WAS IMPORT-SUBSTITUTING INDUSTRIALISATION IN BRAZIL A FAILURE? EVIDENCE FROM THE TECHNOLOGICAL STRUCTURE OF EXPORTS, 1945-1973

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Interpretations of Brazil's industrial development during the twentieth century have undergone substantial changes in past decades. Up to the early 1960s, there was a positive view of past achievements and a feeling that a newly industrialising country such as Brazil, despite all the appalling social inequalities and chronic external imbalances, had been successfully going through the phases leading to a mature industrial economy, in a Rostowian fashion. Three decades later, however, general opinion had radically changed. Scholars were almost unanimously pointing out the historical distortions and inefficiencies involved in Brazilian industrialisation, which qualified the results achieved in terms of industrial growth and diversification. And some considered the legacy to be even worse, seeing Brazil's industrialisation process as a conspicuous example of the failure of a protectionist, inward-looking, import-substituting industrialisation model in Latin America - an example in sharp contrast to the successful cases of emerging East Asian industrial powerhouses. In this view, import-substituting policies not only reduced short-term social welfare but, more importantly, kept industry in a state of lack of competitiveness and technological inertia.

The present article is an attempt to assess the latter view in its more robust claims, i.e., that import-substituting policies caused technological stagnation in the long run, by using new estimates of the technological content of Brazilian manufactured exports during the classic period of import-substituting industrialisation after World War II. The article begins with a review of macroeconomic data and of the issues involved, followed by presentation and analysis of the data on the technological content of exports. The next section examines how empirical results could be explained theoretically. The final section summarises the findings and draws the main conclusions.

1. The main issues

Brazil's late industrialisation has been investigated from many angles. There is little disagreement about the rapid industrial growth that occurred from the late nineteenth century onwards, which led the country to be the 10th largest world economy in 1960. Such a performance, in turn, is usually set in the context of highly regressive wealth and income distribution which, if not reinforced, was at least not substantially modified by the rapid

industrialisation process during the twentieth century. Similarly, another drawback associated with Brazilian industrialisation is its lack of technological dynamism, despite noticeable economic growth. Indeed, recent scholarship has emphasised the negative impacts of import-substituting policies, in which technological innovation is usually presumed to be virtually absent. From this point of view, economic historians have reassessed Brazil's industrialisation by seeing it as an artificial process, which relied on trade protection, subsidies, and distortive state intervention.

The following section contains data which illustrates the historical record of industrial growth and its features in post-war Brazil. This is complemented by a summary of the view which addresses the negative impact of import-substituting policies on the manufacturing industry. The aim is to identify the main hypotheses about the link between those policies and the predicted effects on technological performance.

Growth and distortions

Viewed from a long-term perspective, the Brazilian historical experience in the twentieth century represents a classic example of profound economic and social change brought about by a rapid process of industrialisation. In 1900, Brazil was only ranked third in Latin America after Mexico and Argentina (22nd in the world) in terms of GDP (Gross Domestic Product). Fifty years later, Brazil had already become the largest Latin American economy (11th in the world). By 1973, the Brazilian economy was consolidated as the biggest in Latin America and ranked among the major economies in the world (10th in the world), with the average growth of GDP between 1945 and 1973 achieving 6.7 per annum.[1]

The rise of the Brazilian economy in the twentieth century was largely a result of a substantial expansion of industry. The average growth of industrial output between 1945 and 1973 reached 9.1 per annum.[2] This performance led to major structural changes as measured by sectoral shares of GDP. The industrial sector increased its share of the country's total output from 14.0 per cent in 1910 to 20.8 per cent in 1940 and 35.8 per cent in 1970. As can be seen from Table 1 below, this increase in industry's relative share of national output took place at the expense of agriculture, which witnessed a reduction in its share from 35.8 per cent in 1910 to 25.0 per cent in 1940 and 11.5 per cent in 1970.

[1] Data from Maddison, *Monitoring*, pp. 180-92.

[2] Calculated from Zerkowski and Veloso, 'Seis décadas', pp. 337-8.

Table 1. Sectoral shares of GDP, 1910-70 (per cent)

Year	*Agriculture*	*Industry*	*Services*
1910	35.8	14.0	50.2
1920	31.9	17.1	50.9
1930	30.6	16.5	52.9
1940	25.0	20.8	54.2
1950	24.3	24.1	51.6
1960	17.8	32.2	50.0
1970	11.5	35.8	52.6

Note: GDP at factor prices.
Source: Abreu and Verner, *Long-term*, p. 26.

The magnitude of industrial change can also be seen from the structural transformation from traditional to non-traditional industries; the latter understood as more sophisticated, requiring manufacturing activities in terms of labour skills and technology. This is a rather rough classification, since it arbitrarily puts together activities which may have quite different levels of skills and technology. For a while, however, this taxonomy can be useful as a first approximation of the changes in industrial structure and a more accurate picture will be presented in section 2. The share of non-traditional industries so defined grew from 29.0 per cent of a proxy of total value added in the manufacturing industry in 1939, to 58.4 per cent in 1975, as shown by Table 2. New manufacturing activities such as metallurgy, mechanical, transport materials and chemicals grew rapidly between 1939 and 1975. By contrast, traditional manufacturing industries, established back in the nineteenth century, experienced a sharp relative decline, the most noticeable case being that of the textile industry, which saw a reduction in its relative share of the country's manufacturing value added from 21.8 per cent in 1939 to 6.1 per cent in 1975.

Table 2. Distribution of value added (proxy)[a] of non-traditional and traditional products in the manufacturing industry, Brazil, 1939-1975

Industry	*1939*	*1949*	*1959*	*1970*	*1975*
Manufacturing industry	100.0	100.0	100.0	100.0	100.0
Total non-traditional products	*29.0*	32.8	47.4	53.8	58.4
Metallurgical	7.5	9.4	11.8	11.6	12.6
Mechanical	-	2.1	3.4	7.1	10.3
Electrical materials	5.4	1.6	4.0	5.4	5.8
Transport materials	-	2.2	7.6	8.0	6.4
Chemicals	6.6	5.3	8.6	10.0	12.0
Pharmaceutical products	2.7	2.8	2.5	3.4	2.6
Paper	1.5	2.2	3.0	2.6	2.5
Non-metallic mineral products	5.3	7.1	6.6	5.9	6.2
Total traditional products	*71.0*	67.2	52.6	46.2	41.6
Textile	21.8	19.6	12.0	9.3	6.1
Food products	23.3	20.5	16.4	13.5	11.3
Other traditional products[b]	25.9	27.1	24.2	23.4	24.1

Source: IBGE, *Estatísticas históricas*, p. 386.
Notes:
(a) *valor da transformação industrial*, used as a proxy to the industrial value added: see, IBGE, *Estatísticas históricas*, p. 370.
(b) other traditional products include wood, furniture, rubber, leather, perfumes, soaps and candles, clothing and footwear, beverages, tobacco, printing and publishing, and miscellaneous.

The rapid industrial growth and structural change in Brazil outlined so far were stimulated by a diversified mix of economic policies, which included multiple exchange rates, quantitative import restrictions, foreign exchange controls, tariffs, and fiscal and credit subsidies. Initially, these tools were often a product of balance-of-payment crises and attempts to achieve external balance. From the mid-twentieth century, however, promoting manufacturing activities also became an explicit economic policy target by successive governments. Restrictive licenses for imports, along with an overvalued exchange rate (1947-1953), multiple exchange rates (1953-1964) and tariffs (from 1957) were often devised to reduce industrial imports in favour of domestic production. Local companies could also resort to legislation entitled ‘similar domestic production’ (*Lei do Similar*) which allowed them to apply for the prohibition of imports of a specific product, and to supply it domestically. Perhaps the best illustration of these trends in the post-World War II era was the massive programme of subsidy, credit, market reserve and foreign exchange benefits adopted in favour of the motor industry and intermediate goods, the Targets Plan (*Plano de Metas*), between 1956 and 1960. The Targets Plan was particularly successful in its aim of setting up industries

- parts and motor vehicles - with strong forward and backward linkages and externalities, which acted as powerful incentives for developing more diversified and sophisticated manufacturing activities.[3]

Despite the myriad policy tools adopted in Brazil after World War II, the *rationale* behind the tool was already relatively clear in the 1950s. Protection of industry should be kept at a high level, both to redress balance-of-payments imbalances and to foster import substitution of all ranges of goods which could be replaced by those of domestic production. Estimates of trade protection in the manufacturing industry can be seen in Table 3 below.

