arch. and town planning, trade, crafts and industr. programmes transport and communications, agriculture, forestry & fishing programmes)/total third level students *R&D Activities* = the branch of scientific and technological activities dealing with all systematic creative work undertaken in order to increase the stock of knowledge and the use of this knowledge to devise new applications. S&ENG = persons with scientific or technological training (usually at the third level) who are engaged in professional work on R&D activities, administrators and other high-level personnel who direct the execution of R&D activities; *Technicians* = persons engaged in that capacity in R&D activities who have received vocational or technical training.

Sources: UNESCO, various years; World Bank, various years; WIPO, various issues; IAB 1988.

Chile has had very high enrolment rates in primary education for many years. Moreover, the technical orientation of education (53% according to the UNESCO "scientific students' ratio") may increase the effectiveness of education on NTC creation. Also the indicators on the stock of human capital confirm that Chile has a relatively good and broad educational base, and that it has had it for quite a long time.[25,26] However, the outflow of qualified professionals during the years of the dictatorship has probably had a negative impact on the country's stock of human capital.

Summarizing on human capital, Chile shows to have a general educational level high for an LDC (although lower than a dynamic NIC like South Korea), and reflects a technical orientation. Secondary and tertiary education enrolment rates have always been high. A possible weakness lies in the few students in vocational schools, an important source of intermediate technical skills.

The existence of skills by itself is not sufficient to explain NTC. It has to be combined with purposeful *technological effort*. Following our simplified approach, technological efforts and technology sourcing are the third fundamental determinant of the capabilities that, together with incentives and institutions, determine NTC. Two related aspects are relevant to this issue: the intensity and direction of local technological efforts, and the country's strategy to acquire (and import) technology.

Measures of technological effort should take into account all the efforts of assimilating technology, adapting it to local conditions, mastering production process and design, trouble-shooting at the shop-floor level, experimenting new products and processes. Unfortunately, only very aggregate measures of the efforts are available, such as the expenditure in formal R&D. This is more important at higher levels of industrialization with high-tech, large scale indus-

[25] Meller moderates this view, when he recalls that until the late 1950s there was a complete lack of concern about the development of domestic human capital capacity, and no training of engineers and technicians specializing in copper. Until very late, little (if any) of the resources earned from exports (and their taxation) of nitrates (1880-1930) and copper (since 1920) were being invested in human capital formation. It took many years to develop a domestic capacity to analyze the role of copper and to educate Chilean professionals and technicians, to the extent that: "... it was often stated that one could learn more about Chilean copper in foreign libraries than in the national one" (Meller 1991, p. 44).

[26] The famous Harbison-Myers index computed for 1958 confirms this idea, with Chile at the high level of 51, and South Korea at 55.

tries.[27] Chile is still at a very low level of R&D expenditures, much lower than what has been recorded by the successful East-Asian NICs. A partial correction for the shortcoming of these figures, including only "formal" technological efforts, is provided by the information on R&D expenditure in the productive sector and financed by productive enterprises. This expenditure is the most relevant to industry and its dynamic development, as it only includes R&D expenditures considered useful by productive enterprises. However, these figures do not modify the above conclusions for Chile.

TABLE 10

FORMS OF TECHNOLOGY IMPORTS

	Imports of capital goods								
	(mill. curr. US$)			% of GDI			% of MVA		
	1965	1975	1986	1965	1975	1986	1965	1975	1986
Chile	203,4	501,4	1056,9	22.6	53.5	43.0	13.6	34.2	19.3
Colombia	205,9	582,8	1165,2	20.1	26.2	20.2	22.2	24.6	22.4
Korea	73,1	1909,3	10787,9	16.1	33.4	37.6	10.4	34.5	36.6
	Net foreign direct investment flows								
	Annual Avg. (mill. curr. US $)				% of GDI				
	1970-74	1975-79	1980-84	1985-87	1970-74	1975-79	1980-84	1985-87	
Chile	-141,6	95,0	223,0	72,0	(-9.5)	(4.5)	(5.4)	(2.6)	
Colombia	30,8	51,8	338,2	658,7	(1.7)	(1.4)	(4.6)	(14.0)	
Korea	73,2	55,6	-1,4	314,3	(2.3)	(0.4)	(-0.0)	(1.0)	

Source: IMF various years, World Bank 1987; UNCTC 1986; ESCAP 1988. "Capital goods" = SITC 7000, "Machines and Transport Equipment".

These data on local technological effort are intrinsically related to the country strategy to import technology from abroad. This technology acquisition can take a formal or an informal form, depending on whether it is paid for and subject to contract or simply transferred through observation, publications, imitation, embodied in skilled people shifting from one country to the other, or flowing from

[27] In all industries, however, the role that R&D has in developing a firm's "learning" and "absorptive capacity", *i.e.* its ability to identify, assimilate, and exploit knowledge from the environment, and not only to "create new knowledge", must not be underplayed (Cohen and Levinthal 1989).

foreign buyers to developing countries' manufacturers. The major forms of formal technology transfer from abroad are: imports of capital goods, foreign licensing and foreign direct investment. These forms vary in the extent of the local TC required, ranging from foreign direct investment (FDI), that requires the least developed local NTC, to the import of only capital equipment at the opposite extreme. Chile liberalized its foreign trade since 1974, thereby easing the access to modern capital goods for national manufacturers. It has depended heavily on "packaged" imports of technology via FDI (contrary to South Korea), but it has made little formal effort to assimilate and build upon that technology, and set up insufficient infrastructures to support local TC building.

