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Productivity performance in developing countries

Country case studies

Brazil

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Executive summary

The objective of this report is to assess Brazil's productivity performance since the 1960s and explore the main determinants and policies behind productivity change.

One of the most striking aspects of Brazil's long-term growth is the loss of dynamism observed from the beginning of the 1980s onwards. After average rates close to 7% since the 1940s, GDP growth averaged only 1.6% per year in the period 1981-90. In the late 20th and early 21st century the economy experienced limited recovery: 2.4% p. a. between 1995 and 2004. What is intriguing is that, despite this lacklustre performance, productivity growth resumed in the early 1990s. This was due to major economic reforms implemented since then, all of which boosted growth in the medium to long-term.

The evidence on average labour productivity (ALP) in the manufacturing sector indicates high variance around a long-term average of 2.9% p.a. A relatively long period of fast ALP growth from the late 1950s to the mid-1970s (except from 1963-67) was followed by a period of near stagnant productivity until the early 1990s. The recovery since then occurred concomitantly with import liberalization. Phases of fast output growth were also marked by productivity growth.

An exercise to evaluate the importance of aggregate ALP to explain GDP growth in Brazil suggests that it represented a decreasing, but high share of GDP change over time from the 1940s to the 1970s. Between 1980 and 1991 labour productivity growth was negative, a trend reversed in the 1990s.

UNIDO's database statistics show an initial long phase of high ALP growth concomitant with strong GDP growth. Between 1960 and 1980 ALP grew, on average, at 4.1% p.a., while GDP grew at 7.5% p.a. A second phase of ALP (more modest) growth took place in the post 1992 period: ALP grew at 1.6% p. a. and GDP at 3.6% p. a. The period between 1980 and the early 1990s was marked by strong macroeconomic instability, one of the consequences of which was a mediocre productivity performance. Brazil's relative position with respect to the US ALP deteriorated somewhat between 1961 and 2000. The drop in Brazil's position was mainly due to the poor macroeconomic performance during the recession together with the high inflation phase of late 1980s and early 1990s.

One of the most important factors behind recent productivity performance is the growth of ALP in agriculture since the mid-1970s due to the introduction of new crops, improved agricultural inputs and modern farming and managerial techniques. Other sectors, besides agriculture, have experienced productivity gains since the early 1990s, although strong productivity gains were concentrated in a small number of sectors. A few sectors actually experienced a decline in productivity.

TFP accounted for between 32% and 42% of manufacturing value added growth during the 1960s. The cross-sector pattern of TFP change was dictated by a number of mostly interrelated variables: size of plants, market concentration, market share of foreign firms, payments for patents, foreign technology purchases, skill of the labour force, growth of plants, capital stock growth and market share of output from new plants.

TFP represented 20% of the rate of output growth of the Brazilian manufacturing sector in the 1970s, a lower share than in the 1960s. Sectors which relied more heavily on

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imports of material inputs, machinery and equipment and technology were those with the highest TFP growth. This suggests the existence of incorporated embodied technological change - also a feature of post-1990 productivity performance - when import liberalization resulted in increased use of both imported raw materials and machinery and equipment.

Slow TFP growth in Brazilian manufacturing from 1975 and 1985 was associated with slow output growth in the same period. There is also an association between sector patterns of TFP change and trade orientation. Export growth and TFP change were found to be positively associated, the link between them possibly being output growth led by faster export growth. This is an indication of the pro-cyclical nature of productivity.

From 1970 to the late 1990s it was found out that manufacturing TFP experienced a substantial recovery in the 1990s, a finding confirmed by nearly all studies. One investigation based on a sample of large firms found that import liberalization had a major influence on productivity performance. Another established that productivity growth not only resumed in the 1990s, but also was partially based on the closure of some of the smallest and least productive firms in a type of 'natural selection' process.

All known studies on aggregate TFP growth drew attention to two main issues: the importance of physical and human capital accumulation for increasing growth and the role of productivity change in this growth-enhancing process. Most studies on capital accumulation in Brazil indicate that investment was a critical factor. The historical record suggests that capital accumulation was *the* major factor behind GDP growth, indicating that one can hardly expect growth resumption on a significant scale without investment increases. The Brazilian experience in the 1990s indicates precisely this phenomenon of low investment in physical capital concomitant with slow GDP growth. A positive aspect of this period was, however, the attainment of substantial productivity gains.

Early studies on trends in capital accumulation in Brazil highlighted the fact that the pace of accumulation was very rapid from the 1950s to the 1970s, but fell back later on. Almost all countries in Latin America experienced sharp increases in capital-output ratios, indicating falling capital productivity, although Brazil was the worst example of this trend.

TFP change represented a varying share of GDP growth. According to one source, aggregate TFP growth reached 2.5% p.a. in the period 1965-70 and 2.1% p.a. in 1970-74, both of these phases of fast growth. In the 1950s, in turn, it accounted for over half of total GDP growth. In general, GDP growth was largely explained by growth in factor inputs (except in the 1950s), although the available research also indicates some divergence of findings, in part depending on the periods chosen. In general, TFP growth in the 1980s was negative, as both labour and capital inputs grew faster than GDP.

The importance of human capital accumulation has also been documented. One comparison of the 1950s and 1960s concluded that GDP growth reached 6.64% p.a. in the former decade and 5.78% p.a. in the latter. Total labour contributions represented, respectively, 33% and 47% of GDP growth in both decades. Residual growth was 40% of GDP growth in the period 1950-60 and 21% in 1960-70.

A more recent growth accounting exercise indicated that human capital represented only a small portion of Brazil's growth in some periods. Its contribution was small especially in the years between 1994 and 2000, at only 7% of GDP growth. TFP, in turn, explained a substantial share of GDP growth in all periods except 1981 to 1993 while physical capital accumulation and TFP growth accounted for most of Brazil's growth since 1930. TFP growth seems to have been systematically associated with the growth in the stock of machinery and equipment: some TFP growth was gained through capital-embodied technological progress.

Other studies on the importance of aggregate TFP change produce a less consensual conclusion on the relative relevance of factors of production. One of them, devoted to the period 1930-1993, found that the contribution of capital accumulation to a 6.1% average GDP growth was 5.11%, labour contributed with 0.84% and TFP the remaining 0.16%. In addition there was no significant impact of human capital on GDP growth.

Aggregate results for more recent periods contradict some of these last conclusions: in the period 1970-97, both for the economy as a whole and for the manufacturing and agricultural sectors the contribution of capital was high, although TFP change also represented a major source of GDP growth in some sub-periods. This was especially true in the 1990s, both in the manufacturing sector and in the overall economy.

Recent research arrived at similar results, emphasizing the crucial role of capital deepening in GDP growth in periods such as 1974-84 (the last decade of the military regime). GDP growth in this decade could only be maintained by very high doses of capital deepening financed by external debt accumulation. In both periods, 1964-74 and 1993-02, the contributions of capital deepening were very small or nil. The importance of TFP change varied substantially over time, reaching negative values during the periods 1974-84 and 1984-93. In the remaining periods, it represented a large share of GDP growth.

We also interpreted the phases of rapid growth and slumps in productivity and identified the major factors behind productivity change using UNIDO's database to distinguish between effects arising from catching up on the technological frontier or technology shifts. In good measure, and in most years, TFP performance follows GDP performance - suggesting, again, that productivity is pro-cyclical. Capital deepening was a major determinant of GDP change from 1968 to 1980, following a sizeable contribution of some 30% of average GDP growth in 1962-67. During the 'lost decade' of 1981-92, on the other hand, its contribution was negative. After 1992 a modest 0.16% average capital deepening was observed, to be compared with GDP's 3.58% average growth. TFP growth, at 1.57% p.a., represented a high share of average GDP rates of increase in the most recent period: 44% of GDP growth in 1993-2000. Average TFP growth rates were low in the 1980s (0.44% p.a.) and, even more so, in the second half of the 1970s (0.28% p.a.).

The breakdown of TFP growth into technical efficiency change and shifts in the technological frontier shows that changes were mostly based on technical change, or innovation, rather than on changes in technical efficiency. Technical change was positive most of the time in the 1960s and made a significant contribution to TFP change. It also displayed strong growth after 1991, following two decades of a lacklustre performance. We therefore found strong evidence of the importance of innovation in raising TFP

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during particular periods. Furthermore, after 1991, it occurred at rates never before experienced. Efficiency change, on the other hand, was, on average, positive only during the high GDP growth periods of 1968-74 and, to a lesser extent, 1975-80. We noted that these were precisely the years in which the fixed capital stock expanded most. This association suggests that gross investment is a major vehicle of efficiency change. In the remaining years the indicator of efficiency change was, on average, negative. This was true during the period 1962-67 and from 1981 onwards and after 1992 in particular, suggesting that there is little evidence of catching up to the technological frontier in this last period. All recent TFP change was due to technical change, thereby indicating the important role of innovation in this respect.

In assessing the major determinants of productivity we analyzed them in decreasing order of importance, as suggested by the Brazilian experience and in a sequence that begins with factor supply and allocation. Factor accumulation explained a substantial share of GDP growth. Factor supply refers to physical capital, investment in human capital and 'labour quality', and physical infrastructure. Factor allocation refers to structural change and to the role played by the financial system in the allocation of resources.

Growth of physical capital proceeded at very fast rates throughout most of Brazil's past, concomitantly with output growth. But capital productivity decreased substantially from the mid-1970s to the early 1990s, following a nearly universal trend, albeit at a more rapid pace. Capital accumulation growth rates began to fall from the early-1980s onwards as macroeconomic imbalances and uncertainty increased sharply and concomitantly with the debt crisis and the threat of hyperinflation. Capital stock growth recovery in the 1990s was, at best, modest. The reasons behind the performance observed are only partially based on reduced savings and rather emphasize the role of three factors: increased price of investment, diminished capital productivity and decreased capacity utilization. Not only does capital accumulation growth account for a substantial share of aggregate output growth, but productivity growth also explains a sizeable part of the performance observed. Fixed capital also has an important contribution to make, particularly when we note that fast capital growth was associated with changes in technical efficiency.

The availability of labour has not been a hindrance to Brazil's growth, as an elastic supply of manpower has characterized past performance. The fact, however, that employment, and especially formal employment, has recently been growing more slowly than long-term rates suggests that the level of expertise in the workforce is also expanding at a slower pace. The educational system has gone through pronounced changes in contemporary Brazil. Increased enrollment rates in all levels of education have been the norm since the 1970s and the number of graduates has risen steadily since the 1980s. Despite recent advances, the still below-average quality of manpower is a powerful impediment to innovation. Attention has been drawn to the fact that, among the factors most closely associated with the probability of engaging in innovative activities, two are directly linked to the labour force: training and level of education.

Two aspects deserve closer attention when assessing factors making for slower human capital improvements: the widespread existence of informal labour relations, which poses powerful barriers to economic growth and productivity change and the strict set of rules and regulations that govern the labour market. Informal employment practices have several causes, the most important being: (i) high costs implied in formalized activities which can be divided into those arising from rigid rules (e.g. the formalities for creating

and closing down businesses, rules governing labour relations, the excessive tax burden on formal firms and high social security contributions); and (ii) the low enforcement capacity of the authorities, often associated with slow judicial processes and a backlog in the system.

Strict labour market regulations are also a hindrance to productivity advances. These regulations were not addressed during the reforms of the 1990s. They remain essentially the same as when they were first implemented in the 1940s. Indeed, Brazilian labour regulations are among the most rigid in the world and a source of inefficiency: they fail to protect the workers and are an obstacle to the more efficient allocation of labour resources. This translates into increasing informal employment. Rigid labour laws result in a lower level of recruitment, slower output and productivity growth. The existing regulatory framework has imposed high and increasing labour costs.

The role of physical infrastructure, on the other hand, has not been especially productivity-enhancing in the last decade. There is no doubt that, prior to that, the physical infrastructure did not hamper growth and productivity to any significant extent. Indeed, the Brazilian industrialization process was characterized by high publicly-funded investment in infrastructure, especially in the generation, transmission and distribution of electricity and in road construction. This was the case up to the early 1980s, when the fiscal conditions in the country began to worsen. As the fiscal crisis became deeper, infrastructure investment, which was (and still is) mostly publicly funded, suffered severe cuts. Privatization was adopted in the 1990s as one way out of the problem, but represented only a partial, and so far ineffective answer in most sectors. Public-private partnerships (PPPs) are presently seen as an - also partial - solution for infrastructural financing difficulties.

Roads and ports have not contributed much to efficiency improvements in the recent past either, as the existing infrastructure has reached levels of nearly complete utilization due to lack of (budget-constrained) public investment. Institutional change and reform since the early 1990s have not been able so far to attract private investment to physical infrastructure of this kind. A study of the long-term impact of infrastructure investment on growth and productivity of private inputs in Brazil shows that there is a strong association between infrastructure investment and GDP in the long-run. There is also a significant correlation between infrastructure and TFP change. Electrical energy, transportation and telecommunications are the segments that most closely influence GDP. Accordingly, the fall in public investment in electrical energy and transportation since the 1980s had a significant negative impact on output and productivity in the Brazilian economy.

Structural change has also contributed to growth and productivity. There have been periods in which production shifted to sectors characterized by above-average labour productivity, while in other phases the opposite occurred. The changing nature of structural change reflects the macroeconomic environment and performance in the sense that slow growth is associated with a poor productivity performance. In addition, productivity gains were not evenly distributed over time among sectors. Most sectors had above-average ALP in the long-run, led by the financial sector, manufacturing industries, mineral extraction and public utilities, construction and public administration and there was some long-term convergence towards the average.

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Aggregate ALP change can be broken down into two components: a structural, or allocation term and a pure productivity component. The results of a breakdown exercise point to the long-run importance of factor allocation. The effect of changes in the productive structure represented from 35% (in the 1950s) to 49% (in the 1960s) of the total absolute increase in aggregate ALP in the economy. Their complement is given by pure productivity increases. The effect of structural change ceased to exist after 1980 and the major part of (diminished) ALP change was caused by sectoral ALP in the 1980s. In the period 1991-2000, a negative allocation effect meant that labour shifted to sectors of below- average ALP, as in the previous decade. The positive ALP growth achieved, modest as it was, was entirely due to sectoral ALP growth. One of the implications for future productivity growth is that it is not enough to improve sectoral productivity performance. It is also necessary for a shift in the employment structure from sectors with low, and sometimes decreasing productivity (commerce and other services), to sectors with above- average ALP.

The effectiveness of the financial system as a source of productivity growth is also a matter of concern. For want of a system of long-term financing, resources available to firms have been very much constrained. Foreign loans and foreign direct investment (FDI) together with loans from the Brazilian National Development Bank (BNDES) constitute sources of long-term finance. It is acknowledged that funds internally generated have been by far the main source of finance for firms. By and large, the financial system has not assumed had its expected role in the allocation of resources, despite the fact that the country's financial system has undergone significant transformation since the mid-1990s. Despite this, the ratio of credit to GDP continues to be extremely low.

Low financial intermediation reflects many factors, but especially the very high basic interest rate in the economy - one consequence of high spreads and jurisdictional uncertainty. High spreads, in turn, reflect four main factors: precautionary measures against non-payment of debts, fiscal expenditures associated with loans, judicial difficulties to recover bad loans, and little competition among banks. Securities markets such as bond and stock markets play only a limited role in financing new investment and the expansion of activities. Firms, therefore, rely mainly on funds internally raised and only large enterprises firms resort to external finance. In addition to present constraints, the available commercial bank credit is only of short-term maturity. Private agents display a clear preference for government liquid assets. Fears of default on public debt also push lenders to short-term loans. On the other hand, partly due to low financial intermediation and partly to improved central bank supervision, the financial sector has proven to be reasonably solid, with very few cases of bankruptcy in the recent past. Its role as an economic growth agent is, nonetheless, still in its early stages.

Most credit to firms, whether for expansion or new business development comes either from retained earnings or from the Brazilian National Development Bank (BNDES), the sole institution to grant long-term loans. Privatization of the banking sector in the 1990s did not result in the complete disappearance of public banks.

Knowledge embodied in human capital has been an important source of productivity change in Brazil in some, but not all periods analyzed. Training processes have become more common among firms. After the beginning of trade liberalization, the intense organizational changes that characterized most of the manufacturing sector (as well as the

telecommunications and the financial sectors) also included a renewed emphasis on training. Perhaps more importantly, capital accumulation - which can also be viewed as increasing the stock of knowledge and hence productivity, through embodied and disembodied technological change - has seen substantial growth as well in certain periods. In some of them, at least, capital accumulation involved a high proportion of state-of-the-art imported machinery and equipment, which is a very important source of productivity gains.

Product and process innovation from indigenous R&D activities in Brazil has been limited and concentrated in time. Reliance on technology transfers from abroad has been historically the norm. The role of FDI in this context is of great importance, as the process of technological change is largely restricted to absorption and adaptation (or imitation) of innovations generated elsewhere. Innovation is resource-constrained and imitation is not necessarily based on the latest technologies. Technology absorption has also been uneven over the years.

Despite this, Brazil appears to be in a not too unfavorable position with respect to the innovation race, when compared with other developing countries. This is because of (a) the existence of a diversified and vertically integrated manufacturing structure; (b) a large domestic market; (c) a sizeable network of R&D institutions and firms engaged in R&D; (d) a wide range of graduate courses, in both number and quality; (e) linked to the previous, growing scientific output; (f) a competitive aeronautical industry; (g) a competitive commodity-based agricultural sector, relying on endogenous R&D. The creation of new technology has been mostly restricted to a few sectors and activities, mainly oil extraction, mining and agriculture. In all these cases research has been conducted by state-owned enterprises (SOEs), as in the oil and mining sector, or by state research institutions.

The technological intensity of Brazil's exports, in turn, reflects the predominance of low technology products, as expected from the country's rich natural resource endowments. Primary commodities represented 40% of total exports, labour and natural resource-intensive manufactures accounted for 13% and low-technology manufactures 8% in 2003. Average technology goods were responsible for 19% of total exports (the world average being 30%); and high-technology products accounted for 12% (the world average being 30%).

The role of FDI with respect to technology absorption and adaptation is also noteworthy. Since the worldwide generation and diffusion of technological capabilities and skills is largely concentrated on TNCs, their role in enhancing these aspects in Brazil seems undisputed: TNCs are primary conduits for the transfer of technologies and related skills, with linkages and spillovers to firms and institutions outside the TNC system playing an important role in the diffusion of technology. Equally, organizational and managerial practices propagated by TNCs - central factors to the competitiveness of firms - facilitate the efficient utilization of labour, capital and technological resources.

The long-established concept of the association between R&D intensity and TFP growth seems to be confirmed in Brazil. Periods of relatively high TFP growth have also been phases of relatively high R&D intensity often associated with TNC performance. An overall assessment of the country's absorptive capacity for new technology would also

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highlight the major improvements since the early 1990s, as trade policies successfully induced productivity change.

The financial and physical capital provided by TNCs is one of FDI's main contributions to productivity growth. New FDI flows into Brazil increased the existing capital stock and led to more efficient resource use. FDI also induces multiplier effects - as all investment does - through forward and backward linkages and spillovers, in the form of positive externalities. FDI's contribution to Brazil's fixed capital stock has nonetheless remained at a low level.

Despite the role foreign capital played in Brazil's development, many legal restrictions had historically been placed on FDI remittances, repatriation, access to sectors of investment, etc. The overall direction of change since the early 1990s has been clearly towards greater liberalization. Thus, both tradition - i.e. the existing stock of FDI - and market size, coupled with an economic policy (mostly) conducive to attracting inflows of foreign capital were the main factors responsible for increased FDI flows in the 1990s. The stock of FDI is presently estimated at US\$ 130 billion (December, 2004).

Brazil has experienced significant progress in terms of trade, finance and FDI liberalization since the late 1980s. Lower barriers to trade, FDI and portfolio capital flows, together with decreased transport and communications costs, have resulted in more options for firms in terms of where to produce and to sell. This, in turn, fostered more integrated patterns of TNC production, as represented by augmented FDI flows, as the debt crisis of the 1980s waned and debt restructuring took place. New inflows of FDI and new trade policies have been self-reinforcing.

Recession and slower demand growth since 1990, coupled with trade and financial liberalization have also intensified competitive pressures. From the mid-1990s until 1999, a relatively overvalued exchange rate further intensified these pressures. One result of these developments was an increased concern with productivity and competitiveness at plant level, as firms were forced to exploit every available source of efficiency. Many of them, in particular the small and least productive companies did not survive the competitive pressures. Not infrequently, firms became the targets of mergers and acquisitions, an area in which TNCs have been particularly active. FDI flows into Brazil displayed new impetus after 1992, initially in the form of portfolio investment attracted by high real interest rate differentials relative to other countries, due to the high interest paid on government debt. Later on, FDI was stimulated by stabilization, demand growth and privatization and inflows reached historically high levels, especially in the years from 1994 to 1998.