Table 3. Nominal protection in the manufacturing industry, Brazil and European Economic Community, c. 1960 (per cent)[a]

Industries	*Brazil*[b]	*EEC*[c]
Manufacturing industry (97 products)[d]	*165*	*17*
Non-metallic mineral products (2 products)	33	10
Metallurgy (12 products)	79	7
Machinery (20 products)	73	11
Electrical materials (10 products)	302	17
Transport materials (10 products)	170	17
Furniture (1 product)	336	18
Paper and products (1 product)	36	6
Rubber products (2 products)	106	21
Leather products (1 product)	336	19
Chemicals (13 products)	109	11
Perfumes and soaps (1 product)	325	19
Textiles (4 products)	248	9
Clothing and footwear (3 products)	345	21
Food products (16 products)	238	37
Beverages (1 product)	346	13

Source: Macario, 'Protectionism', Annex III. Industries reclassified by the author.

Notes:

[a] *Ad valorem* incidence of duties and charges in Brazil and EEC. Products included are 'the most representative of the production and trade of the countries concerned', Macario, 'Protectionism', p. 74.

[b] Duties and changes in March 1962.

[c] Duties and charges c. 1960.

[d] Manufacturing industry averages are weighted by the number of products in each group.

As Table 3 shows, by the early 1960s, nominal protection (measured by charges and duties on imports) in Brazil was very high, as well as being indiscriminate, with an average of 165 per cent over import prices in the manufacturing industry, compared to an average of 17

[3] Shapiro, *Engines.*

per cent in the European Economic Community (EEC). Two features can be stressed regarding specific classes of products. Long-established industries, such as the textile industry, enjoyed particularly high protection rate (248 per cent over import prices) and defied the logic of infant industry, which commended only a transitory period of protection for new industries, before being left to compete with imports. This pattern is also evident in other non-durable consumer goods industries: for example, food products, with an average of 238 per cent over import prices.

Also, modern industries benefited from exceptionally high trade protection, even though well-established foreign companies had a substantial share in these new branches of the manufacturing industry.[4] A case in point was the production of electrical consumer goods and motor vehicles, in which the incidence of duties and charges on imports was over 300 per cent.[5] The logic of the protection policy was also apparent in the industries with relatively lower levels of nominal protection, such as metallurgy and machinery (79 and 73 per cent, respectively), since their duties and charges too were quite high by international standards (compared to the EEC, for example).

These trends shown by data on nominal protection are confirmed by estimates of effective protection; that is, with value added taken into account, along with final prices, for calculating trade protection. In fact, there is evidence that the effective rates of protection were even greater than nominal rates in Brazil's manufacturing industry. Again, the most favoured industries were those which were already mature in the 1960s. In 1966, for example, estimated nominal protection was 101 per cent, whereas effective protection rates reached 136 per cent for rubber products. Likewise, nominal protection was 181 per cent and effective protection 379 per cent for textiles, and 226 per cent and 337 per cent for clothing, respectively. Estimates for the manufacturing sector as a whole also indicated differences between nominal and effective rates of protection, at 96 per cent and 113 per cent, respectively. In 1954, the same indicators for the manufacturing sector in Norway, another developing country included in the sample, were just 8 per cent.[6]

The effects of high protection were clearly perceived as far back as the heyday of import substituting industrialisation. Early in the 1960s, for example, the Economic Commission for Latin America (ECLA) published a thorough study by one of its economists,

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[4] [quote data on shares.]

[5] Macario, 'Protectionism', Annex III.

[6] Balassa, 'Nominal', table 3.1, p. 54; Bergsman and Malan, 'Structure', table 6.6, p. 120.

Santiago Macario, in which he argued that the fundamental principle of the protectionist policy in Latin America had been one that pursued 'the idea that imports of all goods which [were] or [might] be produced in the country concerned should be prohibited, or subject to prohibitive duties'.[7] Indiscriminate protection and import substitution at any cost was a strong incentive to the development of inefficient industries. Shielded from external competition, Macario pointed out, domestic firms could charge high prices and had little incentive to produce efficiently. Moreover, by negatively affecting productivity and competitiveness, the protectionist policy also hampered the development of manufacturing exports and aggravated external vulnerability. The message was the same as that conveyed by similar studies: that Brazil and other Latin American countries had been nurturing major inefficiencies and distortions in their otherwise noticeable process of industrial growth and diversification.[8]

Despite strictures on the way in which import substitution had been carried out in Brazil and other Latin American countries, Macario argued that trade protection was a legitimate means of promoting the development of new industries which would have the potential to stand up to foreign competition. He argued for a 'rational protectionist tariff', to be established according to the 'stage of development of the national economy' and designed to provide moderate and temporary protection only for new and promising industries. In other words, the problem was not with the protection itself, but rather with the policy of indiscriminate trade barriers and import substitution at any cost which historically prevailed in Brazil and other Latin American countries.[9] As we will see below, this is a quite different point.

Recent views

A branch of recent scholarship has developed a more pessimistic view of the import-substituting industrialisation than that presented by Macario and others in the 1960s and 1970s. In what can perhaps be interpreted as an attempt to expand the criticisms by present-minded analyses of the failures of the inward-looking model in the 1980s and 1990s, a group of economic historians has provided a long-run perspective of the underlying causes of substandard economic performance by Latin America compared to the East Asian economies. The main issue raised by this perspective has not been about the short-term, static effects of protection on social welfare – although these distortions remain central to the argument. More

[7] Macario, 'Protectionism', p. 75.
[8] *Ibid.*, pp. 78-83; Balassa *et alli*, *Structure of protection*; Bergsman, *Brazil*.
[9] Macario, 'Protectionism', p. 85. Recent versions of this argument can be found in Thorp, *Progress*, ch. 6.

important are the dynamic effects of protectionism. Exceptionally high trade protection is seen as the major, or only, factor responsible for what has been supposed to be a lack of innovation and technological change in Brazilian industrialisation.

Actually, the argument is not so clearly formulated. Instead, technological inertia is assumed to be the logical outcome of distortions and inefficiencies caused by trade protection. At the same time, hardly any attempt has been made to define what 'technology' is, let alone to measure it in any way. In any case, the overall opinion has been that economic stagnation, caused by technological inertia, was the most negative outcome of import-substituting industrialisation from a historical, long-run perspective.

Perhaps the best-argued version of this view is that developed by Victor Bulmer-Thomas.[10] Bulmer-Thomas sustained that, despite high trade-barrier protection, the domestic private sector of countries such as Brazil was unable to respond to incentives for investment in the post-war years because of two severe limitations: lack of finance and of 'the technology required for mounting sophisticated industrial enterprises'.[11] According to the author, governments in Latin America had to resort to both multinational companies and public investment in production activities to be able to implement their strategy of fostering the manufacturing sector. Despite the short-term success of this scheme in terms of rapid industrial growth, the distortions generated by high trade protection were very high: '[i]nefficiency stemmed from the distortions in factor prices, the lack of competition in the domestic market, and the tendency toward an oligopolistic structure with high entry barriers.'[12] The outcome was that the high cost and inefficiency of industrial production made exports of manufactured goods virtually impossible – so that Latin American industrialisers continued to be dependent upon volatile primary exports and inflows of foreign capital. Since the imports of more sophisticated intermediate and capital goods could not be easily suppressed, countries like Brazil were condemned to chronic balance-of-payments instability and crises throughout the post-war period.

The two basic hypotheses in Bulmer-Thomas's argument were that trade protection was the main or only factor responsible for distortions and inefficiencies in manufacturing production, and that domestic firms were unable to engage in any sort of innovation. Although not clearly stated, the latter hypothesis was crucial for the author's conclusions

[10] Bulmer-Thomas, *Economic history*.
[11] *Ibid.*, p. 281.
[12] *Ibid.*, p. 283.

about the inward-looking model. The full impact of the core policy of this model – i.e., the high protectionist barriers – could only be understood by means of its long-run consequences on economic dynamism and competitiveness, beyond its immediate effects on social welfare. Indeed, Bulmer-Thomas put little emphasis on the impact of trade protection on consumer and producer surpluses as stressed by the static analysis of tariffs. In the Bulmer-Thomas's view, it was the inability of domestic firms to implement any sort of innovation that would be the most important drawback of the high-trade protection policy which characterised the inward-looking model in a country such as Brazil.

Despite its centrality in Bulmer-Thomas's analysis, the hypothesis of technological inertia as a feature of the import-substituting industrialisation was never sustained by evidence. It was only taken for granted that the lack of technology for building up 'sophisticated industrial enterprises' was a crippling limitation which inhibited the fast-growing industrial sector from being competitive and from exporting. In this sense, the absence of technological innovation in the manufacturing industry is at the same time a hypothesis and a key result of the Bulmer-Thomas's analysis of import-substituting industrialisation. The same can be said for the hypothesis that trade protection was the main or only cause of distortions leading to paucity of innovation. There was no consideration of other possible causes related to the domestic conditions which could help explain the presumed lack of technological innovation - for example, labour skills, engineering capabilities, research and development organisations, educational levels and labour market conditions. In other words, the primacy of trade protection as the main or only cause of technological deficiencies in the new industrialisers of Latin America was also taken for granted.