5. Concluding remarks

Chile thoroughly liberalized its international exchanges since 1974. The industrial response to the structural reforms implemented has been slow, with widespread deindustrialization and the development of industry along a pattern favouring technologically simple activities only after 1984. This is confirmed by the evidence on international specialization.

The explanation that has been suggested here is that Chilean manufacturing activities did not perform well, given the existing level of NTC, because some crucial determinants of NTC were missing, namely industrial and technology policies. Moreover, little effort was devoted to investing in the creation and improvement of NTC, that thus failed to improve and grow in depth and extension.

The incentives deriving from the international trade orientation provided a strong inducement to compete. However, due to some misleading (and temporary) changes, they tended to give conflicting and misleading signals until 1982. This may have prevented new export-oriented investments for some time, hindering the development of technologically complex exports. The evidence presented suggests that the strong incentives from the broad liberalization were sufficient to determine a strong response of the simpler-technology activities, but the absence of selective support (designed in function of the learning requirements of individual technologies) and the little

formal (and informal) technological efforts may have prevented the upgrading of more complex manufactures. Little technological effort was exerted, and expenditures on R&D stayed at very low levels, especially those undertaken by productive firms (the most relevant to industrial development). The high level of human capital, in spite of the large outflows after 1973, allowed some technological upgrading to take place, but this was constricted to sectors with natural CA (resource-based). The upgrading did not reach into more demanding activities in manufacturing, where some selective and temporary protection, and careful support, were needed.

An interesting result of this study is to suggest how good education and favourable incentive structures have not been enough, in Chile's case, to produce strong progress until the late 1980s. Now the situation is improving, but it has been preceded by many years of very poor manufacturing performance. Competitive inducements to NTC creation have to be provided by the policies ruling international trade and domestic resource allocation, but taking into account the need for infant industry protection. Investments in physical and human capital have to go together with technology efforts, both of a formal (R&D and education) and informal (training, plant-level product and process development) nature. The institutional framework for technology and exports has to remedy market imperfections and failures, widespread everywhere and especially in LDCs. Finally, the potential for learning and internalizing missing markets that large conglomerates offer should be explored, together with the design of the incentive mechanisms to induce the necessary inter-firm competition. Future policies must take all this into account.

APPENDIX 1

TABLE A.1

SELECTED MACROECONOMIC INDICATORS, CHILE 1960-88

	1	2	3	4	5	6	7	8	9	10	11	12
Year	GDP growth	Inflation	Absorption	Public deficit	Investment rate	Real i rate	i rate spread month	Real wage	Unemployment rate	Foreign debt	Copper price	Terms of trade
	% change											
1960	4,8	11,6	6,1		13,9			45,8	7,4	1010	30,8	139,9
1970	2.1	32.5	1.8	6.7	16.4	6.7		82.1	7.1		64.2	226.1
1973	–5.6	487.5	–6.2	30.5	7.9			58.6	4.6	4048	80.8	187.2
1974	1.0	497.8	2.4	5.4	21.2			55.5	9.7	4774	93.3	197.8
1975	–12.9	379.2	–20.8	2.0	13.1	15.4	–3.17	53.9	16.2	4854	55.9	118.5
1976	3.5	234.5	0.2	–3.9	12.8	51.2	2.64	59.8	16.8	5233	63.6	127.8
1977	9.9	113.8	14.2	–0.4	14.4	39.2	1.02	72.6	13.2	5613	59.3	114.4
1978	8.2	49.8	9.7	–1.5	17.8	35.1	1.67	83.0	14.0	7011	61.9	111.0
1979	8.3	36.6	10.5	–4.8	17.8	16.6	1.38	92.1	13.6	8663	89.8	118.5
1980	7.8	35.1	9.3	–5.4	21.0	12.2	1.49	100.0	11.8	11207	99.2	100.0
1981	5.5	19.7	11.6	–0.3	22.7	38.8	1.59	109.0	11.1	15591	78.9	84.3
1982	–14.1	9.9	–24.1	3.4	11.3	35.1	1.36	109.3	22.1	17159	67.1	80.4
1983	–0.7	27.3	–4.6	3.3	9.8	15.9		97.3	22.2	18037	72.2	87.5
1984	6.3	19.9	8.5	4.5	13.6	11.3		97.6	19.2	19659	62.4	83.2
1985	2.4	30.7	–1.9	2.9	14.6	11.1		93.2	16.3	20403	64.3	78.5
1986	5.7	19.5	5.4	1.6	14.7	7.7		94.4	13.5	20716	62.3	82.0
1987	5.7	19.9	7.3	–0.3	16.9	9.4		94.7	12.3	20551	81.1	77.0
1988	7.4	14.7	8.9	–3.6	17.0	7.4		102.8	11.2	19186	117.9	–

Notes to columns.