Trade liberalization makes it more difficult for domestic firms to protect themselves from competition in their home markets and to guarantee secure sources of profits. Therefore, liberalization is also associated with inward FDI in the sense that both generate increased productivity through competitive pressures. In actual practice, in countries facing structural change of the kind experienced in Brazil experienced since the 1990s, these two issues are closely intertwined. Rapid labour and TFP growth, cost reductions per unit of output, successful product innovation, enlarged market share and increased comparative advantage in foreign trade (as reflected in higher export levels) are typical competitiveness-related variables associated with the presence of TNCs in Brazil. The export orientation of foreign-owned firms is, on average, higher than that of domestic

firms, partly due to the role and extent of intra-firm trade they tend to undertake. In addition, host countries provide export incentives which are taken up more readily by TNCs than by domestic firms, reflecting competitive advantages in international markets due, for instance, to superior marketing channels and/or managerial flexibility.

The competitive environment has been changing markedly in Brazil since trade liberalization, privatization and other state reform programmes, although production in certain manufacturing industries remains very concentrated on a small number of enterprises. This is especially true of sectors such as steel, certain construction materials, beverages (e.g. beer and soft drinks), chemicals and petrochemicals, not to speak of non-manufacturing activities such as mineral (oil and non-oil) extraction.

The same can be said of the asset and income inequality issue. Brazil is well known for its unequal distribution of income and high incidence of poverty, although both have changed somewhat in the last decade, largely as a result of the Real stabilization plan. Thus, the overall impact of reforms on poverty was limited. There are two channels through which reforms may affect poverty: income growth and income redistribution. In both cases the results of the reforms were relatively insignificant. The effect of these aspects (inequality and poverty) on productivity change is not easy to evaluate. Widespread income inequality makes for small markets for many goods and services. Therefore, scale economies cannot be achieved and productivity is, likewise, limited. For this reason, large income and asset inequality have hampered productivity growth.

Environmental concerns have not so far been given the attention they deserve in Brazil. Except in a few cases, usually related to the generation of electric energy in large hydro-electric plants requiring large-volume water reservoirs, environmental regulations have had no great positive or negative impact on productivity growth. This may well, however, change in the near future.

As to integration into the world economy, Brazil has traditionally been an extremely closed economy due to ISI policies and the protectionist practices they entailed. However, the country has recently become more and more integrated in terms of both trade and finance. Recent trends in export growth, after the exchange rate devaluation in 1999 and the adoption of a freely floating exchange rate regime, boosted exports which became a relevant source of demand growth, particularly in 2003-2004, when they were responsible for the economic recovery. Brazil is competitive in a broad range of goods, from aeronautical equipment to steel and soy and related products. Activities based on natural resources (such as mining, steel and agribusiness) have developed export capacity faster than others, resulting in productivity gains in these sectors.

The market reform process that Brazil began in the late 1980s and early 1990s has remained incomplete, in the sense that it lacks complementary institutional reforms in areas such as sectoral and overall regulation, property rights, judicial and labour market reform. Another aspect of excessive regulation is its role in expanding the informal economy, because it induces companies to operate at sub-optimal scales and capital intensity, causing both labour and total factor productivity to be lower than otherwise. Although its overall effect is difficult to gauge, institutional change in Brazil has been proceeding in the right direction since the early 1990s, although there are still difficult and unresolved issues to be addressed.

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Concerning the invariants, Brazil has clearly benefited from its geographic location, natural-resource endowments and potential market size. Political institutions have been increasingly responsive to the need to improve regulations and growth-enhancing instruments. Natural-resource endowments are clearly positive in Brazil: good quality land (in good measure made possible by improvements in the agricultural land due to indigenous R&D) and mineral resources abound, with the exception of coal; Brazil is also competitive in mining and likely to become self-sufficient in oil due to deep-sea production.

The analysis of the role of economic policies, both sector-specific (i.e. manufacturing) and general, in affecting productivity suggests that the Brazilian productivity record has been largely dictated by development policies, strategies and institutions put in place during the import substitution industrialization (ISI) phase and by the changes that took place thereafter. The record was also influenced by the overall macroeconomic performance together with policies and strategies in the sense that productivity, both labour and multi-factor, seems to be pro-cyclical. The main explanation for this is the existence and strength of scale economies and other hidden productivity-enhancing factors that tend to respond positively to the pace of output growth, especially in the manufacturing sector. Apart from the overall growth strategies and performance, firms fared differently in terms of productivity, depending on specific institutional, market and sectoral characteristics.

As a general rule, the objectives of industrial and trade policies were subordinated to macroeconomic objectives after the Real Plan was implemented in 1994. Thus, trade policy became formally oriented towards increasing trade flows and monitoring these flows so as to ensure an adequate supply of goods on the domestic, prevent unfair trading practices and contribute to the balance of payments equilibrium. The impact on the structure and performance of the manufacturing sector was significant. Productivity increased substantially during the decade, but competitiveness suffered from the exchange rate appreciation. Still, despite policy-makers stated preference for 'horizontal' instruments, as opposed to industrial targeting - something which was clearly in line with the priority attached to macro stabilization - one of the main legacies of President Cardoso's (1995-2002) industrial policy was markedly sector-oriented: the automotive agreement with Argentina.

Different studies have confirmed empirically that trade liberalization had a positive effect on productivity. Productivity growth has been the answer to increased import competition in a number of sectors, although the Brazilian experience in this respect was also one of extremely varied responses. To some extent this reflects the fact that it is difficult to single out effects of trade liberalization, privatization and other reform on productivity performance. Nevertheless, it is tempting to attribute the improved productivity results in many sectors over selected periods of time to the reforms of the late 1980s and early 1990s. Against this background, the high volatility in output growth, exchange and interest rates that characterized this period affected individual sectors in different ways.

The 1990s also witnessed the introduction of new and modern management and organizational techniques, especially in manufacturing. These two phenomena coincided, leading firms in nearly all sectors to restructure, further boosting productivity - albeit at the cost of a substantial reduction in employment in the manufacturing sector. By focusing on defending market shares instead of expanding activities, this form of

restructuring led to a concentration of investment on modernization rather than on developing productive capacity.

The main constraints to productivity growth have been identified as follows: (i) low levels of capital accumulation, partially caused by increased prices of investment goods and diminished capital productivity until the early 1990s; this, in turn, is in line with worldwide trends from the mid-1970s onwards, inefficiencies in the domestic production of capital goods and the increased share of the construction sector in total capital formation; (ii) institutional aspects, such as the lack of proper regulation and a deficient infrastructure, particularly since the late 1980s; (iii) the poor quality of the labour force, despite recent changes - faster expansion of TFP was observed in the 1960s and 1970s in sectors with a more skilled workforce; (iv) technology transfer from abroad was mostly possible through FDI and TNC and their role has changed substantially over time, with a clear improvement since the early 1990s; (v) the sectoral composition of fixed investment evolved towards an increasing share of construction in the total; since productivity is more closely associated with machinery and equipment absorption than construction expenditures, the recent results suggest constraints to productivity growth. The established nature and composition of the capital stock had a positive effect on TFP: lower average ages of firms or higher proportions of output in the case of newer firms characterized higher TFP gains in both decades.

Privatization led to substantial change in Brazil's economic landscape since it was implemented over the past two decades. The privatization programme was a major source of attraction for new FDI and the share of foreign investors in the overall privatization proceeds increased substantially over time. Part of the success in attracting FDI was due to changes in the legislation governing such flow and those which abolished the previously existing restrictions on the level of foreign capital allowed in privatization. There is evidence that privatizations in the area of infrastructure made possible increases in investment and productivity. Yet only a minor part of the rise in productivity translated into lower prices for consumers, due apparently to the absence of significant competition in infrastructure and tariff-indexing rules.

It is difficult to single out the effects of privatization and other reforms on productivity performance. However, the improved productivity record in sectors such as mining, steel, petrochemicals, public utilities and telecommunications can clearly be attributed to privatization. Although it is tempting to generalize and state that privatization "caused" productivity growth, this assumption must be approached with more caution: in at least two infrastructure sectors (communications and public utilities), output growth and productivity had been occurring at very rapid rates before privatization began.

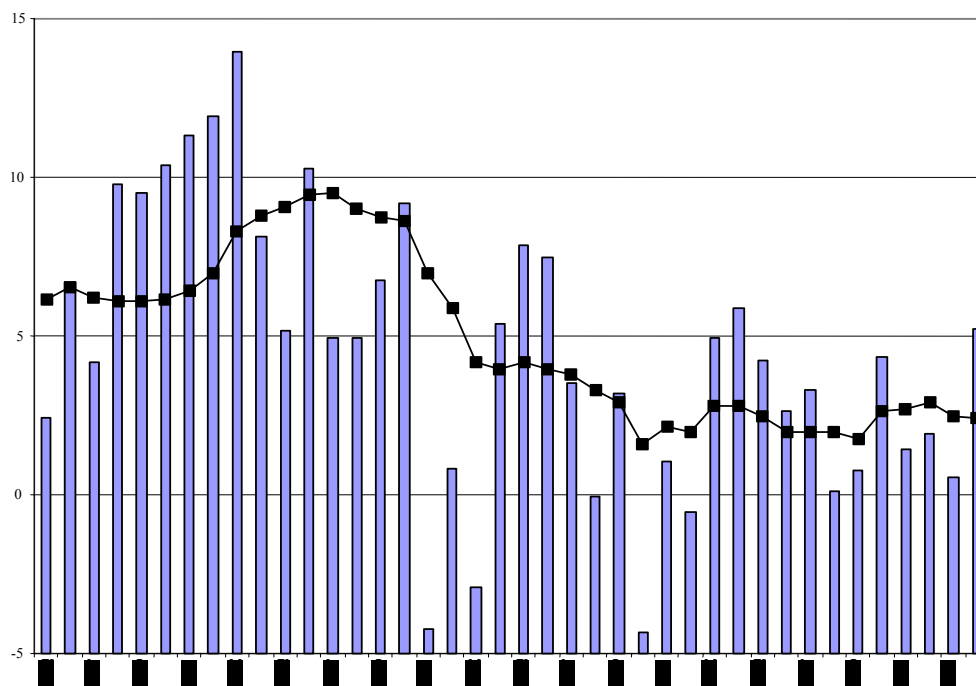
I. Productivity performance in Brazil: Introduction

1.1 Overview and context

One of the most striking aspects of Brazil's long term growth experience is the loss of dynamism observed since the beginning of the 1980s (Figure 1.1). Indeed, GDP 10-year average growth rates plunged from figures of almost 10% p.a. between 1968 and 1977 to 1.6% p.a. in the period 1981-90. In the late 20th and early 21st century the economy experienced only a limited recovery, as witnessed by a 10-year GDP growth average of 2.4% p.a. between 1995 and 2004.

Behind the poor performance since 1980 lie difficulties and issues such as failed stabilization attempts - often associated with recessions (1981-83, 1987-88, 1990-92), and a succession of mostly exogenous shocks. These included external crises (1995, 1997 and 1998), the blow-up of the NASDAQ bubble, a domestic energy crisis (2001), the effects of September 11 on the international economy, Argentina's default (2001) and fears about economic policy changes associated with prospects of a left-wing Lula presidency. Consequently, a confidence crisis ensued in 2002 which required drastic measures (in the form of reinforced fiscal rectitude and high interest rates) and resulted in only minimal GDP growth in 2003 (only 0.53%). As a result of the measures taken, however, GDP growth resumed in 2004 and is likely to continue in 2005 (albeit at a slower pace than in 2004).

Figure 1.1: Brazil — GDP growth rates and their 10-year moving averages, 1965-2004 (%)



Source: Brazil, National Accounts. Originally in Bacha and Bonelli (2004)

Productivity performance

Important economic reforms were implemented since the early 1990s, all of which were growth-enhancing in the medium to long-terms. It is fair to say that these reforms have not so far been able to boost the country's growth performance and potential. In part, this was due to the aforementioned succession of shocks. In particular, it emerges that changes in investment and savings rates alone cannot be blamed for Brazil's reduced dynamism and, that predictably, productivity also played a role in this poor economic growth record, especially in the 1980s.

Our appraisal of long-term Brazilian growth starts during the strong growth acceleration in the second half of the 1950s under President Kubitschek. The years 1956 to 1960 constitute a period in which intense industry-based structural transformation took place. The establishment of many of Brazil's modern manufacturing plants producing consumer durables (especially cars and electrical-electronic goods and equipment), intermediate goods and capital goods dates from this period. Loose monetary policy associated with the construction of the new capital, Brasilia, led, however, to severe inflationary pressures by 1960.

Attempts to reconcile growth and inflation under hard exchange rate constraints led to tensions that were to be felt in the early 1960s. As inflation accelerated and investment faltered, growth rates began to fall. A political crisis partly associated with President Quadros' resignation from office (August, 1961) also indicated that major economic reforms were called for. The subsequent populist regime of 1962-63 was not able to cope with conflicting economic proposals as inflation rates soared. Political instability, the inability (or unwillingness) to curb inflation and the difficulty to deal with balance of payments (BOP) disequilibria led to a drastic deterioration of macroeconomic conditions. This state of affairs ultimately resulted in a military intervention in early 1964 that would last for 21 years, until 1985.

Growth under the initial years of the military regime was modest, as inflation was painfully and only partially controlled through monetary policy and wage squeezes. There were, however, successful attempts at economic reform between 1964 and 1967, including a major tax reform. The ongoing unresolved issue of government financing was ingeniously dealt with by indexing revenues and the issuing of new public debt indexed to past inflation. The foreign debt was rescheduled thanks to recourse to the FMI and support from the international financial community. BOP disequilibrium was handled in part due to the recession that followed. This also helped to solve the external crisis on account of new foreign capital inflows, export growth and import repression during the recession then experienced.

Institutional breakdown, however, did not mean a change of growth patterns. These featured continued recourse to FDI and technologies similar to those in the developed countries and, in particular, the adoption of protectionist measures¹ in the context of a typical import substitution industrialization (ISI) model. In the late 1960s Brazilian economic policy also benefited from the new wave of international financing associated with the market for petrodollars - a phenomenon which is at the root of the foreign debt crisis in the country would experience from the late 1970s onwards and which led to the

¹ Except for brief episodes, such as the attempts at trade liberalization between 1967 and 1968, aborted after the first oil crisis.

foreign debt default of 1982. Nevertheless, growth resumed at a very fast pace after 1967, as Brazil embarked on a phase of strong external borrowing and financing.

A useful characterization of the period 1968-1980 distinguishes between two sub-periods. The first one, 1973-74, was an epoch in which GDP grew on average at a little more than 10% yearly and was termed the 'Brazilian Economic Miracle'². The second sub-period up to 1980 was characterized by slower growth and variable growth rates. This performance could only be achieved, however, by steeply increasing foreign debt, which complemented domestic savings in financing strong capital formation acceleration. Foreign indebtedness was pursued especially after the first oil shock, as the government refused to adjust the economy to the new and much less favourable prevailing international conditions. In a period marked by international recession, as in the mid-1970s, Brazil continued to grow at rapid rates – though slower than previously observed (see Figure 1) - due to rising foreign indebtedness.

This represented an effort to postpone the cost of adjustment throughout the 1974-80 period, thereby maintaining both high levels of consumption and investment. This phase was known as 'the forced march economy' period. The country's vulnerability to shocks, however, did not diminish. Dependence on imported oil, for instance, persisted, albeit disguised under the stability of nominal prices and the fall of real prices, given world inflation in the period 1973-78³. The need to adjust became crucial after the country was hit by the second shock wave of the late 1970s which brought the second oil shock, a sharp increase in international interest rates due to monetary policy changes in the USA, and an international recession between 1980 and 1982. This constituted a severe blow after a period marked by strong external indebtedness without any accumulation of foreign exchange reserves.

The course of economic policy was swiftly modified in late 1980, when the government opted for reducing the level of economic activity in an attempt to reverse the trade deficit and generate exportable surpluses. The ensuing industrial recession represented a fundamental economic policy change adopted to deal with the external crisis, the effects of which would tarnish the remaining of the 1980s. The growth-cum-debt model finally came to an end after a long phase of increasing external and domestic disequilibria. One of the victims of the ensuing recession would be productivity growth.

The two last decades of the 20th century shared a common feature: very low GDP growth rates, when compared with the previous decades. This was, however, their only feature in common. Just as the 1980s were termed 'the lost decade', a more proper epithet to the 1990s would be 'the decade of incomplete reform'. This is due to the fact that, following over ten years of macroeconomic instability and persistently high, and rising inflation, the 1990s were marked by economic reform and stabilization.

² The 'miracle' was also possible due to a favourable combination of: existing idle capacity - generated during the 1963-67 recession - loose monetary and fiscal policies, including a host of fiscal incentives for investment and exports; public investment, including that of established and newly created state-owned firms.

³ In 1978 Brazil imported 80% of the oil it consumed. Oil imports represented nearly one-third of total imports, despite huge investments in oil exploration which were to mature only in the early 1980s. See Malan and Bonelli (1987) for a more detailed account of economic policy and performance from the 1970s to the mid-1980s.

Productivity performance

As in many other countries in Latin America, the issues of foreign debt, external crises, and their implications dominated economic policy in Brazil during the 1980s. Among these it is important to highlight the strong acceleration in inflation, despite unsuccessful stabilization attempts, and the domestic recession (1981-83). The strategy of contracting domestic absorption to service the debt was adopted throughout the first half of the decade, but was relaxed subsequently⁴. Growth resumed briefly between 1984 and 1986, but, at the end of this short period and following another unsuccessful stabilization plan based on an overall but short-lived price freeze, inflation picked up again. An overvalued exchange rate in 1986 made things worse, because the economy was overheated. This resulted in another BOP crisis that led to a painful (in its consequences) default on foreign debt in early 1987.

The last three years of the 1980s represented a phase of imbalances and maladjustments, as inflation rates reached near hyperinflation levels against a background of increasing indexation. Short-term economic cycles succeeded each other until 1990, when a bold stabilization attempt took place - only to fail again. Productivity, in particular, continued to falter, as will be shown below.

The recession of 1990-92 was provoked in the context of another unsuccessful attempt to curb inflation which, nonetheless continued at very high rates afterwards. After the ousting of President Collor for corruption charges (late 1992) and the end of a severe institutional crisis, a new economic team took office and profited from the predominantly positive expectations generated by the arrival of a new government. The level of activity began to grow soon afterwards as firms reacted to expansionary measures in view of idle capacity. This was concomitant with import liberalization, which, together with privatization and other state reform, resulted in faster than ever rates of productivity change in manufacturing and other tradable-producing sectors.

Growth picked up in earnest after the Real Plan - an ingenious and successful stabilization initiative - was implemented in mid-1994. The rapid increase in real incomes made possible by sudden inflation deceleration boosted demand and GDP growth. This was followed by an only temporary output deceleration during the Mexican crisis (late 1994 to early 1995). The effects of the Asian and Russian crises were strongly felt in the context of a foreign exchange rate regime based on a slowly adjusting exchange rate - in good measure made possible by strong productivity growth in sectors producing tradable goods. As shown in Figure 1, GDP growth rates fell between 1996 and 1997 and nearly zeroed in 1998. Following a foreign exchange rate regime change in early 1999 when Brazil embarked on a free-float regime, growth seemed to pick up - only to be aborted again during the aforementioned events of the early 2000s. Growth resumption in 2004 was mainly based on the recovery of trade and, to a lesser extent, investment. The existence of idle capacity generated in the preceding years made for a relatively cost-free (in terms of investment expenditures), but very fast recovery: GDP grew by 5.2% in 2004, the highest rate in ten years.

As expected, productivity change has been part and parcel of Brazil's growth record. Indeed, as it will emerge, an important element of the admittedly modest post 1992 growth has been productivity-based. The next section documents these aspects.

⁴ See Malan and Bonelli (1987) for an account of developments from the late 1960s to the early 1980s.

1.2 Objective of study

This study aims to investigate productivity performance in Brazil, with the growth of the overall economy as the main focus. The investigation is intended to analyse general factors as well as factors specific to Brazil.

1.3 Methodology

Secondary data from official government documents have been used. In particular, comparative cross-country TFP data provided by UNIDO were used to discern trends. Primary data were generated through a limited sample survey to validate some of the assertions made.

1.4 Organization of report

Following the Executive Summary, Section 1 presents a brief account of macroeconomic performance and economic policy since the 1950s by way of introduction. Section 2 is devoted to the analysis of productivity change in the manufacturing sector and in the economy as a whole, distinguishing between average labour productivity (ALP) and total factor productivity (TFP). Section 3 assesses the major determinants of productivity change in Brazil. Section 4 evaluates policies affecting productivity and highlights the role of market reform in enhancing productivity growth the 1990s. Section 5 concludes by indicating areas in which UNIDO could assist the Brazilian government in improving the country's productivity performance.

II. Growth of the economy and productivity trends

2.1 Record of GDP growth

The changing features of productivity growth and, in general, productivity performance are explored in this section, which is divided into: Labour productivity in manufacturing; TFP change in the manufacturing industries; Labour productivity growth in the total economy; TFP change in the economy as a whole. This section provides an interpretation of productivity change against the overall growth experience briefly described in the previous section.

Growth of output per worker (average labour productivity, ALP) in the manufacturing sector between the late 1950s and the early 2000s

This sub-section provides an account of labour productivity change based on two sets of data: gross output (quantum indices) and manufacturing employment (production value added and total employment, including white-collar workers and both formal and informal employment from 1990 to 2003⁵).