The two hypotheses mentioned above are pivotal to Bulmer-Thomas's final assessment of the post-war industrialisation in countries such as Brazil: '[t]he inward-looking model, particularly in the 1950s, is now seen as an aberration... although the excesses were often unnecessary the model – even in a less-distorted form – still cannot be defended.' Contrary to Macario, Bulmer-Thomas saw no room for temporary and strategic use of trade protection as a means to boost new and promising industrial activities. The problem with the import-substituting industrialisation lay not in its excesses, but rather in its very use of distortive policies (mainly trade protection) which generated deep-rooted inefficiency. By suppressing imports, according to Bulmer-Thomas, there was no way of keeping 'the productive apparatus efficient and technologically up to date'. This is indeed a logical

deduction, based on the presumed inability of domestic industrial firms to be innovative in any sense.[13]

The view that distortions hindered long-run economic development in Latin American countries has been upheld by other economic historians. Alan Taylor, for example, examined the impact of distortions other than trade protection on Latin American growth compared with the Asia-Pacific region between 1970 and 1990. He started with a well-known picture of the classic period of post-war import-substituting industrialisation as a 'rapid resource allocation toward manufacturing as demanded by the strategy', although with a high price to be paid in terms of 'massive distortions and levels of inefficiency that precluded manufactured exports.'[14] As his focus was upon economic growth, Taylor did not elaborate the argument further, but implicit in it was the notion that distortions caused by trade protection in the classic years of the inward-looking model thwarted productivity growth, technological change and competitiveness.

The basic conclusion by the interpretations discussed so far, therefore, is that the major problem of post-war import-substituting industrialisation in countries like Brazil was not short-term reductions in social welfare, but technological stagnation in the long run. However, as already noted, the empirical basis for such a conclusion is tenuous at best. Estimations of the technological activity in Brazil, the largest industrial country in Latin America, can help to assess the claims outlined before. If historical data indicate technological stagnation and lack of international competitiveness in the very heyday of import-substituting policies, they would provide support for the assertions of those economic historians who have regarded the import-substituting industrialisation mostly as a failure. Otherwise, if results are at odds with those predicted, there would be good reasons to look for different explanations of the industrialisation process in post-war Brazil.

2. The methodology of technological content of exports

It is difficult task, in economic history studies, to assess the evolution of technological capabilities in a specific economy. Technological capabilities are a key aspect of economic performance in the long run. In particular, prospects of income and wage increase, productivity growth and competitive strength are to a large extent dependent upon firms' ability to use their human and physical resources efficiently, and to introduce incremental

[13] *Ibid.*, p. 288.

[14] Taylor, 'On the costs: historical perspectives', p. 7. This quotation, however, did not appear in the version published later: Taylor, 'On the Costs: price distortions'.

improvements and more substantial changes in products and processes.[15] Traditional quantitative measures of economic growth and industrial diversification say little about the quality of productive structures and their learning and innovation capabilities. Labour and total factor productivity are also used to indirectly express the qualitative changes in production and organisational methods. Yet the limitations of productivity measures as proxies of technological change are significant. Increases in labour productivity, for example, may come from short-term rationalisation by firms, which, by reducing the number of workers or other inputs, need not be associated with new strategies of technological, organisational and product innovation.[16]

The alternative measures which seek to overcome the limitations of productivity include the export structure of an industry or a country as a whole.[17] This approach contains two basic hypotheses. First, it is assumed that the composition of a country's exports and the type of export specialisation reflect its technological and innovative capabilities. The link between exports and technology lies in the features of the productive structure: as domestic production is characterised by activities which differ in terms of application of knowledge, labour skills, wage levels, linkages and externalities, the export structure tends to reflect domestic learning and innovative capabilities. Second, it is considered that the toughest test for assessing the competitiveness of an industry or a country is its ability to keep or expand its exports. Exported products would be those which had achieved large enough efficiency in their production process to be able to penetrate demanding and competitive external markets.[18]

Thus, as exported goods can be classified according to their degree of technological content, which are in turn related to the estimated features of the productive activities which originate them, i.e., application of knowledge, labour skills, wage levels, linkages and externalities, it would be possible to have a good proxy of domestic technological capabilities based on the technological content of exports. For example, a country with an export structure made up of goods with low or no technological content, through time would indicate technological stagnation. In turn, a country which shows a growing share of exported products with a higher technological content would suggest an ability by domestic firms to upgrade and diversify their production and organisational structures.

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[15] Lazonick, *Competitive advantage*; Lundvall (ed.), *National systems*.
[16] Link, *Technological change*.
[17] Other indicators are, for example, patenting and Research & Development spending.

Technological classification of exports

The classification of exports by technology adopted here follows the method used by Sanjaya Lall to analyse the export structure of developing countries. This method is based on and modifies previous taxonomies elaborated by Keth Pavitt and OECD.[19] In Lall's classification, exported products are initially aggregated at the three-digit level of the United Nations' Standard Industrial Trade Classification (second revision): SITC Rev. 2. Then, the products are grouped into five categories, according to the estimated technological intensity required for their domestic production (see Appendix A). The resulting categories provide only a rough calculation of the technological content of exports, since products are classified by estimates of the use of technology and skills in the production process. Furthermore, aggregation levels may put together goods which have the same label but different quality and technological content. Finally, export data do not show whether manufacturing came about from developing domestic skills and resources or was just set up as a simple assembly line. Deficiencies such as these suggest that the generalisations found below must be treated with caution. Despite the limitations of export data, however, most of the products classified by technological categories seem to fit in well with what is known about manufacturing technology. By using them carefully, these data can be employed along with other qualitative and quantitative sources to provide valuable insights for historical analysis.[20]

The five technological categories of export products can be described as follows. The first group, *Primary Products*, comprises agricultural and extractive exported goods with no or very little industrial processing. Coffee, cotton, fresh meat, unmilled cereals and copper are some examples in this category (a complete list of all groups is presented in Appendix A). Manufactured products in turn are grouped into four different categories. *Resource Based Manufactures* are processed natural resources, usually of a simple, labour-intensive and low-skill type. Yet there were products in this group which could be more intensive in capital and technology, like mineral ores and processed fruits. Examples of resource based manufactures are prepared meat, dairy products, chocolate, processed wood, refined petroleum, rubber tyres, paper, wood manufactures, iron ore, glass and organo-inorganic compounds.

Low Technology Manufactures consist of goods with stable and well-diffused technologies, labour intensive and low-skill content. The same caveat as that to the previous

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[18] For studies inspired by this approach, see Dalum, 'Export'; and Reinert, 'Competitiveness'.
[19] Lall, 'Technological structure'; Pavitt, 'Sectoral patterns'; and OECD, *Globalization*.
[20] Lall, 'Technological structure', pp. 6-7.

group applies, however: there are products in this category which tend to be more skill- and technology intensive, such as footwear, garments and steel bars. Some examples of low technology goods are leather and its products, textile yarn, cotton fabrics, pottery, railway materials and manufactures of base metal.

Medium Technology Manufactures include products intensive in capital, technology and labour skills. Although technology for this category could be available in international markets, its diffusion, adaptation and improvement were complex and required substantial learning capabilities. Products in this category include motor vehicles and parts, synthetic fibres, fertilisers, pig iron, radio receivers, agricultural machinery, textile machinery and machine tools.

Finally, *High Technology Manufactures* are characterised by rapid technological progress, high R&D content and sophisticated skills. Requirements including complex infra-structure, high level of labour and management skills, and interaction with research institutions made technology development in this category especially difficult for newly industrialising countries in Latin America, for example. Typical products are medicinal and pharmaceutical goods, office machines, automatic data processing, telecommunications equipment and aircraft.

3. The methodology applied to Brazil's exports

The analysis of Brazilian exports presented in this article comprises two important periods of Brazilian economic history after World War II. First, there are the years of classic import-substituting industrialisation between 1945 and 1962, which were marked by an increasing number of economic policies geared towards fostering manufacturing industry. Second, the analysis includes the economic boom between 1968 and 1973, which was largely based on the industrial structure set up in the previous years. The whole period can be seen as a privileged opportunity to assess the first results of the import-substituting industrialisation and the impact of previously identified distortions on export and technological performance.

Brazil's export data

The export data used in the present article were drawn from the yearly general statistics (*Anuário Estatístico do Brasil*), which recorded the official primary data on foreign trade.[21] These data were published for seven major groups: live animals, raw materials, food and beverages, chemical and pharmaceutical products, machinery and vehicles, manufactures

defined by raw materials and other manufactures. These general categories were broken down into two more detailed levels. By taking the lowest level of aggregation, the statistics covered hundreds of exported products by year. For 1961, for example, there are about 270 products in the most detailed classification.