[1] Current GNP per capita, US$.
[2] CPI annual changes. From 1971 to 1979, CPI revised by Cortazar and Marshall 1980.
[3] Private C + public C + total I, 1961 for 1960.
[4] As a % of GDP. Considers general government and public enterprises.
[5] As a % of GDP, constructed from current values.
[6] Yearly equivalent of real interest rates (deflated by the CPI) on short-term unindexed loans in pesos (30-90 days). 1988 August.
[7] Average spread between bank deposit rates in Chile and LIBOR. Monthly rates.
[9] Greater Santiago, as computed by Universidad de Chile.
[10] Total external debt at the end of each year, including IMF but excluding debt payable in domestic currency; 1961 for 1960, 1973-76 excluding IMF; 1988: August. Million US$.
[11] Cents per lib.

Source: Banco Central de Chile.

TABLE A.2

COMPARATIVE ECONOMIC PERFORMANCE, CHILE 1950-87

Years	Manufacturing GDP				
	Chile	Latin America	Argentina	Brazil	Colombia
1950	100.0	100.0	100.0	100.0	100.0
1955	120.9	135.4	121.5	148.1	139.6
1960	157.7	186.5	149.7	240.2	187.6
1965	211.4	253.4	202.1	288.3	246.0
1970	264.6	364.5	259.1	467.3	335.6
1974	276.1	499.5	315.1	753.7	474.2
1975	205.9	505.3	306.9	782.5	480.2
1976	218.0	541.1	297.7	878.0	501.3
1977	236.7	560.9	320.9	898.0	508.5
1978	258.6	584.0	287.1	952.3	558.9
1979	279.1	628.0	315.7	1017.8	593.1
1980	296.2	662.9	304.4	1110.0	600.3
1981	304.0	627.5	256.3	994.5	584.7
1982	240.3	612.2	243.2	990.1	575.7
1983	247.7	587.2	267.9	929.0	582.3
1984	271.7	618.0	278.2	986.7	617.7
1985	274.9	644.5	249.6	1068.9	635.7
1986	296.8	685.5	281.6	1188.8	677.7
1987	313.1	699.0	280.1	1201.0	718.0

Source: Joint Industry and Technology Division, ECLAC-UNIDO.

TABLE A.3

INDUSTRIAL PRODUCTION, INDEX NUMBERS, CHILE 1976-88
(1980 = 100)

ISIC		1976	1979	1981	1982	1988
311	Food	97	96	106	108	134
313	Beverages	70	103	108	92	118
314	Tobacco	84	95	88	73	86
321	Textiles	88	103	94	69	124
322	Wearing apparel	67	81	118	64	98
323	Leather & products	124	92	111	83	56
324	Footwear	139	144	104	86	103
331	Wood and cork	111	125	94	75	110
332	Furniture	76	87	95	59	244
341	Paper & products	93	110	109	91	135
342	Printing & publishing	49	54	100	91	108
351	Industrial chemicals	80	100	89	70	118
352	Other chemicals	72	115	105	95	126
353	Petroleum refineries	85	105	95	74	108
355	Rubber products	70	81	91	62	95
361	Ceramic products	28	39	65	12	151
362	Glass & products	91	106	93	50	129
369	Other non-metal. minerals	59	86	115	64	130
371	Iron & steel	60	87	90	60	120
372	Non-ferr. metal industries	77	103	99	108	123
380	Machinery	61	75	98	44	64
381	Metal products	65	99	106	83	118
383	Electrical machinery	50	88	96	52	124
384	Transport equipment	29	85	92	54	51
390	Other industries	120	90	151	70	58
300	*Total manufacturing*	*74*	*94*	*101*	*85*	*119*

Sources: INE, *Encuestas Manufactureras Anuales*, Santiago. In principle, establishments employing 10 or more persons.

APPENDIX 2

Methodology to classify exports according to labour skill and technological intensity

Exports have been classified into two sub-groups from the ISIC data for the three sample countries.

Sectoral data are taken from: Instituto Nacional de Estadisticas, *Cuentas de producción nominales de la industria manufacturera*, Santiago, Chile, and from: U.S. National Science Foundation, *National Patterns of Science and Technology Resources*, 1982, NSF 82-319 for the figures on R&D and S&ENG.

1. Labour skills intensity

using two different statistical indicators: average wage (AVGW, in current pesos) and "skill ratio" (SKR, non-operative/operative workers).

Average wage: low < 400
intermediate $400 < x < 700$
high > 700

Skill ratio: low < 0.25
intermediate $0.25 < x < 0.32$
high > 0.32

2. Research & development intensity

using two different indicators: R&D expenditures on total sales (%, RD) and Scientists & Engineers employed in each sector's activity (%, S&ENG).

R&D: low < 0.8
intermediate $0.25 < x < 3$
high > 3

S&Eng: low < 12
intermediate $12 > x > 35$
high > 35

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