The evidence on ALP change in manufacturing is documented in Table 2.1, which shows average labour productivity growth rates in selected periods. The choice of periods follows from the background performance section above. There was a high variance of ALP around a long term average (1960-2003) of 2.9% p.a. A relatively long period of fast growth from the late 1950s to the mid 1970s (except for 1963-67) was followed by a period of near stagnant productivity that lasted until the early 1990s. From then a strong recovery of productivity was observed, the major part of it having occurred concomitantly with import liberalization during the period 1991-1998. However, as will be seen, productivity growth has continued since then - although at a slower pace.

Labour productivity change in manufacturing since the late 1950s has followed a pattern similar to that of ALP change in the aggregate economy, as it will be seen later on. In addition, it was noted that periods of fast output growth were also phases of strong productivity growth. During the slow growth phase between 1963 and 1967, however, ALP growth rates also declined.

As mentioned, labour productivity growth was strongest in the late 1950s and early 1960s, during the 'miracle' years of 1968-74 and in the 1990s. The years 1974 to 1980 were, in turn, characterized by very low productivity gains, while both the periods 1981-85 and 1986-90 were, on average, marked by negative productivity growth. The strong recovery observed in the 1990s will be more fully explored below. After the exchange rate regime change in 1999, labour productivity grew more slowly than before - despite high productivity growth rates in 2000, 2002 and 2004. This performance was also

⁵ Value added and employment figures for this task come from the Brazilian new system of National Accounts, which starts in 1990.

Productivity performance

associated with negative manufacturing production growth in 1999 and generally slow output growth in the period 2001-2003⁶.

Table 2.1: Labour Productivity Growth Rates in the Manufacturing Sector Selected Periods (% p. a.)

1960-62	4.06
1963-67	1.10
1968-73	5.41
1974-80	0.81
1981-85	-0.90
1986-90	-0.55
1991-98	8.31
1999-03	2.98
Total 1960-03	2.90

Source: Table A.4 (Appendix)

The analysis of manufacturing productivity performance based on value added data from 1990 to 2003 displays a slightly different pattern. The comparison is made difficult by the fact that the Brazilian National Accounts' employment and output data include both formal and informal activities, and blue-collar as well as white-collar workers, while the estimates above were based on employment figures for blue-collar workers only. A comparison of occupation (employment) based on this source and on the source described above can be made from data in the next table and graph.

Table 2.2: Employment in the Manufacturing Sector, 1990-2003 (1,000)

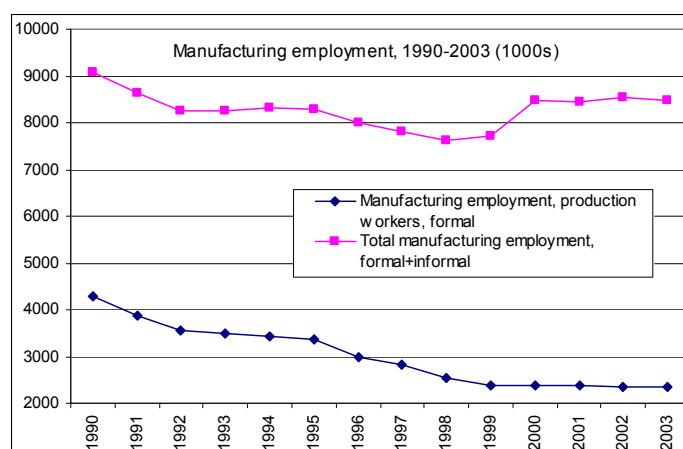
Years	Production workers (blue collar)	(Formal + Informal) Total occupation
1990	4,300.1	9,089.5
1991	3,864.3	8,636.4
1992	3,568.8	8,247.7
1993	3,502.4	8,263.3
1994	3,423.9	8,326.5
1995	3,359.0	8,291.6
1996	2,984.0	7,994.2
1997	2,812.1	7,805.3
1998	2,554.9	7,629.5
1999	2,367.9	7,726.4
2000	2,383.2	8,462.3
2001	2,379.6	8,456.2
2002	2,355.7	8,541.8
2003	2,340.4	8,491.3

Sources: Appendix and National Accounts of Brazil

⁶ Growth resumption in 2004 brought with it a strong increase of just over 5% in average labour productivity in the manufacturing sector.

The divergence between the series is evident: in 1990 formally employed production workers accounted for 47% of total employment in the manufacturing sector and, in 2003, represented only just 28%. It is clearly recognized that the volume of informal employment has been recently growing in Brazil in recent years - the implication of this for productivity change will be analyzed later on. Even so, the change seems quite extreme for a relatively short period of time. In particular, assuming that the number of white-collar workers is approximately equal to 20% of the number of blue-collar workers, the results in the table imply the existence of nearly four million informal workers in the manufacturing sector in 1990, or 43% of total employment at that time.

Figure 2.2: Employment in the Manufacturing Sector, 1990-2003 (1,000)



Source: Table 2; see text

By the same token, manufacturing sector value added growth rates from the National Accounts are different from the physical output growth rates used above in the analysis of the period 1959-2003. As a result, the productivity record based on the value added data differs from the performance shown above.

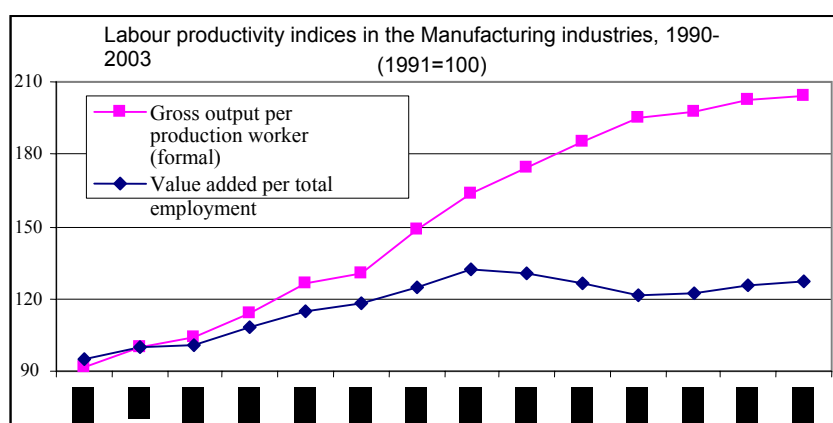
Table 2.3: Labour Productivity in Manufacturing: Alternative Indices, 1990-2003 (1991=100)

	Value added / total employment	Output / formal employment Production workers (blue collar)
1990	94.9	92.0
1991	100.0	100.0
1992	100.4	103.9
1993	108.5	114.4
1994	115.2	126.1
1995	118.0	130.8
1996	125.0	148.9
1997	132.0	163.7
1998	130.5	174.3
1999	126.1	185.0
2000	121.4	195.0
2001	122.3	197.9
2002	125.5	202.9
2003	127.6	204.3

Source: see text

Both series of data show a good productivity performance between 1990 and 1997 and after 2000 – albeit at variable rates. The estimates for the total employment and value added show a decreasing productivity between 1997 and 2000 that does not appear in the other series. With this exception, however, it shows a dynamic productivity performance, especially considering the fact that informal activities are included in these series.

Figure 2.3: Labour Productivity in Manufacturing: Alternative Indices, 1990-2003 (1991=100)



Source: Table 3

Labour productivity change — Total economy

The importance of labour productivity growth to explain GDP growth in Brazil can be evaluated from a breakdown based on the following formula:

$$Y = (Y/E).(E/L).(L/P).P$$

Y = real GDP, E = employment, L = Economically Active Population (EAP); P = total population. Taking logs of the variables in both sides of the above formula permits the breakdown of GDP change into changes in labor productivity, occupation or employment rate (the complement of which is the usual unemployment rate), activity rate (defined as the rate of the EAP to the total population) and population⁷.

It is apparent from the breakdown results shown in Table that labour productivity change represented a decreasing, albeit high, share of GDP change over time from the 1940s to the 1970s. Between 1980 and 1991 labour productivity growth was actually negative and this trend was reversed in the 1990s, when productivity gains recovered. The negative effect of the employment rate was offset from 1970 onwards by increases in the activity rate, as more and more persons of working age joined the workforce. Population growth, in turn, was always a major factor behind GDP change, second only to productivity from 1940 to 1970.

Table 2.4: Breakdown of GDP Change into Selected Components (%)

Components	1940-50	1950-60	1960-70	1970-80	1980-91	1991-2000
% Labour Productivity (Y/E)	74.1	60.1	57.5	55.9	-61.3	37.4
% Employment rate (E/L)	0.0	0.0	-1.2	-1.8	-19.9	-42.8
% Activity rate (L/P)	-14.7	-1.3	-3.9	16.2	40.5	55.0
% Population (P)	40.7	41.3	47.6	29.8	140.7	50.4
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Bonelli (2004)

Data prepared by the UNIDO project organizers allow us to probe deeper into Brazil's aggregate labor productivity performance. The next figure documents the performance of aggregate ALP according to the UNIDO database. The figure displays an initial long phase of high productivity growth concomitant with strong GDP growth. Indeed, between 1960 and 1980 ALP grew on average by 4.1% and GDP rose, on average, by 7.5% p.a.

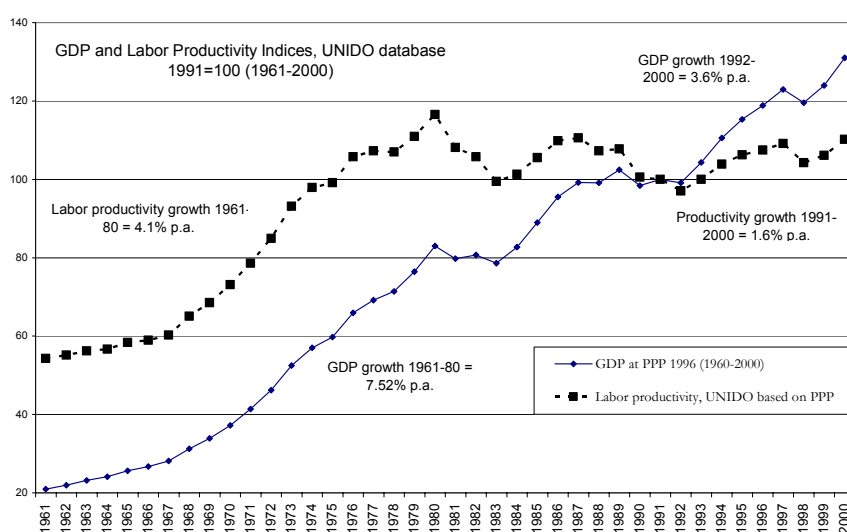
A second phase of ALP growth characterizes the post 1992 phase, when ALP grew at 1.6% p. a. and GDP grew at 3.6% per year. The period between 1980 and the early 1990s was marked by strong macroeconomic instability, as seen, one of the consequences of which was a rather poor productivity performance. According to these results, total ALP levels in 1992 were actually lower than in they had been 12 years before.

⁷ Alternatively, per capita GDP can be described as the product of three ratios: labour productivity, employment rate and activity rate. Since the last two components are likely to be constant or, at least, not vary much in the long run, it follows that GDP per capita moves in line with follows labour productivity.

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These results are reasonably similar — or, at least, display a similar pattern — to the estimates for the manufacturing sector, in which a long phase of ALP growth was also identified from the late 1950s to 1980, with sub-periods of productivity acceleration and deceleration broadly similar to the ones shown above. Again, they show a recovery of ALP growth in the 1990s, while the 1980s, on the other hand, were years of negative productivity growth both in the aggregate economy and, as indicated, in the manufacturing industries. The aggregate and sectoral pictures seem, therefore, highly congruent, both showing a recovery of productivity growth in the 1990s after a long period of near stagnation or even negative rates of change in the 1980s.

Figure 2.4: GDP and Average Labour Productivity, 1961-2000 (1991=100)



Source: UNIDO database

We were also supplied with productivity levels (ALP in the aggregate economy) in Brazil relative to the United States of America, a country that is considered to represent the ‘world technology frontier’. The objective, next, is to evaluate and explain the change in the country’s position relative to the United States. As shown below, Brazil’s relative position with respect to the US deteriorated, though not significantly in the period analyzed (Table 2.5).

Table 2.5: Brazil — Aggregate Labour productivity relative to the US (=100)

1961	2000
25.1	23.9

Source: UNIDO database

As the previous analysis indicated, the loss of Brazil’s productivity position was mainly due to the macroeconomic performance during the recession coupled with high inflation years from 1980 to 1989-90. As we have seen, ALP decreased no less than 15% during the 1981-83 recession, a short-lived slight recovery in productivity was observed in between 1984 and 1987 (when ALP grew by an accumulated 11%) and is partially

associated with temporary GDP growth after Brazil's return to democracy in 1985. However, during the (repressed) hyperinflation and recession after 1988, aggregate ALP decreased again by 12%. As mentioned, one of the legacies of the 'lost decade' was a rather poor productivity performance.

It can be shown that one of the most important factors behind recent aggregate productivity change was the growth of labor productivity in agriculture since the mid-1970s (Bonelli and Fonseca, 1998, *passim*). The rates of productivity increase were boosted in the 1990s with the introduction of new crops, methods, improved agricultural inputs (such as pesticides, fungicides and fertilizers) and well as modern farming and managerial techniques.

One of expected, but unfortunate, results of this process was the steady decline in agricultural employment from a total of 14.9 million workers in 1990 (25.5% of the total employment in the economy) to 12.7 million in 2003 (approximately 18.9% of total employment), representing an average rate of decrease of 1.22% p.a. In the same 13-year period, real value added rose by 55.9% (or 3.47% p.a.). Labour productivity in agriculture (including both crops and farming, or animal production) increased, therefore, by almost 4.8% p.a. on average from 1990 to 2003 - a rate well above the 1.8% p.a. average for the total economy. Assuming an average agricultural employment share of 22%, it follows that agriculture accounted for nearly all of productivity change in the period analyzed⁸.

The conclusion that agriculture accounted for the bulk of productivity gains in the 1990s is of course an oversimplification⁹. In fact, many other sectors have experienced productivity gains since the early 1990s, while a few (even large sectors in terms of employment) have experienced productivity decreases since the early 1990s (Bonelli, 2002). This, however, highlights the fact that productivity gains were very concentrated and agriculture is, by far, an important sector to take into account when explaining the process of productivity recovery in the 1990s. Despite this, Brazil's productivity performance from the early 1960s to 2000 was not good enough to keep pace with that of the USA.

TFP change in the manufacturing sector

Pioneering estimates of TFP change in the Brazilian manufacturing industries can be found in Bonelli (1975), where average TFP growth rates were calculated at the two-digit level of the Brazilian industrial classification between 1959 and 1970, based on a growth accounting approach applied to industrial census data¹⁰. It was found out that TFP accounted for between 32% and 42% of manufacturing value added growth¹¹ during the decade, depending on the value added concept adopted. It was also found that the pattern

⁸ The underlying reasoning is based on the formula that states that overall labour productivity is a weighted average of individual sectors' productivities, the weights being the employment shares of each sector.

⁹ A negative aspect, associated with the laying off of agricultural workers, is the other side of the story. The excess labor displaced from the rural sector found employment, if any, in urban areas. One important implication of this fact is the expansion of the informal (or shadow) economy in these urban areas—a phenomenon to be explored later on, when dealing with the issues of obstacles to productivity change.

¹⁰ The main difficulty of these and other work on TFP at sectoral level is the lack of series on capital stock, each successive researcher having to develop his/her own estimates. Thus, Bonelli and Fonseca (1998) adopted as proxy for capital services the relative change of industrial consumption of electric energy. Obviously, the results obtained with this procedure should be interpreted with great caution.

¹¹ Since manufacturing value added grew at 8.4% p.a., on average, this implies that TFP growth reached between 2.7% and 3.5% p.a.

of TFP change was in good measure dictated by (i.e. positively associated with) a small number of mostly interrelated variables: average size of plants, market concentration, market share of foreign firms, payments for patents, foreign technology purchases, workforce skills, savings of intermediate inputs, growth of average size of plants, capital stock growth, market share of output due to production in new plants (an indication of embodied technological change on account of the – on average - superior technology of newer firms).

Braga and Rossi (1988) also devoted attention to the issue of TFP change in manufacturing at the two-digit level of the industrial classification. They used a translog function applied to 1970-83 manufacturing sector data in order to break down TFP growth into technical progress, scale economies and capacity utilization. One of the main results of their work is that total manufacturing TFP growth was, on average, negative during the period analyzed. The cost function had a consistently negative contribution to TFP change, while scale economies and capacity utilization had a positive impact. They concluded that, in the aggregate, manufacturing did not feature either technical progress or diffusion of technology in the period - a rather disturbing conclusion for a period in which fast growth of output occurred in some sub-periods, such as 1970-76. Their cost function shifted sharply upwards, while manufacturing output increased at 8.2% p.a. Weighted factor inputs grew at 8.8% p.a. between 1970 and 1983, resulting in negative TFP change¹².

Chronologically, the next work to be cited is Pinheiro's (1989) study on TFP growth at the sectoral level between 1970 and 1980 and based on industrial census data. Pinheiro's methodology is a growth accounting procedure based on translog functions that explicitly included raw materials among their arguments, as Braga and Rossi (1988) also did. He found out that TFP growth in the 1970s was a little lower than what had been found by Bonelli for the 1960s¹³: "Total factor productivity expanded on average at 2.6% p.a. in the 1970-80 period, and accounted for 20% of the rate of output growth in the Brazilian manufacturing industry" (p. 210). It must be noted that his results contradict those of Braga and Rossi's (1988) in a fundamental way - despite the fact that both studies were based on translog functions and included raw materials among factor inputs. Pinheiro also noted that "Import bias in factor markets seems to have been positively associated with TFP change. Sectors which relied more heavily, in relative terms, on imports of material inputs, machinery and equipment and on technology were those with a higher growth of TFP" (p. 211). This is strongly suggestive of embodied technological change, also a feature of post-1990 productivity growth, when import liberalization resulted in increased use of both imported raw materials and imported machinery and equipment.

Next under consideration is Bonelli's (1992) essay on growth accounting and TFP change in Brazilian manufacturing from 1975 and 1985, which indicated, among other issues, that TFP change was associated with output growth. This work also explored the existence of associations between sector patterns of TFP change and trade orientation, to establish that nearly half of the inter-industry variation in TFP growth rates can be explained by variables related to export expansion and import change. The results also

¹² It is tempting to attribute their unexpected results in the 1970s to the use of inadequate price deflators for raw materials included in their cost function. As we know, the 1970s and early 1980s were a period in which prices of raw materials increased very fast due to both the oil crises and to the overheated world economy (in given sub-periods within 1970-83).

¹³ Note, however, that the methods adopted by the authors are not the same.

seem well-founded enough to justify the assertion that export growth and TFP change are positively associated, the link between them possibly being output growth led by faster export growth. Evidence was also found that changes in trade-related variables precede TFP changes, rather than the contrary.

A similar conclusion was arrived at by Bonelli and Fonseca (1998) in an analysis of the period 1970 to 1997. Their results point out to a substantial recovery of TFP in the 1990s, compared to the previous years. In fact, an index of TFP change in manufacturing reached the same value in 1980 as it had attained ten years previously. In 1990 the same index was 12% lower than in 1980 and, from 1990 to 1997, grew by 26% (or 3.4% p.a., on average).

Other pieces of work on TFP change in manufacturing also analyze the recovery of total factor productivity growth in the 1990s. Thus, Hay (1998), using micro data - i.e. firm-level data - for a sample of large manufacturing firms established that import liberalization had a major influence on the productivity performance of firms. To quote from his work: "The leading Brazilian manufacturing firms responded to trade liberalization after 1990 with an impressive growth in productivity... This growth was in TFP, indicating a key role for improvements in X-efficiency and technological catch-up." (Hay, 1997, p. 31)

In the same vein, Muendler (2001), also basing his analysis on micro data, found that productivity growth in manufacturing not only resumed in the 1990s but also that it was also partially based on the closure of groups of firms among the smallest and least productive ones. A sort of 'natural selection' operated in a period of generalized adoption of managerial and organizational techniques (Bonelli, 1999a): closure of the least productive firms considerably raised average productivity levels.

2.2 TFP in the total economy

Previous studies and estimates

The analysis of aggregate TFP change and its relationship to growth has been subjected to only limited study in Brazil¹⁴. The consensus on this issue has favored the hypothesis that the 1990s saw the resurgence of productivity growth, after a decade in which negative productivity growth rates (both labor and multifactor) were not uncommon¹⁵.

Two issues deserve closer attention here: the importance of physical capital accumulation for increasing growth and the importance of productivity change in this growth-enhancing process. Most studies on the role of capital accumulation in Brazil indicate that investment was a critical factor most of the time.

In addition, the macroeconomic performance of the 1990s suggests that both labor productivity and TFP contributed to growth. Historical experience, however, suggests that

¹⁴ In part, this is due to the unavailability (or unreliability) of capital stock values until recently. The same applies to the sector studies on TFP change, as in manufacturing, each analyst having to develop his/her own estimate.

¹⁵ See Bonelli (2002) and Bacha and Bonelli (2004) for analyses and references.

gross investment was the major factor behind GDP growth (Abreu and Verner [1997], Ferreira e Malliagros [1998], Bonelli and Fonseca [1998], Pinheiro, Gill, Servén and Thomas [2001], Gomes, Pessôa and Veloso (2003), Bacha and Bonelli [2004])¹⁶.