The classification by technological content consisted of regrouping all individual exported products under the technological categories presented earlier. The first step was to relate individual products to the five-digit SITC Rev.2 classification. For example, each product under 'Vaccines, toxoids, toxins and similars' in Brazil export statistics was assigned to '54164 - Antisera and microbial vaccines' or '54165 - Toxins, microbial cultures and similar products'. Then the products were arranged by the three-digit classification of SITC, and in the latter example, products were classified in '541 - Medicinal and Pharmaceutical Products'. Finally, exported goods were classified by their technological content, according to the taxonomy presented before (see Appendix A).

As Brazilian export data and the SITC Rev.2 classes were often incompatible, conventions had to be adopted. Exported products which could not be assigned to any specific SITC category (for example, 'Other food products') were classified under n.c. (no classification). When products indicated as 'Others' could be identified with some degree of precision, they were assigned to groups which were considered more appropriate (for example, 'Others' in 'Vegetable oils' were assigned to '424 - Other fixed vegetable oils, fluid or solid, crude').

Where there were two or more possible classifications by technology, unidentified products were allocated to the lowest technological category. For example, in 1961, ten products in 'Common metals employed in metallurgy' could be easily classified as Medium and Low Technology Manufactures; a further group of products, however, was registered as 'Other metals' and could not be identified. The procedure in such cases was to classify the non-identified products as part of the lowest technological category – in the example above, 'Other metals' were included in the Low Technology Manufactures category. Such a procedure deliberately biased results against technology-intensive goods when there were doubts about their technological content. The aim was to minimise the risk of overestimating actual technological conditions in Brazil's industry.

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[21] IBGE, *Anuário Estatístico*, various years.

Data standardisation

Up to 1954, Brazilian export data are presented in nominal values and in national currency (*cruzeiros*) only, so that they must be converted into real values and US dollars. Yet standardisation is made difficult because of several exchange regimes and different official exchange rates associated to specific products which were adopted in Brazil during the 1940s and 1950s. The first step was to convert export data for 1945-1954 into US dollars. For this, export exchange rate estimates by Pedro Malan *et al*. (1945-1946, 1948-1952), *Conjuntura Econômica* (1953-1954) and implicit export rates (1947) were adopted. The resulting series can be seen in Table 4 below.

Table 4. Export exchange rates, Brazil, 1945-1954, Cr$/US$

Year	*Official rate/ estimates*	*Coffee*	*Other products*
1945	18.61		
1946	19.42		
1947	18.38		
1948	18.38		
1949	18.38		
1950	18.38		
1951	18.38		
1952	18.38		
1953	18.37	20.00	21.00
1954	18.36	30.00	33.00

Sources:
1939-46 and 1948-52 - Malan *et al*., *Política econômica*, pp. 126 and 160.
1947 - implicit export exchange rate (total exports in *cruzeiros* [Cr$]/total exports in US$), IBGE, *Estatísticas históricas.*
1953-54 - official rate and annual average rates. 'Exportações brasileiras', p. 12, table II.

Estimates of 'Coffee' and 'Other products' rates presented in Table 4 are annual average rates effectively negotiated in the exchange market, according to inquiries carried out by *Conjuntura Econômica*, an economic magazine published by the Getúlio Vargas Foundation (FGV). In 1955, Brazilian export data began to be published in US dollars. Together, the estimated export values in US dollars for the 1945-1954 period and those directly drawn from the export statistics (1955-1973), make up the whole export series in US dollars, which was then deflated by the Producer Price Index of the United States to obtain a constant dollar series at 1970 prices.

4. The technological content of Brazilian exports

The new indicators of Brazilian exports classified by technological content can be first examined by their overall results in terms of primary and manufactured exports. Such indicators differ significantly from other estimates of Brazil's export structure, as processed goods such as prepared fruits, dairy products and iron ore have here been classified as resource based manufactures instead of primary products.[22] Even so, it is possible to see clearly from Figure 1 that the Brazilian economy was largely dependent upon primary exports throughout the 1945-1973 period. The data show that shares of primary products in total exports were never below 50 per cent in the post-war years. Shares of primary goods were particularly high in the first half of the 1950s, when coffee prices experienced a boom in international markets.

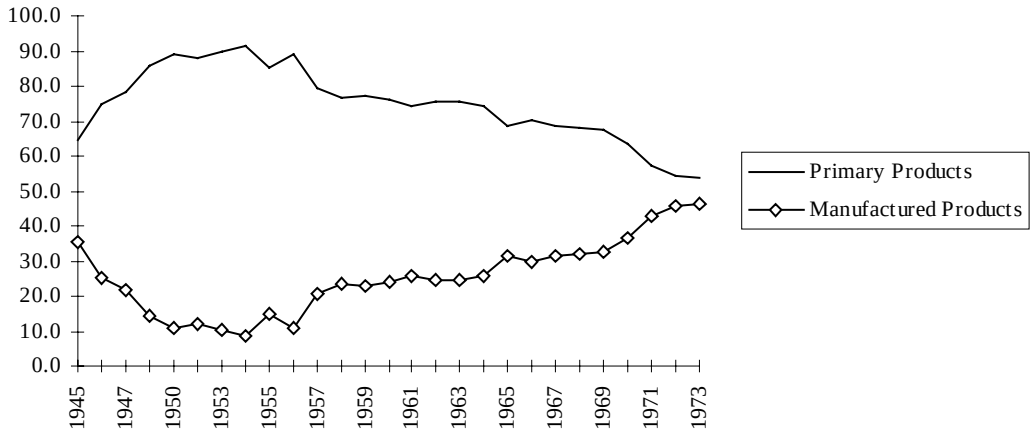

Figure 1 - Total primary and manufactured exports by technological content, Brazil, 1945-1973

Manufactured products amounted to 35.5 per cent of total exports in 1945, owing mainly to the performance of textile products, which had increased their participation in foreign markets after the collapse of traditional suppliers during the war. Yet that increase was short-lived and textile exports dropped sharply in the years that followed. From 1956, however, manufactured goods' relative share of total exports began to increase in a sustained way. By 1973, manufactured products achieved 46.2 per cent of total exports in Brazil.

The technology content of manufactured exports can be seen in Table 5. An important feature of the present results is that resource-based products were the main category of

manufactured exports during the whole period in question. In particular, from 1953 to 1963, the share of resource based products in manufactured exports was more than 90 per cent. If exports are taken as a proxy of technological capabilities, such data clearly suggest that Brazil's industrial sector was dominantly labour intensive, low skill and technologically simple. This seems to be a reasonable generalisation of post-war industrialisation in Brazil which conforms with other quantitative and qualitative assessments. However, other trends also emerged during this time, the most important being that more sophisticated products began to increase their share in manufactured exports.

Table 5. Manufactured exports classified by technological categories, Brazil, 1945-1973 (percentage)

Year	*Resource Based Manufactures*	*Low Technology Manufactures*	*Medium Technology Manufactures*	*High Technology Manufactures*	*Total Manufacturing*
1945	44.2	47.0	6.3	2.6	100.0
1946	65.8	27.5	4.2	2.6	100.0
1947	60.5	33.0	4.8	1.6	100.0
1949	72.1	21.4	4.7	1.8	100.0
1950	86.1	10.7	1.8	1.4	100.0
1951	79.7	15.1	4.3	0.9	100.0
1953	96.6	1.0	2.0	0.4	100.0
1954	96.1	0.7	2.8	0.4	100.0
1955	95.6	1.2	3.0	0.2	100.0
1956	91.1	1.8	6.9	0.2	100.0
1957	95.7	1.0	3.0	0.3	100.0
1958	96.1	1.6	1.9	0.4	100.0
1959	96.4	1.5	1.8	0.3	100.0
1960	94.7	2.7	2.4	0.2	100.0
1961	91.7	1.3	6.0	1.0	100.0
1962	90.7	1.4	6.7	1.1	100.0
1963	90.9	1.7	6.1	1.3	100.0
1964	83.5	4.9	10.1	1.5	100.0
1965	78.6	9.4	10.3	1.6	100.0
1966	79.4	9.4	8.6	2.6	100.0
1967	73.2	10.3	11.7	4.8	100.0
1968	79.7	7.6	8.7	4.0	100.0
1969	77.3	9.3	9.3	4.2	100.0
1970	70.8	12.5	12.0	4.7	100.0
1971	72.3	11.4	12.3	4.0	100.0
1972	66.9	16.0	14.4	2.7	100.0
1973	66.3	16.6	14.6	2.5	100.0

Sources: Appendix B.

The emergence of new activities and products can be initially detected in the low technology category and, more importantly, in medium technology category. Exports of low

[22] For example, according to estimates by Doellinger *et al*. manufactured products achieved 12.7 per cent of total exports in 1965 (against 31.2 per cent in Figure 1) and 19,2 per cent in 1970 (against 36,8 per cent).

technology products indicate the presence of standardised technologies, which usually required relatively low skills and capital, but that at the same time could develop important incremental improvements in products and processes. That exports in this category fell so sharply after 1945 suggests serious problems of efficiency and industrial capabilities, which apparently only began to be overcome in the mid-1950s. A more consistent performance was that of medium technology exports, with export shares steadily increasing from the end of the 1950s. If the notion that such exports were related to a more intensive use of labour skills and technology is correct, the new data presented in Table 5 suggest a growing sophistication of the industrial structure in Brazil between 1945 and 1973. Indeed, as pointed out before, diffusion of medium technologies was not easily achieved and called for major learning capabilities.

High technology products, in turn, had the lowest share of total manufactured exports. Such a result clearly shows the limited technological capabilities of Brazil's industrial structure at the time. Still, the very presence of high technology products in the country's categories of export sales – despite low percentages – may also indicate the existence of technologically sophisticated activities in manufacturing.

Results of manufactured exports in general and of those classified by technology in particular are even more relevant when placed in the context of the highly discriminatory policy against exports prevailing in Brazil during most of the post-war years. The bias against exports was expressed by tariffs and quotas on inputs which raised the cost (and reduced the value added) of export industries compared to import-substituting industries. Furthermore, overvalued exchange rates meant that export industries earned less in domestic currency than they could in a hypothetical free-trade situation. There is evidence that discrimination against export industries in Brazil achieved some of the highest levels observed among developing countries in the 1950s and 1960s. In 1966, for example, eight out of 21 manufactured products in Brazil would have had negative value added if they had been exported: textiles, and leather production, for example.[23] That manufactured exports expanded and diversified in such an adverse context may be a further evidence of technological learning in Brazilian industry after 1945. A more satisfactory assessment of these issues, however, requires lower levels of data aggregation. The next section will provide further evidence on individual product exports.

Performance of individual products

Doellinger *et al.*, *Transformação.*

[23] Bergsman and Malan, 'Structure', table 6.6, p. 120; Balassa, 'Evaluation'.

Table 6 shows the relative shares of individual classes of products in total exports according to technological categories. The years selected (1945, 1960 and 1973) can be used to identify overall trends in exports and industrial capabilities during the post-war period. In the case of resource-based manufactures, simply worked wood is among the major exports in the three years selected, although its relative share fell over the same period. In its place, new products such as sugar and iron ore became the chief manufactures sold abroad in the resource-based category. Also, exports of refined petroleum products seem to indicate the development of more sophisticated manufacturing activities in the wake of the import-substituting policies implemented during the 1950s.

Table 6. Groups of exported products by technology categories, Brazil, 1945, 1960 and 1973

Year	*Groups of exported products*[a]	*Share (per cent)*[b]
	Resource based manufactures	
1945	Wood, simply worked, and railway sleepers of wood (248)	21.4
	Animal and vegetable oils and fats, processed and waxes (431)	15.7
	Meat and edible offal, prepared/preserved, fish extracts (014)	10.9
	Pearls, precious and semi-precious stones, unworked/worked (667)	9.0
	Other fixed vegetable oils, fluid or solid, crude (424)	7.6
	Total	*64.5*
1960	Sugar and honey (061)	20.5
	Iron ores and concentrates (281)	18.9
	Wood, simply worked, and railway sleepers of wood (248)	16.6
	Vegetable textile fibres and waste of such fibres (265)	8.3
	Animal and vegetable oils and fats, processed and waxes (431)	6.8
	Total	*71.1*
1973	Iron ores and concentrates (281)	33.8
	Sugar and honey (061)	26.3
	Wood, simply worked, and railway sleepers of wood (248)	7.8
	Other fixed vegetable oils, fluid or solid, crude (424)	5.7
	Meat and edible offal, prepared/preserved, fish extracts (014)	3.7
	Petroleum products, refined (334)	3.7
	Total	*81.0*
	Low technology manufactures	
1945	Cotton fabrics, woven (652)	72.3
	Leather (611)	8.1
	Textile yarn (651)	7.6
	Clothing accessories of textile fabrics (847)	3.9
	Textile fabrics, woven, other than cotton/man-made fibres (654)	3.0
	Total	*95.0*
1960	Cotton fabrics, woven (652)	41.2
	Textile yarn (651)	17.6
	Leather (611)	15.7
	Structures and parts of structures, iron, steel and aluminium (691)	10.4
	Iron and steel bars, rods, angles, shapes and sections (673)	8.8
	Total	*93.7*
	Footwear (851)	20.2

Year	*Groups of exported products*[a]	*Share (per cent)*[b]
1973	n.c. (various)[c]	17.4
	Leather (611)	9.9
	Made-up articles, wholly/chiefly of textile materials (658)	4.7
	Universals, plates and sheets, of iron or steel (674)	3.9
	Total	*56.0*
	Medium technology manufactures	
1945	Alcohols, phenols, phenol-alcohols and their derivatives (512)	53.1
	n.c. (various)[d]	16.6
	Fabrics, woven, of man-made fibres (653)	13.2
	Pig iron, spiegeleisen, sponge iron, iron or steel (671)	9.2
	Tubes, pipes and fitting, of iron and steel (678)	7.7
	Total	*100.0*
1960	Alcohols, phenols, phenol-alcohols and their derivatives (512)	56.1
	n.c. (various)[e]	10.1
	Pig iron, spiegeleisen, sponge iron, iron or steel (671)	9.5
	Textile and leather machinery and parts (784)	5.2
	Food processing machines and parts (727)	4.1
	Total	*84.9*
1973	n.c. (various)[f]	30.2
	Pig iron, spiegeleisen, sponge iron, iron or steel (671)	11.6
	Alcohols, phenols, phenol-alcohols and their derivatives (512)	8.4
	Fabrics, woven, of man-made fibres (653)	7.3
	Parts and accessories of vehicles (784)	5.0
	Total	*62.5*
	High technology manufactures	
1945	Medicinal and pharmaceutical products (541)	100.0
	Total	*100.0*
1960	Medicinal and pharmaceutical products (541)	89.0
	Aircraft and associated equipment and parts (792)	11.0
	Total	*100.0*
1973	Office machines (751)	25.0
	Automatic data processing machines and units thereof (752)	24.6
	Thermionic, cold and photo-cathode valves, tubes, parts (776)	13.8
	Medicinal and pharmaceutical products (541)	12.1
	Rotating electric plant and parts (716)	6.0
	Total	*81.5*

Notes:
(a) Numbers between parentheses correspond to the three-digit SITC classification, Rev.2.
(b) Share of the five most important products in the technological category.
(c) Other synthetic and artificial textiles; Other tapestry, pile, lacework, etc. textiles; Other clothing and accessories; Other footwear, leggings, gaiters and the like; Other cast iron and steel; Other hand and machine tools, cutlery; Other manufactures of metal; Other diverse manufactures.
(d) Machines, apparatus, tools and utensils.
(e) Other machines and vehicles, parts.
(f) Other organic chemicals; Other soap, cleansing, polishing products, lubricants, artificial waxes, etc.; Other diverse chemical products; rubber and plastic manufactures for domestic use; Other boilers, machinery, mechanical apparatus and appliances; Other electrical machinery, apparatus and appliances; Other motor and not-motorised vehicles; Other optical, photograph, medical, meters, counters, measuring and checking appliances.
Sources: Appendix B.

Two important facts about the low technology manufactured exports can be inferred from Table 6. First, it is possible to see that the puzzle of fast-declining exports in this category between 1945 and 1953 (see Table 5) was mainly related to the textile industry. Textiles achieved 86.8 per cent of low technology exports and 40.7 per cent of all manufactured exports in 1945 but dropped to virtually no sales abroad in 1953. The reason for such a negative performance seems to be linked to deep technological and organisational deficiencies of Brazilian textile firms at the time. Brazilian textile companies had taken advantage of the collapse of international markets and substantially increased their exports during World War II. When foreign buyers returned to their traditional sources after the war, the Brazilian textile industry was unable to compete in price and quality with international producers such as Japan, for example. Exports of textile yarn and cotton fabrics only started to recover moderately in the second-half of the 1950s, partially at least as a result of sweeping changes in work organisation and investments in automatic machinery ignited by the crisis in the immediate post-war years.[24]

Second, there was a clear diversification of low technology exported manufactures from the end of the 1950s. In 1945 and 1960, five classes of products made up more than 90 per cent of all low technology exports, but by 1973 (see Table 6), the share of low technology exports had dropped to 56 per cent. Another indicator of diversification is the group of non-classified (n.c.) manufactures, with 17.4 per cent of the category's exports. The type of products comprised in this group gives an idea of the rapid diversification of low technology manufactures: synthetic and artificial textiles, cast iron and steel, hand and machine tools, manufactures of metal and diverse manufactures. New manufactures such as footwear and steel and iron products appeared in external markets around the end of the 1950s.