From the strictly methodological point of view and, considering the results of cross-section studies based on large samples of countries, a certain discomfort with the use of cross-country studies to provide policy prescriptions has been echoed in passages such as the following one: “Do cross-country regressions define a meaningful surface along which countries can move back *and* forth at will?” (Solow [2001], p.283; emphasis in the original). This does not mean that the results should be ignored, of course. Rather, they highlight research topics that would probably not have been tackled had these studies not been undertaken. They are not, however, a substitute for detailed country studies.

The literature on productivity and economic growth allows for some central conclusions. One of them suggests that one can hardly expect growth resumption on a significant scale can hardly be expected without the increase of investment. The Brazilian experience in the 1990s indicates precisely the prevalence of low investment in physical capital concomitant with slow GDP growth, although a positive aspect of this experience was the attainment of substantial productivity gains, as documented above. In order to attain higher productivity levels it is necessary to continuously incorporate technological advances, invest in physical capital, increase the educational level of the workforce and engage in market reforms that increase TFP. As one keen observer put it: “...the non-technological sources of differences in TFP may be more important than the technological ones. Indeed, they may control the technological ones, especially in developing countries. Obvious examples include things like the security of contracts, the intensity of competition, and respect for instrumental rationality as a mode of behaviour” (Solow, 2001, p. 287).

Early studies on trends in capital accumulation in Brazil have highlighted the fact that the pace of accumulation was very fast from the 1950s to the 1970s¹⁷. Hofman’s (1992) work, for instance, was based on carefully developed series of gross and net capital stock based on the perpetual inventory method in six Latin American countries (Argentina, Brazil, Chile, Colombia, Mexico and Venezuela). Among its conclusions on Brazil we find that the total gross capital stock in the country grew at 8.76% p.a. in 1950-73, a rate that increased to 10.40% p.a. in 1973-80, to fall to 5.51% p.a. in 1980-89. Another interesting conclusion is that all countries analyzed, except Chile and Colombia, recorded sharp increases in capital-output ratios - Brazil emerging as the worst case. Since capital output ratios are related to the inverse of the productivity of capital, this means that Brazil’s position with regard to the other countries deteriorated more than the average in

¹⁶ As is well known, these results do not concur with those of the World Bank (2001), which apparently confirmed Easterly and Levine’s (2001) conclusion that only TFP matters: “factor accumulation does not account for the bulk of cross-country differences in the level or growth rate of GDP per capita; something else – TFP – does.”(p. 179). But Pinheiro et al (2001) properly summarize the consensus on the issue in the following: “Physical capital accumulation and TFP growth explain most of the growth dynamics of the Brazilian economy since 1930. The higher the value of the capital elasticity of output used for decomposing growth, the higher the contribution of capital and the lower that of TFP. Note, though, that the two need not be dissociated. TFP growth seems to have been systematically associated with the growth in the stock of machinery and equipment ... It may therefore be that some TFP growth was gained through capital-embodied technological progress”(p. 8).

¹⁷ Goldsmith’s (1986) is an example, although his capital stock estimates are largely based on the study by Langoni (1974), see below.

this respect¹⁸. As stated by the author: “Capital-output ratios increased in Argentina, Brazil, Mexico and Venezuela indicating falling capital productivity” (p. 389).

Elias (1978) also calculated TFP change in Brazil (as well as in other six Latin American countries)¹⁹. He found out that TFP change represented a small part of GDP growth in some phases (such as 1960-65, when it represented only 4% of GDP growth), but not in other periods. In particular, TFP growth rates reached 2.5% p.a. in the period 1965-70 and 2.1% p.a. between 1970 and 1974. In the 1950s it accounted for over half of total GDP growth. In general, he concluded, growth of factor inputs explained GDP growth fairly well.

In a later work, Elias (1992) found out that TFP explained 51% of GDP growth in Brazil in the period 1940-80. But he also found out that in the 1960s the contribution was 24% and in the 1970s even lower at only 13.4% (=1.1/8.2). The result was mainly due to vigorous growth of capital inputs, a little above 10% p. a. From 1980 to 1985, however, TFP growth was negative, according to his estimates (-1.0% p.a.). Both labour and capital inputs grew at rates faster than GDP during this particular period²⁰.

The importance of human capital accumulation has been documented in several studies, beginning with Langoni’s (1974) pioneering attempt at a comprehensive growth accounting exercise for Brazil. Langoni’s growth accounting results are worth spelling out in more detail²¹ and are as follows: GDP growth reached 6.64% p.a. in the period 1950-60 and 5.78% p.a. in 1960-70. The contribution of fixed capital to GDP growth reached, on average, approximately 1.83 to 1.92% between 1950 and 1960 and 1.85% to 2.15% in the period 1960-70. The contributions of raw labour were 1.55% p.a. and 1.41% p.a., respectively, in the periods 1950-60 and in 1960-70. The net contribution of education was 0.31% p. a. (1950-60) and 0.91% p.a. (1960-70). The contribution of sector reallocation of labour (reallocation of workers from less to more productive sectors) was, respectively, 0.27% and 0.42%, while the contribution of changes in the age-sex composition of the labour force reached, respectively, 0.06% p.a. and – 0.16% p. a. Therefore, total labour contributions were 2.19% p.a. and 2.72% p.a., respectively in the decades 1950-60 and 1960-70. Finally, residual growth was 2.62% p.a. in the former decade (40% of GDP growth) and 1.21% p.a. in the latter (21% of GDP growth). Again, TFP change represented, on average, a substantial share of output growth, albeit decreasing between the 1950s and 1960s. Recall that Bonelli’s (1975) and Pinheiro’s (1989) results, when compared, also suggest a TFP growth deceleration - albeit from the 1960s to the 1970s.

A more recent growth accounting exercise, by Pinheiro, Gill, Servén e Thomas (2001), however, indicates that human capital represents only a small portion of Brazil’s growth.

¹⁸ Indeed, the average for all countries studied by Hofman went from 1.9 to 2.8 between 1950 and 1989. Brazil’s total gross fixed capital-output ratio, in turn, went from 1.2 to 3.0 in the same period. All figures in Hofman’s study are in 1980 international dollars.

¹⁹ Note that Elias (1978) assumed values of 0.5 for each input, capital and labor to compute total factor input.

²⁰ Labour is adjusted for quality, comprising education, gender, age, occupation, economic sector and region components. Capital is also adjusted for quality, the quality component being dependent on its composition (and reflected in rates of return, depreciation, capital gains, taxes on capital income and tax deduction allowances) under the assumption that differences in the gross rate of return on diverse kinds of capital (actually, five sectors) should reflect the differences in the services provided by each unit of them.

²¹ Langoni also estimated the social returns to education in Brazil at 28% in 1969, approximately twice the profitability of investment in physical capital.

Productivity performance

Its contribution, as shown in Table 2.5, is low at only 7% of GDP growth, especially during the period 1994-2000. TFP, in turn, explains a substantial share of GDP growth in all periods except 1981-93, the period the authors identify and label as ‘the lost decade’. In their own words:

“Physical capital accumulation and TFP growth explain most of the growth dynamics of the Brazilian economy since 1930. The higher the value of the capital elasticity of output used for decomposing growth, the higher the contribution of capital and the lower that of TFP. Note, though, that the two need not be dissociated. TFP growth seems to have been systematically associated with the growth in the stock of machinery and equipment ...It may therefore be that some TFP growth was gained through capital-embodied technological progress” (p. 8).

Table 2.6: Sources of Growth — Physical Capital, Labour, Human Capital and TFP, 1931-2000 (% p.a.)

Periods	GDP	Physical Capital	Labor	Human Capital	TFP
1931-50	5.14	1.59	0.37	0.84	2.35
1951-63	6.88	2.60	0.56	1.06	2.66
1964-80	7.79	2.69	0.65	1.31	3.14
1981-93	1.64	0.78	0.43	0.26	0.17
1994-00	3.05	0.69	-0.07	0.21	2.23

Source: Pinheiro et al (2001), Table 2.7, “Growth Decomposition with Human Capital Using Mankiw’s (1995) Elasticities”

Other studies on the importance of aggregate TFP change produce a less consensual frame as far as the relevance of factors of production. Concerning the role of capital accumulation, for instance, Abreu and Verner (1997) examined the period 1930-1993 and concluded that:

- (i) The contribution of capital accumulation to a 6.1% average GDP growth was 5.11%. Labour force contributed 0.84% and the residual, TFP, the remaining 0.16%. Capital accumulation was, therefore, crucial in explaining long term GDP^{22 23}.
- (ii) There was no significant impact of human capital on GDP growth – but this does not imply that education is not important. From their time-series regression equation (Table 5.9, p. 105) the authors conclude that “The estimated coefficients – on average years of primary, secondary and tertiary education – cannot be rejected as statistically different from zero. Human capital stocks do not seem to have an impact on economic growth in either the short or long run.”

Concerning the first conclusion Bonelli and Fonseca (1998) - adopting a traditional, but for a shorter period. In the period 1970-97, the contribution of capital was high, both for

²² The elasticity of capital in the Solow model adopted by the authors was 0.69, while that of labour was 0.31. The stock of capital grew by 7.4% and the labour force by 2.7% p.a.

²³ Hofman and Mulder (1997) reach a similar conclusion in their comparative work on Brazil and Mexico, based on data for 1950-1994.

the economy as a whole, the manufacturing sector and agriculture (1975-1996). TFP change, however, also had an impact on these sectors in certain sub-periods, particularly in the 1990s. These authors note that their results suggest the existence of complementarity of factors of production²⁴.

In a recent study Bacha and Bonelli (2004) found similar results. The next table documents their main findings in the context of a Solow-type growth accounting breakdown applied to typical growth phases²⁵. In the table $(1/v)'$ stands for capital deepening (i.e., the difference between the capital-stock-in-use growth rate and that of effective labor.) The breakdown equation shows that both capital deepening shares and effective labour (A.L) explain GDP growth. The last column shows the proportion of GDP growth explained by TFP change. A somewhat lengthy quote is shown after the table. It is useful in order to present the authors' conclusions and their relevance to the present report:

Table 2.7: Brazil, Breakdown of GDP Growth Rates — Solow Model, 1942-2002

Periods	Y'	(1/v)'	L'	A'	A' / Y' (%)
1942-52	0.069	0.011	0.021	0.035	51.1
1952-64	0.067	0.008	0.025	0.032	48.1
1964-74	0.088	0.002	0.032	0.052	59.0
1974-84	0.039	0.026	0.031	0.017	-43.5
1984-93	0.025	0.008	0.025	-0.008	-32.0
1993-02	0.027	-0.001	0.016	0.012	43.1

Source: Bacha and Bonelli (2004)

“The most important result ... (stresses) the crucial role of (capital deepening) to explain GDP growth in 1974-84: ... (at 2.6% per year) was the main factor responsible to sustain an average GDP growth rate of 3.9%, as the growth of effective labor ($A'+L'$) was only 1.4%. Moderate as it was, GDP growth in the last decade of the military regime could only be maintained on the basis of very high doses of capital deepening financed by external debt accumulation. External debt as a ratio to GDP increased to 43.1% in 1984 from 16.3% in 1974, while the ratio of debt service to merchandise exports zoomed up to 102.3% from 33.4%.

In both periods, 1964-74 and 1993- 02, the contributions of capital deepening were very low or nil. This does not mean that the economy was in a stable steady state because v_{ss} did not remain constant in these periods, as shown in Figure 9. The importance of TFP change varied substantially over time, reaching negative values both during the external shocks period (1974-84) - when an amazing 1.7% per year rate of decline was observed – and in the hyperinflation years (1984-93). In the remaining periods, it represented a substantial share of GDP growth, with a high of 60% in the ‘miracle’ years.

²⁴ Results for agriculture suggest a more even distribution of TFP gains.

²⁵ Elasticities of capital and labor are 0.5 each. TFP (A) is assumed to be labor-augmenting and capital is adjusted for utilization (u). The production function takes the form $Y = (u.K)^{0.5} (A.L)^{0.5}$, which can be transformed to $Y = (1/v)^{\alpha/1-\alpha} (A.L)$, used in the decomposition above, and where $1/v = u.K/Y = (u.K/A.L)^{1-\alpha}$

During ... 1993-2002, had it not been for the recovery of A' (1.2% yearly, against -0.8% in the previous period), GDP growth would have been only 1.5%, instead of the observed 2.7% per year. Thus, from the perspective of decadal periods, the two 'lost decades' for TFP were not the 1980s and the 1990s but, rather, 1974-84 and 1984-93 - the long and tormented transition from dictatorship to democracy, characterized by debt accumulation and hyperinflation²⁶."

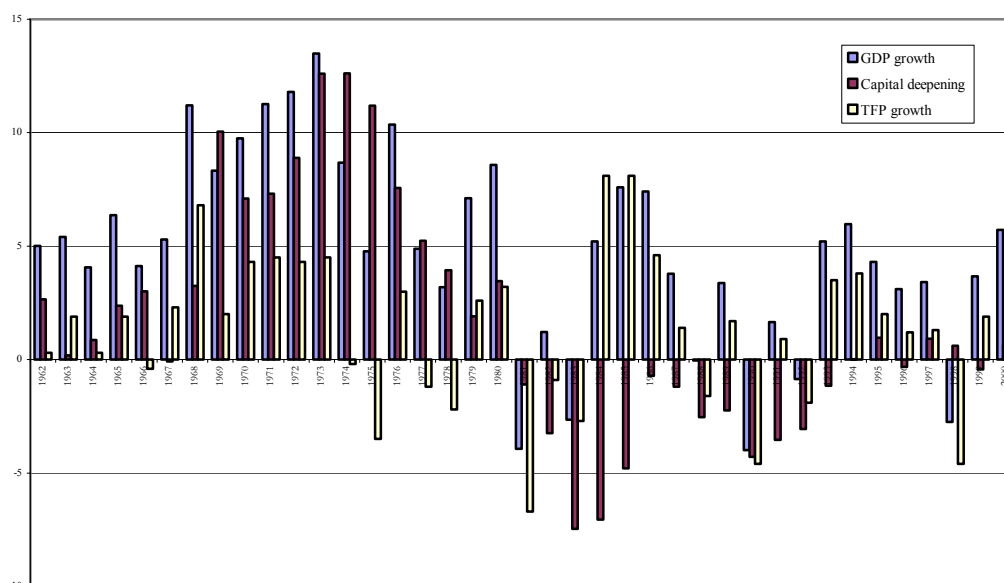
Productivity (TFP) estimates based on UNIDO database

It is also possible to interpret the episodes of rapid growth and slumps in productivity and identify the major aspects of change in productivity by using the database provided by UNIDO. This will enable us to highlight the trends in productivity and the relationship between productivity and output growth. It will also permit a breakdown of output growth into the contributions of capital deepening and productivity change, and the breakdown of productivity (TFP) change in two components:

1. The first component (EFFCH) reflects the process of technological catching up and implies a change in performance or in relative efficiency. It is representative of efficiency change, and reflects evidence of technological advances.
2. The second component (TECHCH) reflects shifts in the frontier, or technology shifts between t and t+1, or technical change, and is evidence of innovation.

The next figure helps us to assess the contributions of capital deepening and TFP to GDP growth (at PPP prices). Years of high GDP growth from 1968 to 1980 were generally associated with rapid capital deepening. The recession years of 1962-67, in turn, were marked by only mild rates of capital deepening growth (DKL). The strong instability phase of 1981-1992 was also characterized, on average, by negative DKL rates, while slow growth after 1992 was accompanied by modest increases in the capital labor ratio.

²⁶ According to the authors: "This result depends critically on considering the 1974-84 period as a whole, which entails viewing the 1980-83 crisis as an integral part of the so-called 1974-80 'forced march'. An alternative would be to consider the shorter 1974-80 period in isolation and the longer 1980-93 period as a single block. Capital deepening as measured by $(1/v)$ characterized both periods, proceeding at 2.0% per year in 1974-80 and at 1.6% per year in 1980-93. But the collapse of GDP growth and technical progress occurred entirely within the latter period. Yearly GDP growth in 1974-80 was lower than in the "miracle" but still a respectable 6.9%. Technical change also declined sharply, but was still positive at 0.9% per cent per year. In contrast, average GDP growth in 1980-93 was only 1.6% and technical change was sharply negative at -2.3% per year. Thus, statistically speaking, the lost periods for Brazil's growth were not two entire decades, but the 13 years between 1980 and 1993."

Figure 2.5: GDP, Capital Deepening and TFP growth, 1962-2000 (%)

Source: UNIDO database

TFP change occurred at rapid rates during the years of the ‘Brazilian miracle’, following slow growth during the 1962-67 recession. In the period immediately after 1974, however, TFP rates were often low or negative, a feature that persisted into the early 1980s and from 1987 to 1992 in particular. TFP growth resumed after 1992, albeit at slower rates than previously. In most years, TFP performance resembled to a great extent GDP performance. The next table presents period averages of the variables shown in the figure above, highlighting some of the features already briefly mentioned.

**Table 2.8: GDP (DY), Capital Deepening (DKL) and TFP (DTFP)
Growth Rates: Averages of Selected Years (% p.a.)**

Period (Annual Averages)	DY	DKL	DTFP
1962-67	5.04	1.50	1.04
1968-74	10.65	8.83	3.72
1975-80	6.02	5.55	0.28
1981-92	1.56	-3.44	0.44
1993-00	3.58	0.16	1.57

Source: UNIDO database

As shown, capital deepening was a major determinant of GDP change from 1968 to 1980, following a significant contribution of some 30% to average GDP growth in the period 1962-67. During the ‘lost decade’ 1981-92, on the other hand, its contribution was negative and, after 1992, a modest 0.16% average capital deepening was observed, compared with 3.58% GDP average growth. TFP growth, at 1.57% p.a., for its part, represented a high share of average GDP rates of increase in the most recent period, with the exception of 1998 and accounted for as much as 44% of GDP growth between 1993 and 2000.

Productivity performance

The breakdown of TFP change into technical efficiency change and shifts in the frontier or technology shifts is undertaken below. Figure 2.6 shows cumulated series of the relevant variables. Table 2.9 below presents yearly averages of GDP, TFP, efficiency change and technical change in the periods identified.

Table 2.9: GDP, TFP, Efficiency Change (DEFFCH) and Technical Change (TECHCH) Selected Periods 1962 to 2000 (% p.a.)

Annual Averages	DY	DTFP	DEFFCH	TECHCH	DTFP/DY
1962-67	5.04	1.04	-1.48	2.57	20.7
1968-74	10.65	3.72	3.15	0.59	35.0
1975-80	6.02	0.28	1.37	-1.10	4.7
1981-92	1.56	0.44	-1.06	1.49	27.9
1993-00	3.58	1.57	-2.95	4.65	43.8

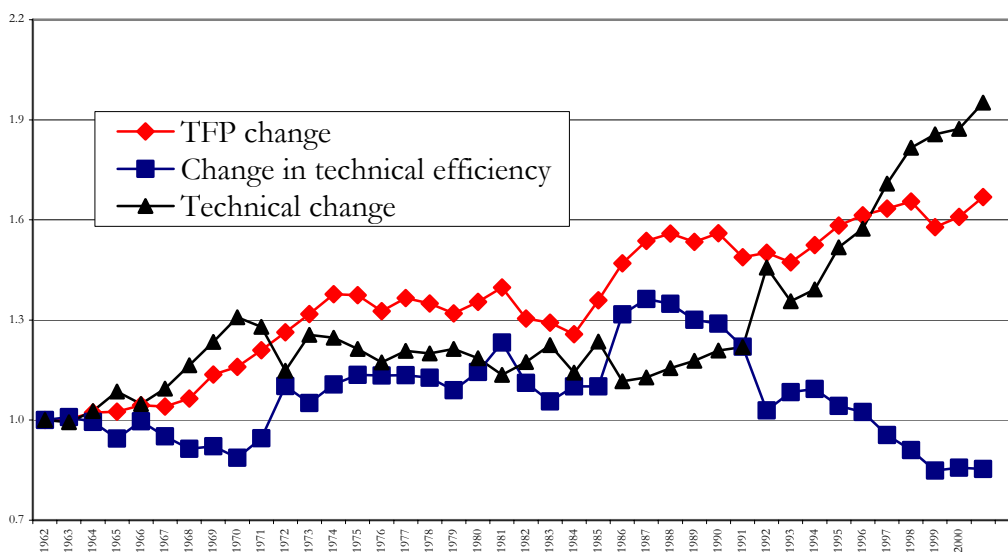
Source: Author's calculations based on the UNIDO database.

TFP change represented a substantial share of GDP growth in the 'miracle' years of 1968-74 and, especially, after 1992. In the second half of the 1970s, it accounted for a very small proportion of GDP growth, in line with previous results. This was a period of strong import substitution, as the prevailing economic policy placed emphasis on substitutive domestic production to deal with balance of payments imbalances. The same trend continued into the first part of the 1980s. Average TFP growth rates were low in the last decade of the 1980s (0.44% p.a.) and even lower in the second half of the 1970s (0.28% p.a.).

From both the figure and table it can be concluded that TFP change was mostly based on technical change (TECHCH), or innovation, rather than on changes in technical efficiency (EFFCH). As stated, TECHCH reflects shifts in the frontier or technology shifts between two periods (technical change), and is an evidence of INNOVATION. EFFCH, in turn, reflects the technological catching-up process and means a change IN PERFORMANCE, or change in relative efficiency. It is representative of efficiency change, and reflects evidence of technological advances.

Technical change was positive most of the time in the 1960s and played a significant role in TFP change. It also displayed strong growth after 1991, following two decades of a lacklustre performance: the index went from 1.22 in 1991 to 1.95 in 2000, again exerting a major influence on TFP change. There is therefore strong evidence of the role of innovation in raising TFP during these particular periods of time. Furthermore, it occurred at rates never previously experienced since 1991.

Figure 2.6: Series of Cumulated changes in TFP and related variables, 1961-2000 (1961=1.0)



Efficiency change, on the other hand, was positive, on average, only during the high GDP growth periods 1968-74 and, to a lesser extent, 1975-80. We note, in passing, that these were precisely the years – as seen above – in which the fixed capital stock grew most. This association suggests that gross investment is a major vehicle for efficiency change.

In the remaining years, the indicator of efficiency change was, on average, negative during the period 1962-67, from 1981 onwards and after 1992 in particular. This suggests that there is little evidence of catching up on the technological frontier in this latter period. All recent TFP change was due to technical change, thereby indicating the importance of innovation in recent times.

III. Assessment of the major determinants of productivity

This section evaluates the most important determinants of productivity growth which are listed and analyzed in decreasing order of importance, as suggested by the Brazilian experience, in the following sequence.

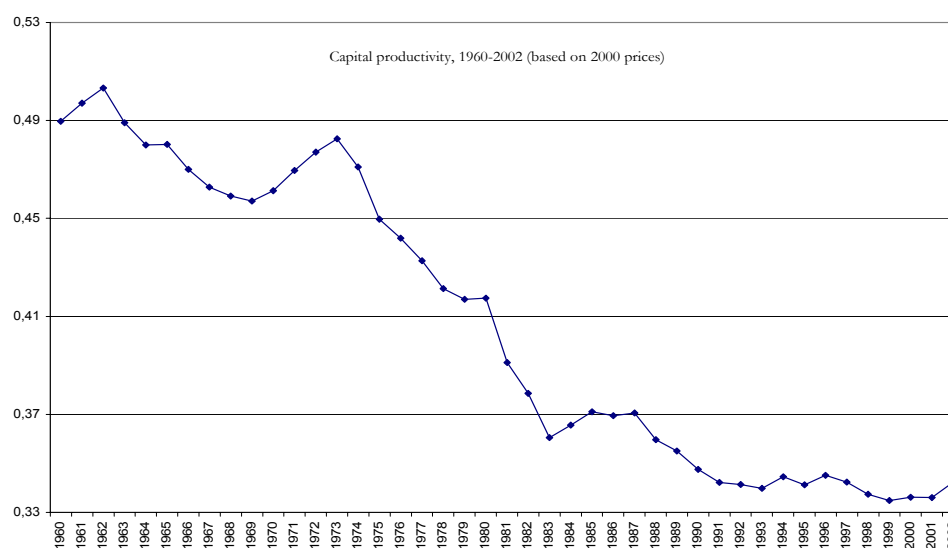
3.1 Factor Supply and Allocation

As shown in Section 2, factor accumulation explained a substantial share of past GDP growth. Factor supply examined here refers to physical capital, investment in human capital and “labor quality” and physical infrastructure. Factor allocation, in turn, refers to structural change - given that different sectors of the Brazilian economy vary with regard to the size of their contributions to productivity growth, the changing allocation of factors across economic sectors is worth examining - and to the role of the financial system in the allocation of resources.

Factor supply: Physical Capital

Growth of physical capital proceeded at very rapid rates throughout most of Brazil’s recent past, concomitantly with output growth in much of past experience. Capital productivity, however, defined as the ratio of real GDP to yearly average utilized capital, decreased substantially from the early 1970s to the early 1990s (see Figure 3.7). This trend is broadly consistent with changes observed worldwide, at least in the OECD countries since the 1970s. What is unique to Brazil is, perhaps, the magnitude of the productivity decrease observed: from 0.50 to 0.33 in nearly 20 years.

**Figure 3.7: Capital productivity, 1960-2002
(Based on series at 2000 prices)**



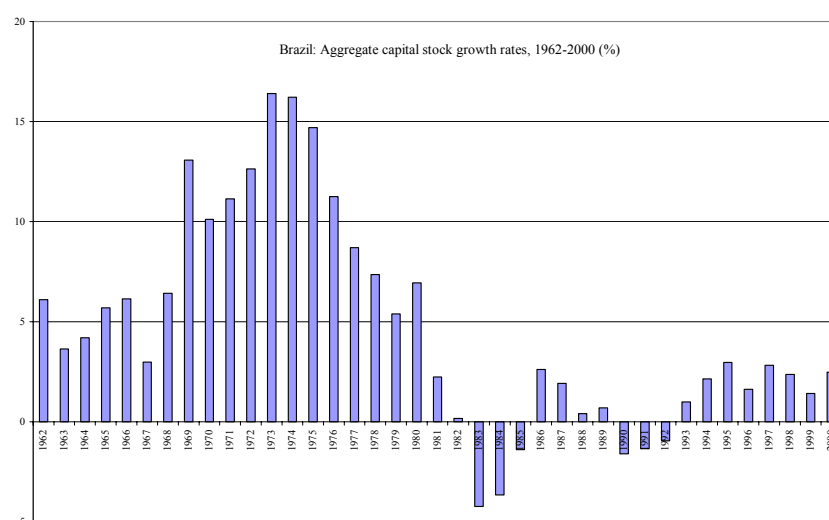
Source: Author’s calculations, based on the Brazilian National Accounts. See Bacha and Bonelli (2004)

As noted, capital equipment - and, especially, imported machinery and equipment - were important sources of incorporated technical change, particularly in periods such as the

late-1960s mid-1970s and from the early 1990s onwards following import liberalization. However, as the analysis in the previous section has shown, capital accumulation growth rates began to fall from the early-1980s onwards as macroeconomic imbalances and uncertainty greatly increased, concomitantly with the debt crisis and threat of hyperinflation. The next figure documents the long-term record of the capital stock growth rate. Capital stock growth recovery in the last years as shown in the figure has been modest, at best.

The reasons behind the performance observed were fully explored in Bacha and Bonelli (2004). The explanation is only partially based on reduced savings. Savings fell after the 1980s, but not by amounts sufficient to explain the fall observed in the capital stock growth rates. Indeed, total savings fell from 22.2% of GDP in the period 1974-84 to 21.0% of GDP in 1984-93 and to 19.6% of GDP in 1993-2002. The explanation emphasizes the role of two additional factors, besides decreases in capacity utilization²⁷: increased prices of investment and diminished capital productivity. As shown, capital productivity fell almost continuously from the mid-1970s to the early 1990s and remained more or less stable thereafter. The relative investment price (defined as the ratio between the price deflator of gross fixed investment and the price deflator of GDP), in turn, increased almost continuously from the mid-1970s to 1989 (see Figure 3.8). The reasons for the increase in the relative price of investment have been formulated as follows by Bacha and Bonelli (2004):

Figure 3.8: Capital Stock Growth Rates, 1962-2000 (%)



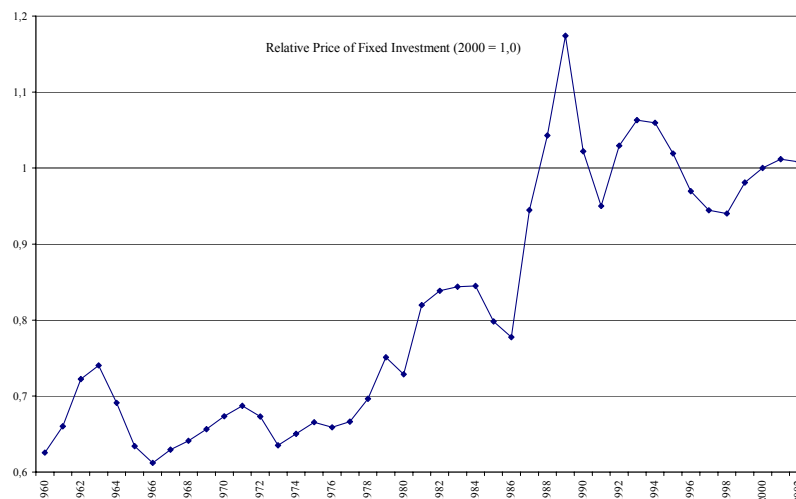
Source: UNIDO database

“The increase in the relative price of investment is a Brazilian anomaly in a worldwide perspective. The Penn World Tables world average for this price ratio remains nearly constant in the 1950-2000 period ... explanations for the rise of the relative price of investment in Brazil include: (i) increased oligopoly power in industries producing both final and intermediate investment goods (such as cement); (ii) inefficiencies in the capital goods production process, as more and more of previously imported goods are produced

²⁷ It can be shown that the capital stock growth rate can be considered as equal to the expression $s \cdot v \cdot u \cdot (1/p) - d$ where s is total saving rate, v is capital productivity, u is capacity utilization, p is the price of investment (relative to the overall GDP deflator) and d is depreciation. See Bacha and Bonelli (2004), section 4.

domestically; (iii) higher demand for durable goods, including housing, as a shelter against hyperinflation and financial default risks, with reflexes on the relative price of such goods if the supply curve is upward sloping ...; (iv) oligopolistic price-makers' defensive pricing behavior in face of government procurement payment delays, in a context of accelerating inflation; (v) price-index measurement error This would come in the form of an overestimation of the increases of the nominal prices of investment goods particularly during the 1987-89 hyperinflationary period". (p. 13)

Figure 3.9: Relative price of investment, 1960-2002 (2000 = 1.0)



Source: Author's calculations, based on the Brazilian National Accounts.

These trends help to explain Brazil's poor growth performance—and, by extension, its poor productivity performance, if we accept that GDP growth and TFP are associated (i.e. that productivity is pro-cyclical, as repeatedly suggested). Indeed, a simple correlation between these two variables over the period 1962-2000 results in a coefficient of 0.77, thereby indicating their association.

Therefore, capital accumulation accounts for a substantial share of aggregate output growth and TFP growth also explains a sizeable part of the performance observed in some periods. The association between TFP and capital accumulation is not significant, but fixed capital has an important contribution to make, the more so when we take into account that capital stock growth is associated with changes in technical efficiency. It therefore emerges as one of the single most important economic growth determinants, both due to changes in its amount (a 'quantity' effect) and to technical change incorporated into new machinery and equipment, which makes for advances towards the technological frontier.

Factor supply: Labor and Human Capital

From a purely quantitative standpoint, the supply of labor was not a hindrance to Brazil's growth, as an elastic supply of manpower has characterized past performance. Thus, for instance, the working age population (WAP) grew at 2.17% p.a. in the 1990s (1991-

Productivity performance

2000), while the economically active population (EAP) grew at 1.74% p.a. in the same period²⁸. The long-term growth rate of the EAP, based on Demographic Census data, was 3.06% p.a. between 1960 and 2000. In the same period the total population growth rate reached 2.26% p.a.

The fact, however, that - since 1990 - employment, and especially formal employment, has been expanding at a slower pace than longer-term rates suggests that levels of expertise in the workforce may also be growing more slowly, probably because of informal employment growth. This is especially true in the manufacturing industries. This point will be taken up later, as we believe that one of the main obstacles to productivity increases arising from labor inputs is the very high (and probably increasing) degree of informal labor relations in Brazil.

The educational system has gone through marked changes in contemporary Brazil, as shown in Table 10. The increased rate of enrollment in all education levels can be gauged from the table, which shows deep changes and, indeed, an acceleration after the 1970s. By that year, illiterate persons still represented almost one third of the workforce. Emphasis on college education began in the 1960s and proceeded at fast rates ever since then. The proportion of the labour force with (incomplete + complete) college education went from 1.2% in 1950 and, again, in 1960, to 2.2% in 1970 and reached at least 4% in 2000.

Table 3.10: Breakdown of the Labour Force According to Education Level Achieved 1950 to 2000, Selected Years (%)

Education groups	1950	1960	1970	2000*
Illiterate	48.3	41.4	31.1	13.2
Lower basic (0-4)	43.9	50.5	54.6	21.4 (0-3)
Upper basic (5-9)	4.8	4.5	7.4	32.1 (4-7)
Intermediate (10-12)	1.8	2.3	4.7	14.3 (8-10)
College (13-17)	1.18	1.25	2.21	18.3 (11- +)**

Sources: Langoni (1974), p. 67, and www.ibge.gov.br Notes: * refers to population aged 7+; **group 15+ years of study (complete college) represented 4%; group 11-14 the remaining 14.3%

Recent estimates for the 1990s, covering the years 1992 to 2002, are available in a recent study (Paes de Barros, Carvalho, Franco and Mendonça, 2004) that highlights the importance of labour force education and qualification in Brazil. Firstly, the authors undertook a detailed breakdown of family per capita income change between 1992 and 2002 based on a novel methodology. They found that labor productivity accounted for 50% of the recorded per capita income increase observed in the period²⁹. Change in average labor productivity is, in turn, explained by two variables, with the following weightings: changes in labor force qualification (87%) and changes in the quality of jobs

²⁸ UNIDO database tables indicate a labour force growth rate of 2.0% p.a. in the same period.

²⁹ Changes in demographic variables explained 30% of the total per capita income increases while 35% originated from transfers received by families. Negative components added 15%.

(13%). Therefore, changes in labour force qualification accounted for approximately 44% of the total income per capita increase between 1992 and 2002³⁰. Note that per capita income grew, according to the household surveys, 30% between 1992 and 2002. Labour force qualification, therefore, reflected in the increased level of education of workers, played a major part in explaining GDP growth and productivity³¹.

As a result of improvements in the educational system, the number of graduates (master's and doctoral degrees) has also increased steadily since the 1980s. A recent study (Viotti, 2005, our translation) summarizes the main trends as follows: "the accelerated expansion of scientific production in Brazil has been in good measure due to the increase in the stock of graduates (master's and doctor's degrees). Between 1987 and 2003 the number of these graduates increased, respectively, 657% and 832%. In 2003, no less than 27,630 Brazilians got master's degrees and 8,094 completed their doctoral programs. In addition to that, rates of enrollment expansion in doctoral programs in the last few years, as well as scholarships, will make it possible to graduate 10 thousand PhDs in 2006, a figure that will reach 16 thousands in 2010. Just for comparison: in the USA the yearly number of graduates has been hovering around 41 thousand PhDs per annum in the last 10 years.

Scientific production has grown accordingly. There are indications that the contribution of this production towards increasing world scientific knowledge is becoming significant... this growing supply of human resources of high qualification and capacity to produce scientific advances represents an important base upon which one can build a national innovation and technological learning system " (Viotti, 2005, *passim*, our translation³²).

Despite strong recent advances, the still below-average quality of the labour force is a powerful impediment to innovation. De Negri and Salerno (2005) found out that among the four variables most closely associated to the likelihood of innovation, two are directly associated with the labour force: training and school attainment. Firms that engaged more decisively in identifying and succeeding in innovative initiatives with a view to external activities deployed more educated workers. Schooling levels of the labour force have a positive effect on the innovative capacity of firms, beyond other advantages such as the ability to learn new techniques.

Although still of below-average quality, two aspects deserve closer consideration: firstly, the widespread existence of informal labour relations, which represent powerful barriers to economic growth and productivity change and, secondly, the strict set of rules and regulations that govern the labour market. We turn to these themes next.

One of the main issues related to the development of a productive labour supply is the existence of a large informal workforce, making for a sizeable shadow economy in Brazil.

³⁰ The authors also note that the degree of average labour productivity inequality in Brazil is substantially larger than in other countries of Latin America, thereby contributing to per capita income inequality. Higher than average labor productivity inequality in Brazil is explained mainly by "quality of jobs" inequality rather than by the degree of inequality in "labour qualification", the weighting being approximately 4.5:1.

³¹ About 75% of family income in Brazil is derived from labour income. Therefore, income inequality reflects labour market differences. Better jobs imply higher productivity and higher per capita family income.

³² Dr. Viotti was kind enough to update his previous results in a letter to the author in mid-June, 2005.

Productivity performance

A recent study argues forcefully that informal labour is a powerful obstacle to productivity growth in Brazil (McKinsey&Company, 2004)³³.

The McKinsey study defines informality as the performance of licit activities in irregular forms and involving non-compliance with regulations (concerning tax and duty evasion; falsification of fiscal control instruments: non-payment of social security: lack of wage regulation and undeclared employment: non-observance of requirements on product quality, property rights, environment, etc.) that imply substantial hidden costs to the economy³⁴. The costs associated with compliance with existing legislation are an inducement to less competitive firms to turn to the informal economy as a strategy for survival.

The productivity gap between informal and formal firms in Brazil is estimated at about 50%. This is due to the difficulty to access financial market mechanisms, reduced access to the judiciary in order to enforce contracts, disincentive to expand due to fears of detection by government agencies in charge of enforcing tax and other legal norms and procedures and involvement in productive changes formed within the informal economy.

Once operating in the informal economy, there is little incentive for firms to invest in physical and in human capital. Access to credit markets is made more difficult. Informal operations have no incentive to grow in order to avoid visibility. Their relationships also tend to revolve around other informal firms. The study by McKinsey (2004) concluded that increasing the formal relative to the informal or shadow economy would have an important impact on Brazil's GDP and productivity. Thus, for instance, the lower-than-average use of capital relative to labour - a typical feature of informal activities, and one often associated with lower productivity levels - follows from the tax evasion on labour costs. These and other barriers to formal economic activities are powerful impediments to productivity growth.

As to its size, a recent World Bank document (**Doing Business in Brazil**, 2004) estimates that the shadow economy accounts for 40% of Brazil's gross national income and for 50% of the non-rural labour force.

From the McKinsey (2004) report we also learn that informal labour activities remained more or less constant between 1992 and 2002 (56.6% of the employed population in 1992 and 55.0% in 2002). It has remained almost stable only because agriculture's share in total employment has decreased. In fact, from the Brazilian household surveys (PNAD) we see that the share of informal labour in agriculture was estimated at 90% (91.5% in 2002 and 89.9% in 2002). Figures for the remaining sectors were: manufacturing industries, 26.9% and 37.1 %, in 1992 and 2002, respectively; construction, 61.3% and 71.1%; trade, 43.9% and 53.3%; transportation and communications, 28.5% and 42.0%; public administration and social services, 20.8% and 17.7%; and other services, 58.8% and 56.0%. Therefore, in the non-farm sector, as a whole, informal labour increased from 42.9% of the employed population in 1992 to 46.0% in 2002. This reflects migration from

³³ Informal labour relations are tolerated because of the social implications of high unemployment: it is better for the poor to have some income, even if earned in the shadow economy, than to have none. Therefore, there is a cultural perception that a certain degree of informality is tolerable and, indeed, acceptable. But the implications for productivity advances incorporated in these activities should not be overlooked.

³⁴ Drug trafficking, prostitution and gambling are (obviously) not included in their definition of informal activities.

rural to urban areas, as will be further explored below. With regard to the composition of informal labor activities within the manufacturing sector, the report states that it is concentrated in sectors such as clothing and accessories (where 62% of employment is informal³⁵), textiles (56%), food products and beverages (40%), metal products (38%).

The informal sector in Brazil has several causes, the most important of which are: (i) high costs implied in formalized economic activities including those arising from rigid rules for creating and closing down businesses, for example³⁶, rules governing labor relations³⁷ (see below); the excessive tax burden on formalized firms and contributions to social security³⁸; and (ii) the low enforcement capacity of the authorities, often associated with a slow judiciary and a disproportionate judiciary burden³⁹.

McKinsey (2004) concludes its report by presenting estimates of the output and productivity gains that could be achieved by decreasing the informal sector. After applying an equation to data on productivity growth rates and informal sector data in 26 manufacturing industries, a significant and strong negative association was found. The equation results were then used to predict productivity growth over the period 1996 to 2001 under two assumptions on informal sector reduction (20% and 40%) in all sectors, simultaneously. Manufacturing output would then increase by an additional percentage between 1.5% and 3.0%. Labour productivity would be increased from the 1.4% recorded p.a. to 2.8% or 4.6%, depending on the level of contraction of the informal sector achieved. The study also suggests that, for the economy as a whole, the additional productivity increase would be in the order of 1.5% p.a., which is quite a significant impact.

As mentioned⁴⁰, strict labour market regulations are also a hindrance to productivity advances in Brazil. Labor market regulations were addressed by the reforms of the 1990s. They remain essentially the same as when were first formulated and implemented in the 1940s⁴¹. Indeed, Brazilian regulations are among the most rigid in the world and lead to severe inefficiencies: they do not protect the workers and are an obstacle to the more effective allocation of labour resources. This translates into increasing informal employment (as mentioned, nearly 60% of labour).

Rigid labour laws results in a lower level of hiring, slower output and productivity growth. Soaring labour costs have been imposed by the existing legal framework: hiring costs in the form of compulsory and non-negotiable charges amount to over 100% of the direct wages (CNI, 2005, *passim*) and substantially increase labour costs.