Exports of medium technology products showed a similar trend towards diversification and more complex products. Alcohols, phenols, phenol-alcohols and their derivatives were the major exported manufactures during the 1940s and 1950s, but at the same time other products witnessed substantial growth in their relative shares. Along with pig iron, man-made fabrics and other manufactures from iron and steel, new products such as machinery and parts began to play a relatively important role in exports. This result can be seen initially through the high relative shares of non-classified products (n.c.) in the three years selected (see Table 6), since the n.c. group consisted largely of machines, tools and parts.

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[24] Colistete, *Labour relations*.

It is also possible to identify the performance of individual machinery, tools and parts exports. The data is not detailed enough to make a precise statement about when these goods began to be exported, since most of them were classified as 'other machines and tools' throughout the 1950s. It was only in 1964 that the general statistics adopted a more detailed classification which specified a larger group of machinery and parts exports.[25] Even so, Brazil's export data already recorded exports of textile, leather, food processing and printing machinery and their parts, as well as mechanical handling equipment (lifts and elevators), during the 1950s. Among the exported products which began to be specified in the early 1960s (1961 or 1964), were steam boilers, internal combustion piston engines, non-electric engines and motors, agricultural machinery, paper and pulp machinery, machine-tools, equipment for distributing electricity, passenger motor cars, motor vehicles for transport of goods and materials, and parts and accessories of motor vehicles in general. In all these cases, production processes were sophisticated and required high levels of engineering and designing capabilities, a skilled labour force and an ability to implement, adapt and improve existing technologies.

Finally, exports of high technology manufactures also witnessed diversification despite their low shares in total exports throughout the post-war years. Medicinal and pharmaceutical products were the only high technology goods exported from 1945 onwards. It seems to reflect earlier technological capabilities developed in the production of alkaloids, medicaments, vaccines and the like in Brazil. Apart from such products, only exports of small aircraft were recorded during the 1950s. However, new high technology products came to the fore in the mid-1960s. The most important were office and automatic data processing machines, thermionic, cold and photo-cathode valves, tubes and parts, and rotating electric plants and parts (see Table 6). In addition to these products, there were also exports of telecommunications equipment and parts, electrical power machinery and electrical machinery and apparatus. Like the evidence from other categories, these results seem to indicate an increasing degree of technological complexity in Brazil's manufacturing industry during the post-war years.

[25] IBGE, *Anuário Estatístico*, various years. These data are not shown in the present article and can be supplied by the author on request.

5. Explaining the results and implications

There are two main conclusions which can be drawn from the present estimates. First, that import-substituting industrialisation in Brazil during the post-war years was marked by increasing technological sophistication and diversification. Contrary to recent views by economic historians who have assumed technological stagnation as a feature of the inward-looking model, the evidence points to an ability by local firms to learn, adapt and improve both existing and new products and processes. Second, it is also clear from the estimates presented earlier that the scope of technological change in manufacturing was rather limited. In particular, medium and high technology manufactured exports were still only a small fraction of total exports between 1945 and 1973, which suggests that the industrial structure was predominantly labour intensive, low skill and technologically simple. More importantly, growth rates for more sophisticated manufactured exports were not large enough to change the traditional reliance of the Brazilian economy upon the volatile markets of primary products with very low or no technological content.

The first result can be theoretically explained by the dynamic effects of trade protection on learning. In a world of imperfect markets and changing productive combinations, increasing production by local firms stimulated by trade protection may generate positive externalities in the form of skilled labour and knowledge which spill over into other industries. Accumulated labour and management experience in production also can be an important source of learning and efficiency at factory level. Also, learning may arise from adapting basic products and processes to local uses, and user-producer interactions which provide information about problems and deficiencies of designs and components. Such effects can be illustrated by Figure 1.[26]

[introduce figure 1]

At international price p^*, domestic supply is given by *OA* and imports by *AB*. A tariff t raises the international price to $p^* + t$, encourages expansion of domestic production to *OC* and domestic demand falls to *OD*, so that total imports decline to *CD*. It is precisely the increase in domestic production from *OA* to *OC* which can be associated to the learning

[26] Ray, *Development economics*, pp. 669-72; Rosenberg, *Inside the black box*, chapter 6. Figure 1 is based on Ray, *Development economics*, p. 670.

effects mentioned before. The static welfare impact of a tariff can be illustrated by the net dead-weight losses resulting from the increase in producer surplus and decline in consumer surplus (the grey areas). The dynamic welfare effects, however, will arise as long as the cost curve shifts to the right as a result of the learning effects on domestic production. If such effects are strong enough, domestic industry can achieve international competitiveness which allows it to export the formerly protected products.

An accurate assessment of these factors in post-war Brazil is still impossible, given the lack of systematic studies at factory level. Even so, qualitative evidence about some industries and firms suggest that there were significant cases of companies which developed learning and technological capabilities during the classic period of import substitution in Brazil. Although such firms are usually historically seen as basically represented by foreign companies, there were substantial domestic learning effects which were then taken up by local producers. A case in point was the vehicle parts industry which emerged during the 1950s. This industry witnessed a boom from the late 1940s, stimulated, first, by successive external crises and import restrictions and, second, by incentives and trade protection provided by the Brazilian government from the early 1950s. The estimated number of firms jumped from 30 in 1946 to 1,300 in 1960. A strategy favoured by local companies was to establish partnerships with foreign companies to import, assimilate and adapt technologies. Metal Leve, for example, was set up in 1950 and started to produce pistons and piston pins with the technical assistance of the German group Mahle. Cofap, established in 1951, made agreements in the following years with American companies to produce piston rings, cylinder parts and dampers. These and other domestic firms adopted a strategy of forging links with foreign companies to enter the marketplace, and then developed their own expertise in engineering, designing, product quality, and distribution. Metal Leve and Cofap engaged in active learning which allowed them to produce high-quality products and to be competitive on both domestic and foreign markets during the following years.[27]

Another example of developing learning capabilities was the machine-tools industry. This sector grew out of simple repair and maintenance shops which diversified into machinery production as a result of import restrictions and increasing domestic demand for capital goods. In 1961, there were approximately 114 establishments employing about 5,000 people in Brazil, turning out a wide range of products such as lathes, shapers, presses, machines for sheets and drilling machines. Local producers engaged in a process of learning in an industry

which was known for its highly demanding standards of industrial skills, mechanical precision and product quality.[28] One example of this is Romi, a former agricultural machinery producer in the 1930s which turned to the production of lathes in the 1940s. The company grew very rapidly during World War II and later, jumping from 120 employees in 1938 to nearly 1,000 in 1944 and to 1,726 in 1957.

Romi´s first patent dates from 1942, and by 1967, there are records of 120 patents registered by the company in Brazil (68.3 per cent), Argentina (8.3 per cent), Germany (8.3 per cent), Britain (5.8 per cent), Italy (4.2 per cent) and the United States (3.3 per cent). These patents were for product improvements such as speed control devices, as well as entirely new models of lathes. Data for 1962-67 indicate that Romi exported an average 22.4 per cent of its lathe production. In the same period, the company's major foreign markets were South America (49.9 per cent), Mexico/Canada (24.7 per cent), Europe (14.1 per cent) and United States (8.6 per cent).[29]

Given the successful cases of developing domestic industrial capabilities, why does export data show such a limited drive towards learning and technological development? The answer can lie in the nature of technological innovations. Innovation is a cumulative and interactive phenomenon which relies upon a range of social, institutional and organisational factors. Firms do not engage in incremental or radical innovation in isolation of such social and institutional backgrounds. In particular, innovation capabilities are largely determined by the educational levels of the population, industrial apprenticeship and training systems, public and private spending in R&D, inter-company relations, user-producer interactions and labour-management relations both at shop-floor level and in society as a whole.[30]

If innovation capabilities are indeed such a social and institutional phenomenon, Brazil's social and institutional conditions in the post-war years may have been the main reason for the limited technological performance as expressed by export data examined before. Additional quantitative and qualitative evidence can help to make sense of statistical data. Very low literacy rates are a first indicator of the poor social background, and statistics on average years of education for Brazil in 1950 and 1973 are as follows: 2.05 years and 3.77

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[27] Colistete, *Labour relations*, pp. 10 and 125-6.

[28] ECLA, 'Manufacture'.

[29] Relatórios anuais, 1962-1967; Cadastro Padrão, Romi Archives, Santa Bárbara d'Oeste, São Paulo. Data provided by Pollyana Carvalho.

[30] Lundvall, *National systems*. On the role of labour-management relations in innovation, see Lazonick, *Competitive advantage*.

years, compared to 9.10 years and 10.74 years in Western Europe, 9.11 years and 12.09 years in Japan, and 3.36 years and 6.82 years in Korea, respectively.[31] Estimates of the number of workers who completed some type of apprenticeship or other programme organised by the National Service of Industry (*Serviço Nacional da Indústria* or SENAI) between 1946 and 1960 never exceeded two per cent of the total industrial workforce in the state of São Paulo, by far the main industrial centre in Brazil.[32] Finally, labour relations in post-war Brazil were highly confrontational and antagonistic, both on the shop-floor and in society at large. Employers held an anti-labour policy which rejected compromise the leftist labour militancy which had taken over official trade unions and helped to mobilise at grassroots levels since 1945, demanding real wage increases and social rights. Together with low wages and poor working conditions, such a confrontational pattern of labour relations seems to have undermined the environment required to produce an improvement of products and processes which could have raised the overall standards of industrial manufacturing in Brazil at the time.[33]

In the end, a highly heterogeneous industrial structure emerged in post-war Brazil, since only a core group of firms actually succeeded in developing learning capabilities which allowed them to embark in incremental innovation and high-quality production. A clear illustration of this is the vehicle parts industry. Along with successful cases of firms such as Cofap and Metal Leve, the majority of domestic parts producers ended up in replacement markets and low-quality manufacturing.[34] Another example is the machine-tool industry, and a study carried out by ECLA in 1961 found out that only eight out of 90 machine-tool firms in Brazil could be compared to those of industrialised countries. While the leading group showed 'creativity vitality' and were highly efficient by international standards, the remaining firms used antiquated equipment, lacked technical expertise and turned out low-quality products.[35] Thus, highly heterogeneous technological capabilities seem to have been a feature of the Brazilian industrial sector in the post-war years. Such an outcome can help explain the apparently contradictory results drawn from data about the technological content of manufactured exports in Brazil, which show evidence of developing learning capabilities and limited technological change.

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[31] Maddison, *Monitoring*, p. 77, table 3-12.
[32] Colistete, *Labour relations*, pp. 40-1.
[33] *Ibid.*, chapters 5-6.
[34] Addis, *Taking the wheel*.
[35] ECLA, 'Manufacture', pp. 78-9.

5. Conclusions

Economic historians of import-substituting industrialisation in Brazil have argued that distortions caused by high trade protection ultimately led to technological stagnation. According to this view, in addition to negative effects on social welfare, new industrial countries such as Brazil paid a very high price for their short-term success in economic growth and industrial diversification. Massive distortions, deep-rooted economic inefficiency and lack of technical progress prevented manufactured exports and condemned the country to long-run economic stagnation. Import-substituting industrialisation would then be a failure precisely in that country which until the 1970s had been the most successful late industrialiser in Latin America.

Yet evidence from the technological content of manufactured exports presented before has not confirmed the prediction of technological stagnation. On the contrary, export data indicate an increasing technological diversification of the industrial structure between 1945 and 1973. This result is still more relevant given the policy of indiscriminate trade barriers and import substitution at any cost which reduced the competitive pressure on firms to produce efficiently and, in addition, produced a high bias against exports in manufacturing industries. It seems that the positive effects brought about by domestic production, stimulated by protection, were large enough to make up for the negative impact of the high level of trade barriers adopted at the time. A plausible hypothesis advanced was that externalities and learning effects originated by increasing local production may have acted as a powerful incentive to setting up new and more technologically sophisticated industrial activities.

Export data also suggest that technological progress was limited. However, it is more likely that the negative effects of exceptionally high trade barriers on incentives and efficiency combined with the social and institutional conditions in Brazil in the post-war years, to produce a serious hindrance for incremental improvements of products and processes. The resulting heterogeneous industrial structure became a feature of import-substituting industrialisation, as only a group of leading firms gained a competitive edge in new and long-established industrial sectors in Brazil.

Even though these results seem plausible, they should be seen only as tentative hypotheses to explain the trends showed in the data. In any case, the present estimates seem to fit better with evidence on firms and industries than the pessimistic view of the import-substituting industrialisation in Brazil. Rather than technological stagnation, there were firms which engaged in searching for new production structures and products. And rather than

failure, there were successful cases and mixed results. If that is true, we should look for new data, methods and perspectives which may help to provide a more historically accurate assessment of post-war industrialisation in Brazil and Latin America.

Appendix A

Technological classification of exports - SITC Rev. 2 (3 digits)

Primary Products

001 Live animals chiefly for food
011 Meat, edible meat offals, fresh, chilled or frozen
022 Milk and cream
025 Eggs and yolks, fresh, dried or otherwise preserved
034 Fish, fresh (live or dead), chilled or frozen
036 Crustaceans and molluscs, fresh, chilled, frozen etc.
041 Wheat (including spelt) and meslin, unmilled
042 Rice
043 Barley, unmilled
044 Maize (corn), unmilled
045 Cereals, unmilled (no wheat, rice, barley or maize)
054 Vegetables, fresh, chilled, frozen/preserved; roots, tubers"
057 Fruit & nuts (not including oil nuts), fresh or dried
071 Coffee and coffee substitutes
072 Cocoa
074 Tea and mate
075 Spices
081 Feed stuff for animals (not including unmilled cereals)
091 Margarine and shortening
121 Tobacco, unmanufactured; tobacco refuse
211 Hides and skins (except furskins), raw
212 Furskins, raw (including astrakhan, caracul, etc.)
222 Oil seeds and oleaginous fruit, whole or broken
223 Oils seeds and oleaginous fruit, whole or broken
232 Natural rubber latex; nat.rubber & sim.nat. gums
244 Cork, natural, raw & waste (including in blocks/sheets)
245 Fuel wood (excluding wood waste) and wood charcoal
246 Pulpwood (including chips and wood waste)
261 Silk
263 Cotton
268 Wool and other animal hair (excluding wool tops)
271 Fertilizers, crude
273 Stone, sand and gravel
274 Sulphur and unroasted iron pyrites
277 Natural abrasives, n.e.s (including industrial diamonds)
278 Other crude minerals
291 Crude animal materials, n.e.s.
292 Crude vegetable materials, n.e.s.
322 Coal, lignite and peat
333 Petrol.oils, crude, & crude oils obtained from bituminous minerals
341 Gas, natural and manufactured
681 Silver, platinum & oth.metals of the platinum group
682 Copper
683 Nickel
684 Aluminium

685 Lead
686 Zinc
687 Tin

Resource Based Manufactures

012 Meat & edible offals, salted, in brine, dried/smoked
014 Meat & edible offals, prep./pres., fish extracts
023 Butter
024 Cheese and curd
035 Fish, dried, salted or in brine smoked fish
037 Fish, crustaceans and molluscs, prepared or preserved
046 Meal and flour of wheat and flour of meslin
047 Other cereal meals and flours
048 Cereal preparations & preparations of flour of fruits or vegetables
056 Vegetables, roots & tubers, prepared/preserved, n.e.s.
058 Fruit, preserved, and fruit preparations
061 Sugar and honey
062 Sugar confectionery and other sugar preparations
073 Chocolate & other food preptions containing cocoa
098 Edible products and preparations n.e.s.
111 Non alcoholic beverages, n.e.s.
112 Alcoholic beverages
122 Tobacco manufactured
233 Synthetic rubber latex synthetic rubber & reclaimed; waste scrap
247 Other wood in the rough or roughly squared
248 Wood, simply worked, and railway sleepers of wood
251 Pulp and waste paper
264 Jute & other textile bast fibres, nes, raw/processed
265 Vegetable textile fibres and waste of such fibres
269 Old clothing and other old textile articles; rags
281 Iron ore and concentrates
282 Waste and scrap metal of iron or steel
286 Ores and concentrates of uranium and thorium
287 Ores and concentrates of base metals, n.e.s.
288 Non-ferrous base metal waste and scrap, n.e.s.
289 Ores & concentrates of precious metals; waste, scrap
323 Briquettes; coke and semi-coke of coal, lignite/peat
334 Petroleum products, refined
335 Residual petroleum products, nes.& related materials
411 Animal oils and fats
423 Fixed vegetable oils, soft, crude, refined/purified
424 Other fixed vegetable oils, fluid or solid, crude
431 Animal & vegetable oils and fats, processed & waxes
511 Hydrocarbons nes, & their halogen.& etc.derivatives
514 Nitrogen-function compounds
515 Organo-inorganic and heterocyclic compounds
516 Other organic chemicals
522 Inorganic chemical elements, oxides & halogen salts
523 Other inorganic chemicals
531 Synthetic organic dyestuffs, etc. natural indigo & colour lakes
532 Dyeing & tanning extracts; synthetic tanning materials

551 Essential oils, perfume and flavour materials
592 Starches, inulin & wheat gluten; albuminoidal subst.
621 Materials of rubber (e.g., pastes, plates, sheets, etc)
625 Rubber tyres, tyre cases, etc.for wheels
628 Articles of rubber, n.e.s.
633 Cork manufactures
634 Veneers, plywood, improved or reconstituted wood
635 Wood manufactures, n.e.s.
641 Paper and paperboard
661 Lime, cement, and fabricated construction materials
662 Clay construct.materials & refractory constr.mater
663 Mineral manufactures, n.e.s.
664 Glass
667 Pearls, precious& semi-prec.stones, unwork./worked
688 Uranium depleted in u235 & thorium, & their alloys
689 Non-Fer base metals n.e.s.