³⁵ Defined as non-contributing to the social security system.

³⁶ The World Bank (2004) document states that it takes on average 152 days to establish a business in Brazil. The average closing down period is 10 years.

³⁷ The World Bank (2004) document states that Brazil has the third least flexible labour legislation in the world.

³⁸ Of the tax rate of 34.1% of GDP collected in 2001, 11.0% came from employer social security contributions and 12.1% from indirect taxes. Mc Kinsey (p. 28, 2004).

³⁹ Anecdotal evidence: while in Brazil the Supreme Court examines some 164,000 processes each year, the Supreme Court in the USA issues sentences on only about 100 cases per annum, only.

⁴⁰ As is well known, the relative size of the informal sector is associated with the rigidity of labour regulations. See CNI (2005).

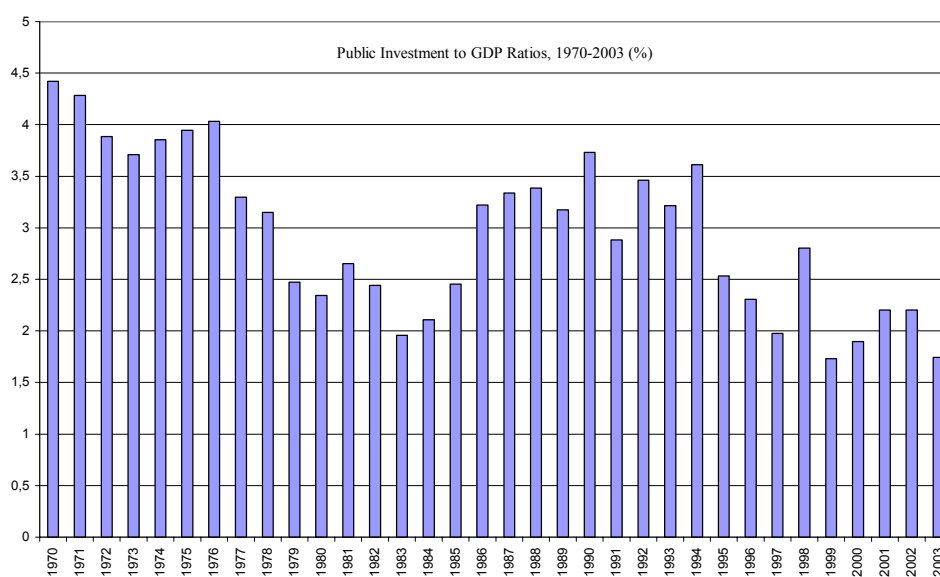
⁴¹ The existing labour code covers more than 900 legislative articles on virtually all aspects of labour relations, leaving little room for labour negotiations, for instance.

Government intervention is theoretically justified when there are market failures such as information asymmetries and an imbalance in bargaining power. Information problems are usually dealt with via intermediation systems that facilitate supply and demand market equilibrium. Bargaining power problems have been dealt with in other parts of the world via stimuli to association and a priori guarantees of rights. None of these have, however, been put in place in Brazil and labour regulation reform is still not on the current policy agenda.

Factor supply: Infrastructure

The physical infrastructure, on the other hand, has apparently not been especially productivity-enhancing in the last decade⁴². There is no doubt that prior to that decade the existing physical infrastructure did not hamper growth and productivity to any noticeable extent. Indeed, Brazilian industrialization was characterized by high publicly-funded investment levels in infrastructure, especially in the generation, transmission and distribution of electricity and road construction. This was the case up to the early 1980s, when the fiscal conditions began to worsen as Figure 3.10 illustrates. Starting from ratios of over 4% in the early to mid-1970s, public investment (mostly in infrastructure) to GDP ratios fell to 2% p.a. in the early 1980s, the late 1990s and early 2000s. In 2003 it fell to 1.7% of GDP and was even lower in 2004.

Figure 3.10: Public Investment to GDP Ratios, 1970-2003 (%)



Source: Brazil National Accounts

The situation got worse as the fiscal crisis became deeper (or, at least, when increased public awareness of this issue made it more visible) from the mid-1990s onwards, because most infrastructure investment was (and still is) publicly funded⁴³. Privatization was adopted in the 1990s as a way out of the problem (see analysis in the next section).

⁴² Telecommunications are a notable exception, though, mainly due to privatization. See also Ferreira and Malliagos(1998). Expansion of the internet and information technologies has been very rapid.

⁴³ In fact, a shortage of electrical energy in 2001 due to low investment levels in public utilities was held responsible for the abortion of a growth recovery phase that had begun in 1999.

Public-private partnerships (PPPs) are presently seen as a (partial) way out of the severe infrastructure financing problems.

Roads and ports have not contributed much to efficiency improvements in the recent past either, as the corresponding infrastructure has reached levels of nearly complete utilization due to lack of (budget-constrained) public investment. Institutional change and reform since the early 1990s (see Section 4) have not been able so far to attract private investment to physical infrastructure of this kind.

The long-term impact of infrastructure investment on growth and productivity of private inputs in Brazil has been studied by Ferreira and Malliagos (1998). In their study infrastructure capital is composed of electrical energy, telecommunications, roads, railways, ports and airports. The authors' objective was to investigate which infrastructure sectors had the closest impact on GDP growth in the long-term⁴⁴. The issue of causality (i.e., between infrastructure capital and GDP or productivity) was also examined. Their main conclusions were as follows: (i) there is a strong association between infrastructure investment and GDP in the long-run; (ii) the income elasticity is between 0.55 and 0.61; (iii) there is also an important relationship between infrastructure and TFP change⁴⁵.

The use of disaggregated series suggested that electrical energy, transportation and telecommunications were the segments that most closely influenced GDP. The fall in public investment in electrical energy and transportation from the 1980s onwards had a significant negative impact on output and productivity in the Brazilian economy.

Factor Allocation: Structural Change

Structural change has played a role, the results of which vary over time. There have been periods in which production shifted (relatively) to activities characterized by higher- than-average (labour) productivity. In other cases the opposite has occurred, as in the 1990s (Bonelli, 2002, *passim*). Broadly speaking, the evolving nature of structural change reflects the macroeconomic environment and performance.

The analysis of productivity change has shown that labor productivity displayed strong growth from the 1950s to 1980. This was increasingly due to the growth of capital labor ratios. In the 1980s capital accumulation continued, but at slightly lower rates than before. Labour productivity change, however, was negative in the decade as a whole. We concluded that the Brazilian economy progressively operated less efficiently over time, especially in the 1980s. In the 1990s, on the other hand, both labour and total factor productivity recovered, despite low aggregate growth. GDP growth was based on new technology and on economic reforms implemented over the decade - among them, trade and financial liberalization, state reform (privatization) and stabilization.

⁴⁴ This issue had already been investigated by Ferreira (1996), who found out that a 1% expansion of federal infrastructure capital (telecommunications, electrical energy, ports, railroads) generated a positive impact on GDP of between 0.35% and 1.12%, depending on the depreciation rates utilized. Considering total public capital (includes state firms and regional and local administrations) the impact varied between 0.71% and 1.05%. This implies a strong relationship between infrastructure investment and GDP in the long-run.

⁴⁵ According to the authors, their endogenous model suggests that a 1% change in infrastructure capital has a 0.53% impact on TFP; a 1% change in infrastructure investment has a 0.23% impact on TFP. Using the exogenous model the elasticity estimates would be between 0.48 and 0.49 and between 0.34 and 0.38, respectively.

Productivity performance

Productivity gains were not evenly distributed over time among sectors⁴⁶. Next we focus on the issue of structural change and its relationship to productivity growth, particularly the changing composition of employment and output⁴⁷.

Table 3.11 shows sector labor productivity levels and growth rates in selected years in the period 1950 to 2000 (original figures are in constant 2000 R\$). Labour productivity was measured as output at market prices⁴⁸ divided by employment estimates obtained from the Demographic Census. As expected from the previous discussion, gains were typically lower in the 1980s than in remaining decades⁴⁹.

**Table 3.11: Productivity levels and growth rates, 1950-2000
(R\$ and %)**

	1950	1960	1970	1980	1991	2000
PIB per worker (at market prices)	4,995	7,657	10,808	17,158	15,494	17,020
(Average growth rate %)		4.36	3.51	4.73	-0.92	1.05
Agriculture	1,306	1,677	2,294	3,743	4,916	7,316
(Average growth rate %)		2.53	3.18	5.02	2.51	4.52
Industry (except Construction)	8,052	14,426	19,463	24,128	26,209	31,440
(Average growth rate %)		6.00	3.04	2.17	0.75	2.04
Construction	13,275	22,972	20,713	29,578	21,991	21,700
(Average growth rate %)		5.64	-1.03	3.63	-2.66	-0.15
Retail and wholesale trade	7,656	10,011	11,583	13,960	8,472	6,908
(Average growth rate %)		2.72	1.47	1.88	-4.44	-2.24
Transport and Communications	1,361	2,041	3,496	8,028	15,117	21,344
(Average growth rate %)		4.14	5.53	8.67	5.92	3.91
Financial activities	25,169	21,317	39,454	52,082	64,828	71,079
(Average growth rate %)		-1.65	6.35	2.82	2.01	1.03
Public Administration	6,262	7,850	11,000	10,260	20,287	25,872
(Average growth rate %)		2.29	3.43	-0.69	6.39	2.74
Other services (residual)	22,858	23,673	24,832	33,533	14,247	14,263
(Average growth rate %)		0.35	0.48	3.05	-7.49	0.01

Source: Author's calculations based on Demographic Census and National Accounts data

Transport and communications was the leading sector in the long-run and was characterized by high productivity gains in all periods, which - compounded - yield a 5.66% p.a. growth rate over a period of half a century. On closer analysis, it is apparent that the gains were more concentrated in the communications sub-sector than in transportation. Gains in the former sub-sector were in the order of 11.4% p.a. between

⁴⁶ As noted, the unavailability of capital stock data at sectoral level constrained the analysis to the total economy.

⁴⁷ We borrow the following approach from Bacha and Bonelli's (2002) unpublished manuscript

⁴⁸ Sectoral output was estimated by sector shares in value added at factor cost (1950-1991) and value added at basic prices (2000).

⁴⁹ Care should be taken when analyzing the data in the table, especially data on public administration and other services sectors because of likely changes in registered employment in the Demographic Census. This is particularly true of the 1991 results.

1991 and 2000, 14.4% p.a. between 1980 and 1991, and, amazingly, 21.0% p.a. between 1970 and 1980⁵⁰.

The second highest productivity growth rate is observed in agriculture (farming and animal production), in which an average growth rate of productivity change of 3.51% p.a. was observed over 50 years. As a result, agriculture's productivity levels increased from 26% to 43% of the national average between the years analyzed.

Public administration falls into third place in decreasing order of productivity growth rates, but this will not be emphasized due to the peculiar way in which public sector output was measured in the past: on a par with population growth. Next in line comes manufacturing (plus mineral extraction and public utilities), showing a 2.76% long-term average, followed by the financial (2.1% p.a. rate) and construction (1.0% p.a.) sectors.

The remaining two sectors (trade/commerce and other services) show negative long-term average labor productivity growth, mainly due to their performance after 1980. These sectors are the ones on which informal labour has concentrated, especially since the 1980s and this explains their poor productivity performance.

Agriculture also employs a lot of informal labour and indeed, as we have just seen, the bulk of it⁵¹. However, the process of labour migration to urban areas has been so intense that the net result was positive, as indicated. Table 3.12 shows the sectoral structure of employment in 1950 and 2000, substantiating what has just been said. It can be confirmed that, even as late as 1950, the labour force in Brazil was largely concentrated in the primary sector: nearly 60% of total employment⁵².

Table 3.12: Sectoral Structure of Employment, 1950 and 2000 (%)

Agriculture	59.91	17.18
Industry (excluding construction)	14.17	14.77
Construction	3.42	6.87
Retail and wholesale trade	5.65	17.14
Transportation and communications	4.03	4.76
Financial sector	0.67	1.27
Public administration	4.93	9.54
Other services (residual)	7.23	28.48

Source: Demographic Census

Fifty years later the share of agricultural employment had fallen to 17%. Trade and other services (the residual sector in the table), on the other hand, accounted for the major part of the increase in employment during the half century analyzed: from a little less than 13% of the total in 1950 to almost 46% in 2000, more than trebling their share in total employment - albeit at the cost of diminishing labour productivity. It should be noted that public administration, construction and financial activities doubled their relative stock of workers, while manufacturing (and related activities) and transport and communications maintained their relative proportions in total employment.

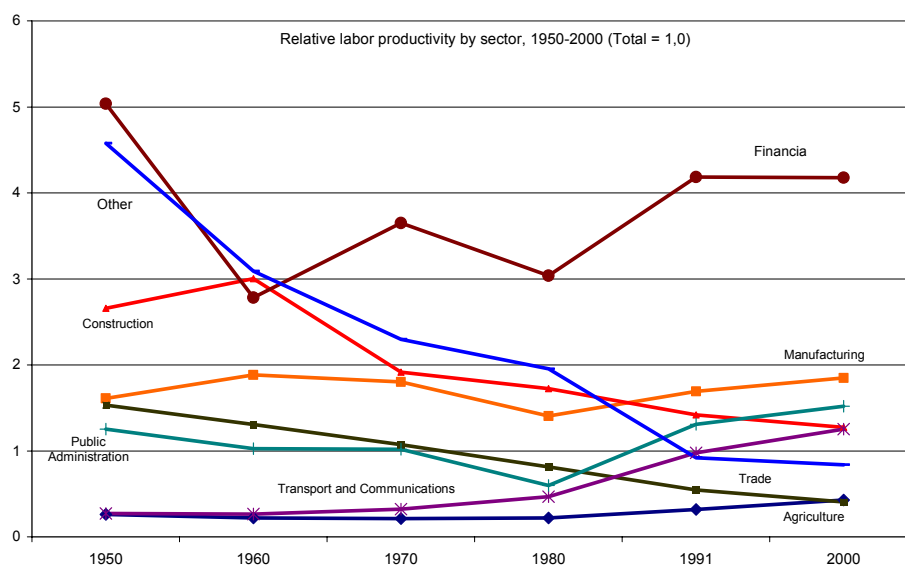
⁵⁰ Before 1970 communications and Transportation were lumped together in the National Accounts.

⁵¹ Other sectors also have considerable stocks of informal labor. Among them, as suggested in Section 2, manufacturing.

⁵² Agriculture's share on total employment was 66% in 1940.

As to the levels, Figure 3.11 shows that most sectors had above-average ALP, led by the financial, manufacturing plus mineral extraction and public utilities, construction and public administration sectors. The figure suggests that there was some convergence towards the average over time. In 1950, the range of relative productivities was from 0.26 (agriculture) to 5.0 (financial services). Fifty years later the range was from 0.41 (trade/commerce) to 4.18 (financial services).

Figure 3.11: Relative Labor Productivity by Sector, 1950-2000 (total=1.0)



We now turn to the main issue in this sub-section: to what extent did factor allocation contribute to overall productivity change. In order to answer this question we suggest the following simple breakdown exercise:

$$Y[T]/N[T] - Y[0]/N[0]$$

equals total productivity change between two periods of time, (0 and T), where N is aggregate employment and Y is aggregate output. A simple algebraic manipulation of the above expression yields

$$Y[T]/N[T] - Y[0]/N[0] = \sum a[i,T].P[i,T] - \sum a[i,0].P[i,0]$$

where $a[i,0]$ and $a[i,T]$ are employment shares for each sector i in the initial and final years considered and $P[i,0]$ and $P[i,T]$ are the labor productivities of the i th sector in the initial and final year, respectively. It is easy to show that the above expression can be considered the sum of two components:

$$\sum P[i,T].(a[i,T] - a[i,0]) \quad (1)$$

and

$$\sum a_{[i,0]}.(P_{[i,T]} - P_{[i,0]}) \quad (2)$$

We identify (1) a structural, or allocation component. It measures the contributions of structure, or allocation shifts over time (weighted by end-year sector ALP ($P_{[i,T]}$)). Expression (2) denotes a pure productivity component, which is given by productivity change between 0 and T (weighted by base-year employment shares).

From these expressions we note that productivity may change even if ALP in all sectors is stagnant: it is only necessary that labour shifts to higher ALP sectors. In this case, all change would be due to the allocation component. Conversely, aggregate productivity may increase without employment share change: it is only necessary that ALP increase in at least some sectors. In this case all change will be due to pure productivity growth (i.e. without structural change). The results of the breakdown exercise applied to decade data from 1950 to 2000 are shown in the following table.

Table 3.13: Breakdown of Average Labor Productivity Change, 1950-2000 (%)

	1950-60	1960-70	1970-80	1980-91	1991-2000
Pure productivity effect	65	51	54	76	142
Labour allocation effect	35	49	46	24	-42

Source: Author's calculations; see text

The breakdown results point to the important impacts of allocation effects on the Brazilian economy from 1950 to 1980. The effect of employment structure changes represented from 35% (in the 1950s) to 49% (in the 1960s) of the total absolute increase in aggregate ALP in the economy in the decades mentioned. Their complement is given by pure productivity increases, which we have termed the technological effect.

The effect of structural change ceased to exist after 1980. In the period 1980-91, aggregate ALP decreased, on average, as has already been shown. Therefore, both effects in the table were negative- their ratio to total ALP change resulting positive. The major part of (diminished) ALP change was caused by reduced sectoral ALP.

In 1991-2000 a negative allocation effect meant that labor shifted (in relative terms) to sectors of below-average ALP, as in the previous decade. The modest positive ALP growth achieved was entirely due to sectoral ALP growth, or to the pure productivity (technological) effect. It should be noted that, if the employment structure had remained unchanged in the period 1991-2000, ALP would have grown by an accumulated 14% instead of by 10%, as effectively occurred.

One of the implications for future productivity growth is that it is not enough to improve sectoral productivity performance. It is also necessary that the employment structure shifts away from sectors with low (and sometimes decreasing) productivity, especially commerce and other services, towards sectors with above- average ALP. Integrating at least part of the informal labor force into the formal economy in the service sectors would contribute to improve overall productivity.

Factor Allocation: Financial System

The effectiveness of the financial system as a source of productivity growth is also a matter of concern in Brazil. In the absence of a system of long term financing⁵³, resources available to firms have been very much constrained. Foreign loans and foreign direct investment (FDI) share with loans from the Brazilian National Development Bank (BNDES) the role of supplying (external to the firm) long-term financing to manufacturing and other sectors. It is acknowledged that funds internally generated have been by far the main source of finance to firms. By and large, the financial system has not had its expected role in the allocation of resources in the Brazilian economy.

The country's financial system has undergone significant transformation since the mid-1990s, in good measure adapting itself to low inflation levels after the Real stabilization plan (1994). But despite all changes, the ratio of credit to GDP continues to be extremely low, in the order of only 25%⁵⁴. Low financial intermediation reflects a host of factors, but, in particular, the very high basic interest rate in the economy⁵⁵, although this is only part of the story. High domestic interest rates are also a consequence of high spreads and jurisdictional uncertainty⁵⁶. High spreads, in turn reflect four main factors: precaution against non-payment of debts, fiscal expenditures associated with loans, judicial difficulties to recover bad loans and little competition among banks⁵⁷.

Securities markets such as bond and stock markets play only a limited role in financing new investment and the expansion of activities. Therefore, firms rely mainly on funds raised internally. External finance is availed of mainly by large firms which can issue bonds abroad at rates considerably lower than those prevailing (if on offer at all) in Brazil. In the 1960s and, especially, in the 1970s there were mechanisms in place to ensure access for even medium-sized and small firms to foreign financing via commercial banks. This, however, became impossible as the debt crisis of the 1980s hit the country and the 1982 debt default took place.

In addition to the present difficulties, the available commercial bank credit is only of short term maturity⁵⁸. There is virtually no long-term financing by private banks. Private agents display a clear preference for government liquid assets (given prevailing interest rates and the way public debts are rolled)⁵⁹. In addition, fears of default on public debt - a consequence of high inflation years and frequent defaults from 1979 to 1990 - also pushes lenders to short-term loans. Solutions in this regard are complex and require regulation and institutional changes.

⁵³ Due, among other reasons, to a persistent inflationary process that led the country to the brink of an overtly hyperinflationary process in the late 1980s and early 1990s.

⁵⁴ In addition, almost half of this share is targeted at specific areas, such as housing and agriculture.

⁵⁵ High real interest rates have been used to curb inflationary pressures in some periods, especially after 1999. Before 1999, during a period of slowly adjusting exchange rates (1995-1998), they were necessary in order to help finance balance of payments deficits.

⁵⁶ Jurisdictional uncertainty as an explanation for the lack of a local long-term domestic credit market and high interest rates is a theme that has been recently explored by Arida, Bacha and Rezende (2005).

⁵⁷ See Reis and Valadares (2004), *passim*.

⁵⁸ A recent study found out that the spread is due 40% to the liquid profit margin of banks; 21% to direct taxes, 8% to indirect taxes; 14% to banks administrative expenditures; and 17% to expenditures associated with debt defaults.

⁵⁹ Public sector savings have been negative for most of the past 20 years.

On the other hand, in part due to low financial intermediation and to improved Central Bank supervision, the financial sector has proven to be reasonably solid, with very few cases of bankruptcy, as witnessed by its resilience in the face of macroeconomic shocks in the last decade. Its role as an economic growth agent is still, however, in an early stage. Most credit to firms, whether to expand or to create a business comes either from retained earnings or from the Brazilian National Development Bank (BNDES), the sole institution granting long-term loans.

BNDES represented a very important source of finance to infrastructure and to manufacturing industries ever since its creation in the early 1950s. Its role as a development agency was reinforced in the late 1960s and in the 1970s. In the late 1980s, however, its sources of funds were reduced, in good measure because previous loans had been granted on very favourable terms, sometimes at negative real interest rates, resulting in low returns from past loans. It is also likely that non-performing loans had an impact on the available funds.

The weak financial sector performance in the past, therefore, can be blamed on the country's structural imbalances, which inhibited private savings and were responsible for increases in the tax burden on financial intermediation. Public banks still maintain a presence, but to a lesser extent than before as the banking sector was privatized in the 1990s⁶⁰.

3.2 Knowledge and the creation, diffusion and absorption of technology⁶¹

Knowledge embodied in human capital was an important source of productivity change in Brazil in some, though not all periods analyzed, as shown in Section 2. In general, the quality of Brazil's labour force - a critical factor in facilitating productivity change - has been improving steadily in the past decades. This has been the case especially since the 1980s, and particularly in manufacturing, as witnessed by increased training of the labour force. Training processes have also become more common among firms with the passage of time. After the beginning of trade liberalization in the last decade, the intense organizational changes that characterized most of manufacturing sector also included a renewed emphasis on training.

Perhaps more importantly, capital accumulation - which can also be viewed as increasing the stock of knowledge and hence productivity, through embodied and disembodied technological change - has also, as we have observed, seen substantial growth in given periods. In some periods, at least, capital accumulation included a substantial share of state-of-the-art imported machinery and equipment, which is a very important source of

⁶⁰ In addition to BNDES, the federal government also owns two large commercial banks: Banco do Brasil and Caixa Econômica Federal. This latter bank has among its main objectives the financing of housing and urban water and sewage systems.

⁶¹ The effects of knowledge on economic growth have recently been assessed by Chen and Dahlman (2004). They used an array of indicators, each of which represents an aspect of knowledge as independent variables in cross-section regressions that span 92 countries for the period 1960 to 2000. They show that knowledge is a significant determinant of long-term economic growth. In particular, the authors find that the stock of human capital, the level of domestic innovation and technological adaptation, and the level of information and communications technologies (ICT) infrastructure all exert statistically significant positive effects on long-term economic growth.

productivity gains. This was especially true during trade and financial liberalization in the 1990s.

In addition, knowledge flows across countries, apart from bringing additional interdependencies among them, represent an important source of productivity change in developing countries. The international spillover effects of knowledge have been strongly reinforced by FDI and TNC performance in the case of Brazil.

On a theoretical level, growth theory has for a long time been (with few exceptions) a theory of exogenous technological change. This was the case until the mid- to late- 1980s, when important new theoretical steps were advanced by P. Romer and R. Lucas. Externalities in the accumulation of knowledge began to be emphasized by these authors, alongside the accumulation of traditional factor inputs: “The stock of knowledge rises over time, as business firms invest in knowledge accumulation... each firm has an incentive to invest in private technology... however, this investment contributes to the aggregate public stock of knowledge. Hence the externality... which raises everyone’s productivity”⁶².

A second line of research, more concerned with innovation, was also initiated by Romer (in 1990) with a view to studying the evolution of productivity (Helpman, *op. cit.*, p.43-44). The models along this line postulate that firms invest in R&D in order to develop new products. Once successful, this allows for high private returns, which are made possible, and protected, by patents. But the legal intellectual protection systems are not perfect, and soon the innovative firm is followed by others (through imitation): “This ‘disembodied’ knowledge becomes available to other innovators and thereby reduces future R&D costs for everyone... (thus) the stock of knowledge available to innovators is a function of past R&D efforts” (Ibid, p. 44)⁶³

Thus, it has been clearly established on both theoretical and empirical applied levels that innovation is associated with productivity growth. Previous research (Bonelli, 1975, Pinheiro, 1989) established that productivity growth in the Brazilian manufacturing sector is associated with and originates from improvements in technical efficiency, broadly understood to include the creation and adoption of innovation (stemming from domestic R&D activities), sometimes through copying (imitation). Our results in the previous section point in the same direction.

The importance of product and process innovation from indigenous R&D activities in Brazil has, nonetheless been limited and concentrated in time. Reliance on processes of technology transfer from abroad has been historically the norm⁶⁴. The role of FDI in this context is of great importance, and will be explored below.

⁶² Helpman, 2004, p. 37-38. This short description refers to P. Romer’s model. Lucas’s model introduced externalities in human capital.

⁶³ Helpman, *op. cit.*, also makes the important point that, although R&D expenditures are much lower than capital expenditures, investment in R&D is not less important than investment in fixed capital because: (i) of the much higher returns on R&D investment relative to expenditures on machinery and equipment; (ii) “because whenever R&D raises TFP, the higher TFP induces capital accumulation. As a result, R&D has both a direct and an indirect effect on output, and the indirect effect can be large” (p. 47).

⁶⁴ Although the analytical emphasis is focused on the manufacturing industries, it should be noted that Brazil has notable exceptions in the form of new and/or adapted agricultural crops made possible by EMBRAPA, the state-owned research firm and (deep water) off-shore oil extraction, in the case of PETROBRAS, the giant state-owned oil firm. See below.

It has also been acknowledged that scientific and technological knowledge and production innovation have recently been subject to an unprecedented boost, in good measure associated with the use of information and communications technologies (ICT)⁶⁵. Knowledge is the central element in the modern economic structure being developed since the late 20th century, and innovation is the main vehicle for transforming knowledge into value. This makes it more difficult for developing countries not to lose position in the technology race, due to their less advantageous starting conditions. There are, however, windows of opportunity to be explored.

In Brazil, the process of technological change is in good measure restricted to absorption and adaptation (or imitation) of innovations generated elsewhere, with the result that the country's competitive position is also restricted in a time perspective (because absorption and adaptation take place with a time lag). Therefore, innovation is both resource-constrained (in the broadest sense not possessing enough human capital, fixed capital accumulation, knowledge infrastructure, maturity of production structure) and time-dependent. Besides, imitation is not necessarily based on the latest technologies and, finally, technology absorption has been uneven over time.

Despite this situation, Brazil appears to be in a not too unfavourably placed with respect to the innovation race, when compared to other developing countries. This is because of (a) the existence of a diversified and reasonably vertically integrated manufacturing production structure; (b) a large domestic market; (c) a sizeable network of R&D institutions and R&D-oriented firms; (d) an important range of graduate courses, in both number and quality; (e) linked to the foregoing: growing scientific output; (f) a competitive aeronautical industry; (g) a viable commodity-based agriculture, relying on endogenous R&D⁶⁶. An international comparison of R&D-based indicators will be presented below.

On the other hand, there are many well-known difficulties for the non-leaders in the technological race, such as Brazil. One of these is based on the fact that technological knowledge is frequently tacit - i.e., not easily transferred through projects, manuals and blueprints. Therefore, gaps between imitators and leaders can only be filled over time, through knowledge, resources and capital (human and financial). Without that, competition is only possible via low wages and subsidies (direct and indirect, e.g. through protection)⁶⁷.

Completely new technologies (creation of new technology) have been mostly restricted to a few sectors and activities, mainly oil extraction, mining and agriculture. As mentioned, in all these cases research was conducted by state-owned enterprises (SOE) in oil and mining or state research entities. This is particularly true of new agricultural crops and varieties made possible by R&D performed at EMBRAPA. A recent exception is the adaptation of car engines to use different kinds of fuel interchangeably or mixed (gasoline and/or ethanol), made possible by R&D performed by (foreign-owned) car manufacturers.

⁶⁵ The role of general-purpose technologies such as ICT in TFP growth is very difficult to detect, but has some very visible effects on the functioning of any modern economy.

⁶⁶ These points have been raised by Viotti (2005), based on the research by De Negri and Salerno (2005).

⁶⁷ Ibid.

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In particular, returns on agricultural R&D performed by EMBRAPA have been shown to be very high and have been almost on a par with returns on fixed capital in explaining agricultural output and productivity in Brazil (Bonelli, 1997)⁶⁸. One of the outcomes from such expenditures on R&D was the extraordinary productivity gains that have characterized the Brazilian agricultural sector since the 1970s, as analyzed in Section 2.

Viotti (2005, our translation) points out that “the Brazilian system of innovation and learning has so far presented overall low dynamism as far as the embodiment of knowledge and innovation into the production *processes* is concerned (emphasis added). The majority of firms seem not to have accumulated enough technological capability to transform themselves into active agents capable of absorbing and generating innovation. This aspect has undoubtedly constrained the process of technological development in the country.”⁶⁹

The relative levels of R&D expenditures are, however, not as low as one would expect from this passage. An international comparison, presented in Table 3.14, helps to put the problem in perspective (See De Negri and Salerno, 2005). The information in the table suggests that Brazil was not in an overly unfavourable position in terms of innovative activities in 2000, when compared to countries such as Portugal, Denmark and Greece, when the R&D expenditures indicator is used to compare these countries. Concerning expenditures on machinery and equipment purchases, the performance of the firms in the sample (those which had in fact made such expenditures in the period analyzed) was such that the country’s position is only equaled by Portugal and Greece. The same could be said of the remaining indicators included in the table: ‘acquisition of other knowledge external to the firm’ and ‘training, introduction to market and other technical expenditures’, in which cases Brazil’s firms (in the sample analyzed) attained the highest ranking, together with a few other countries. Their position is relatively lower in respect of the indicators that portray ‘R&D internal to the firm’ and, to a lesser extent, ‘R&D external to the firm’. (See De Negri and Salerno, 2005)

⁶⁸ The results were found estimating a Cobb-Douglas production function from pooled regression data (time series - cross section) across Brazilian states over time to explain farming output as a function of land, labour, fixed capital and R&D expenditures. The unconstrained coefficients added up to one. The elasticities with respect to fixed capital and R&D were the highest, returns on land and labour were lower than those on fixed capital and R&D.

⁶⁹ The research on which the quote is based has just been published. See De Negri and Salerno (2005).

Table 3.14 – Expenditures on innovative activities by manufacturing firms (in million euros) and ratios to revenues. Selected countries (2000)

Country	Receipts	Expenditures in innovative activities											
		R&D internal to firm		R&D external to the firm		R&D (total)		Acquisition of machinery and equipment		Acquisition of other knowledge external to the firm		Training, introduction to market and other technical expenditures	
		€ mi	%	€ mi	%	€ mi	%	€ mi	%	€ mi	%	€ mi	%
Germany	1,238,953	33,753	2.7	2,463	0.2	36,216	2.9	18,519	1.5	1,142	0.1	9,918	0.8
France	650,268	16,560	2.5	6,656	1.0	23,215	3.6	n.a.	n.a.	n.a.	n.a.	1,882	0.3
Italy	494,207	5,986	1.2	1,256	0.3	7,242	1.5	10,261	2.1	809	0.2	2,162	0.4
Brazil	297,638	2,197	0.7	369	0.1	2,566	0.9	6,831	2.3	689	0.2	3,025	1.0
Spain	272,691	2,130	0.8	665	0.2	2,795	1.0	2,866	1.1	432	0.2	844	0.3
The Netherlands	163,749	3,553	2.2	821	0.5	4,374	2.7	805	0.5	370	0.2	329	0.2
Belgium	146,250	3,024	2.1	613	0.4	3,638	2.5	2,469	1.7	305	0.2	1,664	1.1
Portugal	68,793	257	0.4	164	0.2	421	0.6	1,634	2.4	64	0.1	252	0.4
Denmark	46,493	263	0.6	35	0.1	297	0.6	39	0.1	2	0.0	176	0.4
Greece	22,434	n.a.	n.a.	25	0.1	n.a.	n.a.	538	2.4	n.a.	n.a.	86	0.4

Source: De Negri and Salerno (2005)

Note: Expenditures in R\$, the Brazilian currency, were converted into euros using the average exchange rate prevailing in 2000 (R\$ 1.6898 = € 1). Firms with innovative activity are those that, during the survey period, introduced innovations or had incomplete or unsuccessful innovative projects.

Another recent survey of innovation in the Brazilian manufacturing sector highlights the following issues among its conclusions⁷⁰:

- (i) 31.5% - quite a high proportion - of all firms undertook innovative activities in the years considered;
- (ii) the main innovative sectors were informatics (69% of all firms performed some innovative activities, either in the areas of products or processes, i.e. 109 out of 159 firms in the sample), basic electronics (63% or 153/244), communications (62% or 185/298), medical equipment (59%, or 416/704) and pulp and paper (52%, or 11/21). At the opposite end of the spectrum we find the least innovative industries

⁷⁰ See Kannebley Jr., Porto and Pazzelo (2004), passim. The research on which the authors base their conclusions, called PINTEC – Pesquisa Industrial e de Inovação Tecnológica na Indústria, covered nearly 72,000 firms in the manufacturing industries in the period 1998-2000. This research is a major source of information on innovation in Brazil's manufacturing industries.

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in the following sectors: wood and wood Products, mineral extraction, steel and non-metallic Minerals (materials for the construction industry);

- (iii) there is a clear positive association between firm size and the incidence of innovation;
- (iv) proportionally, foreign firms innovate relatively more than others: 66% as opposed to 55% of joint foreign-national (or SOE) and only 31% for domestically-owned firms;
- (v) innovation is strongly associated with the export orientation of firms.

The last effect is the strongest one: the export activity of a company has a clear impact on its probability of performing innovative activities in all models assessed by the authors. Firm ownership had a less significant than expected effect on the probability of innovating. However, as mentioned by the authors, foreign-owned and joint venture firms assume a more important role when a differentiation is made between innovation for the market and innovation for the firm (or process innovation)⁷¹.

The technological intensity of Brazil's exports, in turn, indicates the predominance of low technology-intensity products, as expected from the country's strong natural resources base. This concentration on low technology-intensive products is a source of concern to many analysts, who would favor - and expect - a higher concentration on high-technology products and sectors in line with international export growth trends. However, processes adopted in producing low-technology products frequently employ the latest (process) technologies and, as mentioned, production of some of these goods has greatly benefited from indigenous R&D.

Some of the main results from the research just cited are as follows: 'primary commodities' represented 40% of total exports in 2003 (against a world average of 11% the year before); 'labor and natural resources-intensive manufactures' were responsible for 13% of total exports, while 'low-technology manufactures' accounted for 8% - in both cases, shares similar to average levels worldwide; 'average technology manufactures' made up 19% of total exports (the world average being 30%); and 'high technology manufactures' 12% (worldwide average: 30%) (F. de Negri, 2004).

Apart from the role of indigenous R&D played by SOE, FDI's role with respect to technology *absorption* and *adaptation* in Brazil is also worth considering. Since the world generation and diffusion of technological capabilities and skills is largely concentrated on TNCs, their role in enhancing these aspects in Brazil seems undisputed: TNCs are primary conduits for the transfer of technologies and related skills, with linkages and spillovers to firms and institutions outside the TNC system playing an important role in the diffusion of technology. Also, organizational and managerial practices propagated by TNCs - central factors to the competitiveness of firms - improve the efficient utilization of labor, capital and technological resources. These practices have been increasingly associated with the extraordinary efficiency, productivity and competitiveness gains

⁷¹ Ibid, p. 122. The authors did not, however, include detailed results on this last aspect.

recently displayed by a number of developing countries, Brazil being no exception⁷². Clearly, the dissemination of these practices through linkages and spillovers from TNCs to other firms has positive implications with respect to productivity in host countries.

The impact on country performance depends on the importance of TNC activities relative to the size of the sector in question. The positive effects are the benefits of market access for firms that can be translated into advantages in the form of increased efficiency, economies of scale, induced investment and learning. These also often resulted in increased foreign trade, particularly given the export activity of TNCs and also efficient import substitution practices.

In the process of improving their own competitiveness, TNCs also contribute to industrial restructuring across sectors, industries and activities. Linkages are also important in this context because they allow foreign affiliates to act as transmission mechanisms. These multiplier effects become more effective the greater the number and areas of interface between local and foreign-owned firms. The gains are greater if they take place under conditions of openness to imports and access to competitive markets and technology. In this connection, the strong export orientation of TNC in Brazil also reflects these multiplier effects.

A final noteworthy aspect of innovation concerns the role played by unobserved R&D-related capabilities in explaining R&D intensity⁷³ in the Brazilian manufacturing industries. The authors of a recent study suggest that "...distributional regularities (in R&D intensity) observed across different sectors probably reflect the presence of unobserved factors", which were interpreted as unobserved R&D capabilities. The authors cite, among these, the adoption of modern organizational practices and "... the possible positive interplay between information technology and workplace organization in conditioning superior firm performance" (Façanha and Resende, op. cit., p. 319).

The long-established convention of the association between R&D intensity - a broadly accepted measure of innovative initiatives - and TFP growth appears to be confirmed in the case of Brazil. Periods of relatively high TFP growth were associated with phases of relatively high R&D initiatives, often associated with TNC performance. This has been very much the case in recent years. An overall assessment of the country's receptivity for new technology would also highlight the major improvements since the early 1990s, as trade and investment policies - including increased FDI - were successful in inducing productivity change.

Foreign Direct Investment and TNC performance

Contrary to the traditional motive for FDI - to access markets for final output - the modern TNC is aware of the need to have a portfolio of worldwide locational assets, to enhance productivity and competitiveness and, in doing so, changes productive conditions in the countries it is based. This may come about in many ways, but predominantly from the enhanced access to both qualitatively and quantitatively superior

⁷² See Bonelli (1999a), for evidence on new organizational and managerial practices in Brazilian manufacturing and their impacts on productivity change.

⁷³ See Façanha and Resende (2004). R&D intensity is measured as the ratio of the number of employees allocated to R&D activities to total employment in the firm.

resources, both tangible and intangible, which TNCs provide, compared with those of domestic firms.

The financial and physical capital provided by TNCs is one of the main contributions of FDI to productivity growth. New FDI flows into Brazil, for instance, added to the existing capital stock and led to more efficient resource use (including absorption of non- or underutilized resources, as in the privatization of public utilities). FDI, like all investment, induces multiplier effects through forward and backward linkages and spillovers in the form of positive externalities. FDI may be accompanied by investments associated with the original project to supply inputs and parts, either by foreign or domestic firms. The contribution of FDI to Brazil's fixed capital stock is, nonetheless insignificant⁷⁴.

FDI brought about by TNCs has been an important source of productivity change in Brazil since the beginnings of the country's industrialization drive in the 1950s. This subsection is concerned with providing background information to answer the following questions: to what extent did Brazil benefit from the improved productivity often associated with TNCs? What are the implications of the superior economic performance, on average, of TNCs over domestic firms? More specifically, is there a clear relationship between an increased FDI presence - as has been the case since the early 1990s, after years of low FDI flows following the debt crisis - and enhanced industrial productivity?

With nearly US\$ 17 billion in 1997, Brazil was one of the largest beneficiaries of FDI inflows among the developing countries in that year. The privatization programme, in which foreign investment played a significant role, is partially responsible for the record after 1990. Flows diminished after the Asian and Russian crises, though, only to recover more recently. At the same time, the car industry has proven to be a very attractive sector, as several large TNCs invested in the country in two distinct waves: in the late 1950s-1960s and in the 1990s (in the latter case, mostly European and Japanese).

Regional economic integration within MERCOSUR and market economy reforms were also important forces behind changes in the 1990s (and subsequently). The policy reforms aimed at replacing inward-oriented ISI policies by a new growth strategy in which liberalization and privatization would be the driving forces to enhance productivity and increased participation in world trade, capital and technology flows. This strategy also required a new approach towards FDI.

Despite the role foreign capital played in Brazilian development, many legal restrictions had historically been placed on FDI remittances, repatriation, sector of investment, etc.

The overall direction of change since the early 1990s, however, has been clearly towards greater liberalization of FDI policies. In 1995 new forms of investment promotion were launched, a specific constitutional amendment was approved by Congress and the new Concessions Law incorporated the new priorities. At the same time, the Central Bank began to implement legal/administrative measures to eliminate discrimination against

⁷⁴ Thus, for instance, a crude contemporary estimate would be in the 6 to 7% range. Recent flows, however, are higher than that: FDI flows accounted for approximately 10% of gross fixed capital formation in 1997, a record year.

foreign capital⁷⁵ in the form of greater liberalization of the capital account of the balance of payments (BOP) to increase convertibility of the domestic currency⁷⁶. Thus, both past history - i.e. size of previous stock of FDI - and market size, coupled with the role of an economic policy (mostly) favourable towards foreign capital were the main factors behind the increased FDI flows in the 1990s. The present stock of FDI is estimated at US\$ 130 billion (December, 2004).

Brazil has experienced significant progress in terms of trade, finance and FDI liberalization since the late 1980s, as it will be seen in the next section. Fewer barriers to trade, FDI and portfolio capital flows, together with decreased transport and communications costs, have resulted in increased options for firms in terms of where to produce and to sell. This, in turn, contributed to promoting more integrated patterns of TNC production, as reflected in augmented FDI flows, as the debt crisis of the 1980s waned and debt restructuring took place. New FDI flows and trade policies served to reinforce each other.