Low Technology Manufactures

611 Leather
612 Manufactures of leather/of composition leather nes
613 Furskins, tanned/dressed, pieces/cuttings of furskin
642 Paper and paperboard, cut to size or shape
651 Textile yarn
652 Cotton fabrics, woven
654 Textil.fabrics, woven, oth.than cotton/man-made fibr
655 Knitted or crocheted fabrics
656 Tulle, lace, embroidery, ribbons, & other small wares
657 Special textile fabrics and related products
658 Made-up articles, wholly/chiefly of text.materials
659 Floor coverings, etc.
665 Glassware
666 Pottery
673 Iron and steel bars, rods, angles, shapes & sections
674 Universals, plates and sheets, of iron or steel
675 Hoop & strip, of iron/steel, hot-rolled/cold-rolled
676 Rails and railway track construction material
677 Iron/steel wire, wheth/not coated, but not insulated
679 Iron & steel castings, forgings & stampings; rough
691 Structures & parts of struc.; iron, steel, aluminium
692 Metal containers for storage and transport
693 Wire products and fencing grills
694 Nails, screws, nuts, bolts etc.of iron, steel, copper
695 Tools for use in hand or in machines
696 Cutlery
697 Household equipment of base metal, n.e.s.
699 Manufactures of base metal, n.e.s.
821 Furniture and parts thereof
831 Travel goods, handbags, brief-cases, purses, sheaths
842 Outer garments, men's, of textile fabrics
843 Outer garments, women's, of textile fabrics
844 Under garments of textile fabrics

845 Outer garments and other articles, knitted
846 Under garments, knitted or crocheted
847 Clothing accessories of textile fabrics
848 Art.of apparel & clothing accessories, no textile
851 Footwear
893 Articles of materials described in division 58
894 Baby carriages, toys, games and sporting goods
895 Office and stationery supplies, n.e.s.
897 Jewellery, goldsmiths and other art. of precious m.
898 Musical instruments, parts and accessories
899 Other miscellaneous manufactured articles

Medium Technology Manufactures

266 Synthetic fibres suitable for spinning
267 Other man-made fibres suitabl.for spinning & waste
512 Alcohols, phenols, phenol-alcohols, & their derivat.
513 Carboxylic acids, & their anhydrides, halides, etc.
533 Pigments, paints, varnishes & related materials
553 Perfumery, cosmetics and toilet preparations
554 Soap, cleansing and polishing preparations
562 Fertilizers, manufactured
572 Explosives and pyrotechnic products
582 Condensation, polycondensation & polyaddition products
583 Polymerization and copolymerization products
584 Regenerated cellulose; cellulose nitrate, etc.
585 Other artificial resins and plastic materials
591 Disinfectants, insecticides, fungicides, weed killers
598 Miscellaneous chemical products, n.e.s.
653 Fabrics, woven, of man-made fibres
671 Pig iron, spiegeleisen, sponge iron, iron or steel
672 Ingots and other primary forms, of iron or steel
678 Tubes, pipes and fittings, of iron or steel
711 Steam & other vapour generating boilers & parts
713 Internal combustion piston engines & parts
714 Engines & motors, non-electric
721 Agricultural machinery and parts
722 Tractors fitted or not with power take-offs, etc.
723 Civil engineering & contractors plant and parts
724 Textile & leather machinery and parts
725 Paper & pulp mill mach., mach for manuf.of paper
726 Printing & bookbinding mach.and parts
727 Food processing machines and parts
728 Mach.& equipment specialized for particular ind.
736 Mach.tools for working metal or met.carb., parts
737 Metal working machinery and parts
741 Heating & cooling equipment and parts
742 Pumps for liquids, liq.elevators and parts
743 Pumps & compressors, fans & blowers, centrifuges
744 Mechanical handling equip.and parts
745 Other non-electrical mach.tools, apparatus & parts
749 Non-electric parts and accessories of machines

762 Radio-broadcast receivers
763 Gramophones, dictating, sound recorders etc
772 Elect.app.such as switches, relays, fuses, plugs etc.
773 Equipment for distributing electricity
775 Household type, elect.& non-electrical equipment
781 Passenger motor cars, for transport of pass.& goods
782 Motor vehicles for transport of goods/materials
783 Road motor vehicles, n.e.s.
784 Parts & accessories of 722--, 781--, 782--, 783--
785 Cycles, etc. motorized or not
786 Trailers & other vehicles, not motorized
791 Railway vehicles & associated equipment
793 Ships, boats and floating structures
812 Sanitary, plumbing, heating, lighting fixtures
872 Medical instruments and appliances
873 Meters and counters, n.e.s.
882 Photographic & cinematographic supplies
884 Optical goods n.e.s.
885 Watches and clocks
951 Armoured fighting vehicles, arms of war & ammunit.

High Technology Manufactures

524 Radio-active and associated materials
541 Medicinal and pharmaceutical products
712 Steam & other vapour power units, steam engines
716 Rotating electric plant and parts
718 Other power generating machinery and parts
751 Office machines
752 Automatic data processing machines & units thereof
759 Parts of and accessories suitable for 751--or 752-
761 Television receivers
764 Telecommunications equipment and parts
771 Electric power machinery and parts thereof
774 Electric apparatus for medical purposes, (radiolog)
776 Thermionic, cold & photo-cathode valves, tubes, parts
778 Electrical machinery and apparatus, n.e.s.
792 Aircraft & associated equipment and parts
871 Optical instruments and apparatus
874 Measuring, checking, analysing instruments
881 Photographic apparatus and equipment, n.e.s.

Appendix B

Table 1. Exports classified by technological categories, Brazil, 1945-1973 (US$ dollars at 1970 prices)

Year	*Primary Products*	*Resource Based Manufactures*	*Low Technology*	*Medium Technology Manufactures*	*High Technology*	*Total Exports*
1945	853,543	207,957	221,056	29,433	12,214	1,324,204
1946	1,239,721	270,726	113,224	17,130	10,534	1,651,335
1947	1,295,674	218,210	119,130	17,303	5,940	1,656,256
1949	1,324,220	156,028	46,319	10,065	3,936	1,540,567
1950	1,630,953	167,740	20,854	3,521	2,738	1,825,805
1951	1,869,281	208,432	39,587	11,224	2,312	2,130,837
1953	1,786,418	198,574	2,055	4,084	768	1,991,899
1954	1,591,005	141,480	994	4,061	617	1,738,158
1955	1,513,962	257,835	3,273	8,201	533	1,783,804
1956	1,604,017	174,362	3,422	13,256	369	1,795,426
1957	1,296,309	322,575	3,276	10,208	1,030	1,633,397
1958	1,097,211	327,934	5,472	6,364	1,310	1,438,291
1959	1,137,823	326,499	5,102	6,091	1,031	1,476,546
1960	1,110,524	327,323	9,190	8,277	844	1,456,158
1961	1,214,657	389,759	5,644	25,535	4,060	1,639,654
1962	1,064,820	313,766	4,954	23,305	3,795	1,410,640
1963	1,233,423	367,456	7,062	24,788	5,084	1,637,815
1964	1,231,027	360,472	21,158	43,649	6,334	1,662,640
1965	1,243,457	442,855	53,128	58,257	9,227	1,806,924
1966	1,347,538	446,504	52,985	48,072	14,641	1,909,741
1967	1,234,626	419,019	58,849	66,978	27,748	1,807,221
1968	1,369,047	512,308	49,091	55,627	25,392	2,011,465
1969	1,584,444	598,184	71,863	71,745	32,433	2,358,668
1970	1,707,125	704,767	124,954	119,001	46,987	2,702,834
1971	1,556,822	842,102	132,579	143,594	46,405	2,721,501
1972	1,987,814	1,117,307	266,679	240,813	45,147	3,657,760
1973	2,667,215	1,520,332	380,286	334,096	56,726	4,958,655

Sources: IBGE, *Anuário estatístico*, various years.

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