Recession and slower demand growth patterns, coupled with trade and financial liberalization have also intensified competitive pressures in Brazil since 1990. From the mid-1990s onwards, a relatively overvalued exchange rate (after the implementation of the Real stabilization plan) further intensified such pressures, up to early 1999. One result of these developments was an increased concern with productivity and competitiveness at plant level, as firms were forced to exploit every available source of efficiency⁷⁷. Many of them – the small and least productive firms, in particular - have not survived the competitive pressures. Not infrequently, firms became targets for mergers and acquisitions (M&A). TNCs have been particularly active in these M&A processes.

FDI flows into Brazil showed new impetus after 1992, initially in the form of portfolio investment, attracted by high real interest rate differentials relative to other countries due to high interest paid on government debt. Later on, boosted by stabilization, demand growth and privatization, FDI inflows reached historic highs, particularly in the period 1994-98⁷⁸.

Brazil's domestic policies played a passive role in drawing in foreign capital, as the concepts of 'getting the fundamentals right' and 'adopting market friendly' policies in domestic markets were considered necessary and sufficient conditions for attracting FDI. Access to these flows was, however, also determined by events occurring elsewhere in

⁷⁵ Foreign companies are subject to the same legal treatment as domestic firms; profits and dividends on foreign investment are exempt (since January 1996) from taxes on wages; portfolio investment repatriation is exempt from income tax; capital gains are exempt from any taxation – although profits and dividends are taxable.

⁷⁶ Thus, for instance, among other liberalizing measures, financial institutions were authorized to keep unlimited amounts of foreign exchange and foreign institutional investors were given access to securities and fixed income bonds markets in Brazil for the first time ever. An analysis of these and other trade and industrial policies in Brazil up to the late 1990s is presented in Bonelli, Motta Veiga and Brito (1997).

⁷⁷ See Bonelli (1999a), *passim*.

⁷⁸ In 1997, for instance, FDI inflows represented nearly half the current account deficit (4.2% of GDP) in that year. The Asian and Russian crises, despite affecting inflows to Brazil in late 1997, were not obstacles to new FDI flows. During 1998, inflows exceeded the most optimistic expectations due to privatization of telecoms. After a temporary decline in the period 2002-2003 associated with investors' fears of policy changes that could be implemented by the new 'leftist' government empowered in 2003, FDI inflows reached high levels again in 2004.

the world economy. Therefore, exogenous factors were powerful determinants of changes in TNC and FDI behavior.

One of the objectives of the liberalization of FDI, trade and finance flows was – as noted - to enhance economic growth and productivity. The benefits depended very much both on the volume of investment and on the prevailing market conditions and productive efficiency of both existing and new firms. FDI changed these conditions in a number of ways. Recent FDI inflows into Brazil have made these issues very important ones for two reasons. Firstly, productivity and competitiveness increases became a key issue in the 1990s due to the critical need to reduce the current account imbalances via augmented competitive exports (and efficient import substitution). Secondly, FDI inflows also complemented domestic savings in financing investment, given the need to increase investment rates for growth resumption.

FDI is also a key variable affecting the contestability of markets and, thus, productivity and, therefore, potentially improves both competition⁷⁹ and competitiveness. This is particularly true in the case of Brazil as far as non-tradables are concerned: banking, retail and wholesale trade, insurance and public utilities are all sectors in which increased FDI flows triggered substantial productivity and competitiveness gains⁸⁰. In addition, the fact that much FDI in the 1990s was directed at non-tradables, also has positive implications for the productivity of tradables: an efficient services sector is a prerequisite for an efficient export sector in the areas of finance/banking, energy, telecommunications, transport systems and ports⁸¹.

A report by McKinsey & Company (1998) on productivity growth and productivity differentials among countries in eight selected activities makes this point forcefully:

“Brazil’s current standard of living is primarily due to low labor productivity and low capital inputs ... local markets were and often still are stifled by regulatory limits on local and foreign competition ... the most important product and capital market barriers remaining to be addressed are tariffs and government ownership ... inconsistent tax enforcement also stifles productivity growth ... the capacity of the whole economy to function as one market hinges on an efficient infrastructure that reduces transportation costs ...(but) comparative analysis suggests that Brazil’s road network may not satisfactorily fulfill this function ... Brazilian ports are twice as expensive to exporters as other Latin American ports ...” (*Executive Summary*, p.3 - 8)

Trade Liberalization, Productivity and FDI

How does trade liberalization directly and indirectly affect productivity? Liberalization makes it more difficult for domestic firms to protect themselves from competition in their

⁷⁹ This aspect is not undisputed: entry of TNCs tends to reduce market concentration and increase competition, unless entry occurs by M&A. On the other hand, TNCs’, larger size, on average, than the local rivals and their technological, marketing and managerial superiority can lead to increased concentration and non-competitive conduct – as of course can entry barriers.

⁸⁰ Some of these areas, such as trade and banking, have been the object of analysis in Brazil by McKinsey (1998).

⁸¹ This is so because the (extra) cost of doing business in Brazil, sometimes known as “Brazil-cost” (*custo Brasil*, or Brazil-specific transaction costs), is clearly recognized as very high due to the inefficiency of the infrastructure and services as well as the negative effects emanating from the existing tax system.

home markets and to guarantee secure sources of profits⁸². Therefore, liberalization should be closely associated with inward FDI in the sense that both generate increased productivity via competitive pressures. In actual practice, in countries facing structural change of the kind Brazil has experienced since the 1990s, these two issues are closely intertwined.

Fast labour and TFP growth, cost reductions per unit of output, successful product innovation, enlarged market share and increased comparative advantage in foreign trade (as reflected in increased exports) are typical competitiveness-related variables associated with the presence of TNCs in Brazil. As noted, FDI has had a strong influence in shaping the output scope and technological base of Brazil's manufacturing sector and its trade structure and performance. In the case of the services sector, the role of TNCs in Brazil was important even before World War II. As noted, in the 1990s FDI flows were concentrated in the area of services (non-tradables).

The export orientation of foreign-owned firms is, on average, higher than that of domestic firms, as seen above. This is in part due to the role and extent of intra-firm trade in which they engage. In addition, host countries provide export incentives which are taken up more quickly by TNCs than by domestic firms, reflecting competitive advantages in international markets due, for instance, to superior marketing channels and/or managerial flexibility. Also, one of the main aspects of export-oriented TNCs is their size: the competitive advantage of a TNC is often related to a unique asset its possession which, in turn, is frequently associated with its size.

Thus, trade and financial liberalization clearly facilitated FDI growth. Changes included the opening up of industries previously closed to foreign investment, the establishment of liberalization schemes and the enhanced role of intra-firm trade - an essential feature of all FDI-generated international production.

A conspicuous result of the recent Brazilian economic performance is the productivity growth record in the manufacturing industries which is frequently mentioned in the present report and came about with little new investment. This change has often been related to trade liberalization, stabilization and the adoption/diffusion of new technological and managerial techniques associated with the new production paradigm that replaced the "Fordist-Taylorist model". All these processes have, however, strong linkages with the expanded presence of TNCs in Brazil. It is not our objective here to break down or identify the specific effects of these processes individually, rather, we just wish to point out that these phenomena were concurrent and contributed to a substantial boost to productivity levels.

A recent report emphasizes the two-way dimension of the competitiveness-FDI link from a different perspective⁸³. From its concluding remarks we extracted the following illustrative passages:

"The efficiency-seeking dimension of present TNC investments tends to reinforce the competitiveness of local production, deepening advances obtained during the recessive years (of 1990-92) and consolidating consumers' gains.... Paradoxically, these welfare

⁸² The issue of trade liberalization and productivity change is taken up again in Section 4.2.

⁸³ Laplane and Sarti (1997), op. cit. Our translation.

and competitiveness gains may not be sustainable if the cost in terms of foreign exchange be considered too high....Results from our TNC survey show that these firms have been very quick in reducing competitive disadvantages relative to the rest of the world. Present investments are directed to the same objective. The interviews allowed us to identify (many) TNCs modernization initiatives which contributed to the dissemination of product and process innovations in their supplying firms...emphasis on efficiency-seeking through standardization of products, processes and organizational and managerial techniques leads to specialization and rationalization in the development of innovations as well... (but) the spillovers of learning processes are low..." (p. 82-83)

The results from the research just cited strongly suggest that TNC modernization initiatives, once adopted, increase productivity and competitiveness very quickly. The authors are, however, sceptical concerning the linkage effects that might be obtained from such initiatives.

3.3 Competition, Social Dimension and Environment

The competitive environment has been changing markedly in Brazil since trade liberalization, privatization and other state reforms have been implemented. In general, it can be said that the economy has become more competitive, although production in certain industries within the manufacturing sector remains very concentrated on a small number of producers. This is especially the case in segments such as steel, certain construction materials, beverages (e.g., beer and soft drinks), chemicals and petrochemicals, not to speak of non-manufacturing activities such as mineral (oil and non-oil) extraction.

The same can be said of the asset and income inequality issue. Brazil is well known for its unequal distribution of income and high incidence of poverty. Both changed in the 1990s, largely as a result of the Real stabilization plan. When inflation rates suddenly dropped in 1994, real incomes increased sharply. The gains were proportionately greater for the poorest segments in the population than for the richest ones. These latter had been better equipped to protect their earnings against inflation. Poverty incidence decreased simultaneously, but the impact on income inequality was not as pronounced. To the extent that reducing inflation is considered part of the package of market reforms, it had a dramatic impact on poverty. But one disturbing aspect of this process was that poverty reduction seems to have been a short-lived, once-and-for-all phenomenon.

Thus, the overall impact of reforms on poverty was rather limited, with the exception of changes just after the implementation of the Real stabilization plan. There are two main channels through which reforms might affect poverty: (i) income growth; and (ii) via income distribution changes. In both cases the results of the reforms were relatively insignificant in Brazil.

The effect of these aspects (inequality and poverty) on productivity change is not easy to evaluate. Large income inequality makes for small markets for many goods and services.

Therefore, scale economies cannot be achieved and productivity is limited accordingly. For this reason, large income and asset inequality hampered productivity growth.

A recent survey on growth and productivity change concludes with the following remarks on the influence of inequality on growth: “My tentative conclusion is that inequality slows growth... Although we can argue with limited confidence that inequality within a country slows its growth, we cannot say much about the channels through which this influence plays out” (Helpman, op. cit., 2004, p.94)

Environmental concerns have not so far had the importance they deserve in Brazil. Except in few cases, usually related to the generation of electric energy (when environmental licenses are not necessarily granted according to the original project’s needs, thereby generating construction delays and cancellations)⁸⁴, environmental regulations have had no great impact – positively or negatively - on productivity growth . This may well change, however, in the near future.

3.4 Institutions, Integration and Invariants

Integration: Brazil has traditionally been an extremely closed economy, due to ISI policies and the protectionist practices they entailed. Thus, for six decades from the Great Depression until the 1990s economic policy had been marked by low integration into the world economy. The country has, however, recently become more and more integrated in both trade and finance (since the mid-1990s) and exports have become a relevant source of demand growth. This was the case particularly in 2003, when exports were responsible for the recovery in the level of economic activity. The flow of trade (exports plus imports of goods and non-factor services) to GDP ratio was nearly 29% in 2003, compared with only 18% in 1994. In the mid-1980s this ratio was even smaller at approximately 15%.

Recent trends in export growth, after the exchange rate devaluation in 1999 and the adoption of a free float exchange rate regime, have boosted exports. Brazil is competitive in a broad range of goods, from aeronautical equipment to steel and soy and related products. The natural endowment base indicates that activities closer to natural resources (such as mining and agribusiness), have developed export capacity faster than most others. This has resulted in productivity gains in these sectors. ALP growth in 2004 indicates that manufacturing as a whole is also benefiting from productivity change: De Negri and Freitas (2004) have shown that TFP change in Brazil was positively associated with the export performance of manufacturing firms.

Increased imports have also been an avenue to improved productivity performance. It has been suggested that part of the successful productivity growth story in the 1990s can be attributed to import liberalization (see next section). Growth was fuelled by the use of improved (imported) raw materials and machinery and equipment. This coincided with economic integration within MERCOSUR, which facilitated more imports and exports from and to neighboring Argentina, Uruguay and Paraguay.

⁸⁴ This is, incidentally, a very hotly debated issue in contemporary Brazil, as private concerns complain of excessive environmental regulation.

Role of Institutions and Regulations that can affect productivity⁸⁵: The market reform process that Brazil began in the late 1980s and early 1990s has remained incomplete, in the sense that it lacks complementary institutional reforms in areas such as sectoral and overall regulation, property rights, judicial and administrative reform. The following quotes summarize the issue of regulatory deficiencies:

“Although macro stabilization dominated the economic scene in the 1980s, this period also recorded a number of market-oriented reforms, essentially geared at eliminating some of the excesses introduced in the post-1974 period (*as a reaction to the first oil crisis*). (*However*), reforms ... counted with very little political support. Indeed, the 1988 Constitution had clear nationalist and ‘statist’ provisions in establishing, for example, public monopolies in telecommunications, ... oil and... distribution of gas, and in setting up barriers to foreign ownership in mining and electricity. Yet, less than two years after ... (*that*), Brazil launched major market-oriented reforms, ... enlarging the trade liberalization, privatization and deregulation programs (*in a substantial way*).” (Pineiro, Bonelli and Schneider, 2004, p. 10-11)

Changes in the regulation of privatized sectors attest to the difficulties in this arena. This is reflected in the problems associated with resolving conflicts of interest and overlapping responsibilities (as in the case of ports) and extending the network operated by private investors (as with highways). Moreover, in the railway sector the break up of state-owned enterprises and the restrictions imposed on cross-ownership seem to have created an excessively fragmented industrial structure.

“There are also four issues that cut across the various infrastructure sectors. First, while great emphasis has been placed on establishing and strengthening regulation, and using privatization to improve the performance of sector SOE, little attention was given to providing the sector ministries with capacity and instruments to carry out policy and planning activities. This has often resulted in the lack of well designed sector models that could help to structure the institutional framework in which regulation and business activities were to take place.

Second, it is necessary to foster government commitment to the new overall framework adopted for infrastructure, with the separation of policy, regulation and business activities. Moving ahead with reform in sectors that are midway into this process is a way to do this, but a more general alignment with this policy stance is also important to generate credibility and in this way reduce the risk perception of private investors. As part of this process, it is necessary to consolidate a new regulatory culture, strengthening and giving a more homogeneous mandate to the regulatory agencies.

Third, it is necessary to develop finance and risk management instruments that help making infrastructure investment, particularly in greenfield projects, more attractive. The necessary increase in annual investment in infrastructure amounts to roughly 1.5 percent of GDP, a large amount by any measure, and certainly one that cannot be financed by the public sector budget, given current fiscal restrictions, and is in excess of the financial capacity of public banks. This increment in investment is also dependent on long-term funds and characterized by risks that are high and different from those faced by standard commercial business.

⁸⁵ Note, however, that institutions are not only cause but also consequence of growth processes.

So, financial sector reform, and in particular lowering of the cost and expanding the supply of capital, seems to be a critical element in a strategy to increase private participation in infrastructure. This seems to have been a key point somewhat overlooked in the reform process. Moreover, although some of the necessary initiatives in this regard will be part of this broader, long overdue reform of financial markets, some are specific to infrastructure projects, and could probably be implemented without having to wait for a comprehensive financial market reform.

Finally, it is necessary to prepare the judiciary to deal with disputes concerning the regulation of infrastructure sectors. In recent years, the courts were asked to interfere in regulatory decisions in the telecom, transportation and electricity sectors. A survey shows that Brazilian judges tend to consider non-economic matters when deciding about issues concerning the regulation of public utilities, and believe that they should go into the merit of the disputes — in contrast with just guaranteeing due process — even when these were the object of decisions taken by the board of regulatory agencies. The slowness and ‘politization’ of judicial decisions are elements that increase the risk of private infrastructure investment, and making the judiciary more agile, predictable and impartial would help to increase it.” (Pinheiro, Bonelli and Schneider, 2004, p. 33)

And:

“Increasing informality is another answer to excessive regulation because it forces companies to operate at sub-optimal scales, causing both labor and total factor productivity to be lower than otherwise. Firms in the informal sector are only able to compete by not fulfilling with their tax obligations. By not paying taxes informal firms gain a cost advantage vis-à-vis formal competitors. This spurious competitiveness brings negative consequences for the economy. In particular, it hinders more productive and efficient companies from expanding their output, while keeping human, management and capital resources locked into inefficient methods of production and imposing a high cost on firms.

The high tax burden is the main component of the cost of being formal. But it is not the only relevant factor. Another important factor is the heavy regulatory burden that falls on formal firms. There is evidence that the share of the informal sector in GDP is in general: (i) higher in countries in which there is a heavier corporate regulation and in which regulators have greater discretion in its application; (ii) larger in countries with a heavier tax burden, with the application of tax norms being as important as the tax rates proper; and (iii) correlated with the quality of public services (more informality corresponds to lower quality services), with the latter measured by the degree of corruption and how the rule of law is applied, especially regarding the legal protection to private commercial investment.

Among the measures of corporate regulation that have been used one finds three indicators: the number of procedures necessary to start up the firm, the official number of working days necessary for completing those procedures, assuming that there are no delays, and the financial cost of doing so. The start up of a firm in the formal sector is a rather complicated process, which demands lots of time and is rather expensive in most countries. More specifically: (i) the number of procedures that need to be followed to start a firm ranges from a minimum of 2 in Canada to a maximum of 20 in Bolivia, with a world mean around 10. In Brazil, there are 15 procedures; (ii) the minimum required time

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to complete those procedures ranges from 2 working days (several countries) to 174 working days (in Mozambique), with a world average of 63 working days. In Brazil, it is necessary 67 working days; (iii) the cost of following these legal procedures ranges between 0.4% of per capita income (New Zealand) to 2.6 times per capita income (Bolivia), with a world average of 34% of per capita income. In Brazil, the cost amounts to 67.4% of per capita income".(Pinheiro, 2003, passim)

In summary, although their overall effect is difficult to gauge, institutional change in Brazil has proceeded in the right direction since the late 1980s. There are, nonetheless, still tough issues which have given rise to much comment in the recent past: rules governing the protection of intellectual property rights, regulatory structures, bureaucratic capacity and special institutional arrangements to support business.

The invariants: (i) Brazil has clearly benefited from its geographic location (including a very large maritime coast), natural-resource endowments and (potential) market size; (ii) political institutions have been increasingly responsive to the need to improve regulations and growth-enhancing instruments; (iii) natural-resource endowments are clearly positive in Brazil; good quality land (in part made possible by improvements in the agricultural land due to indigenous R&D) and mineral resources abound, with the exception of coal; Brazil is also competitive in mining and likely to become self-sufficient in oil due to deep-sea production - although certain types of oil are likely to be imported for years to come.

IV. Discussion of policies with effect on productivity

The influence of both sector-specific (i.e. manufacturing) and general economic policies on productivity is examined in the present section. Both direct and indirect impacts on productivity (through trade liberalization, for instance) are assessed. The main hypothesis is that the Brazilian productivity record has been dictated by development policies, strategies and institutions adopted and/or created during the import substitution industrialization (ISI) phase - broadly speaking, up to the late 1980s - and by the changes that took place after that period, as well as changes in the overall macroeconomic performance within each phase.

Policies and strategies also share responsibility with the overall economic performance in the sense that productivity, both labor and multi-factor, seems to be pro-cyclical. The main explanation for this feature is the existence and strength of scale economies and other hidden productivity-enhancing factors that tend to respond positively to the pace of output growth, especially in manufacturing. Apart from the overall growth strategies and performance, there were different responses in terms of productivity performance on the part of individual firms. These depended on specific institutional, market and sectoral characteristics.

Note that the previous sections dealt with the issue of effects of economic policies (rules on FDI, regulation, etc.). What we add here is an overall appraisal of two broad sets of policies that have had a lasting, although non-homogeneous impact on productivity: trade and industrial policies (focusing on trade liberalization in some detail), the related sectoral composition of gross investment, and privatization.

4.1 Trade and Industrial Policies and Institutional Change⁸⁶

The Brazilian manufacturing sector long benefited from a host of import barriers. The most important among them were high tariff and non-tariff protective barriers and foreign exchange controls. These instruments were, at times, supported by undervalued exchange rates. Imports of so-called 'non-essential' goods were subject to severe penalties and non-tariff barriers were widely used. Redundant tariffs were the norm. Forty-two 'special import' regimes allowed for the exemption or reduction of import duties to support specific sectors and activities until 1988. Starting in the late 1960s Brazil also began to foster export growth, with exchange rate overvaluation being sometimes offset by special export supporting schemes.

Protection, promotion and regulation of manufacturing activities varied over time, but, as a rule, the high tariff and non-tariff barriers associated with ISI were ever present and constrained productivity growth. Excessive protection contributed to profit differentials in favor of domestically oriented, import substituting sectors, diverting resources towards them. Lack of competitive pressures from imports hampered productivity, particularly in manufacturing, and reduced the pressure for greater efficiency and lower prices of non-

⁸⁶ Since it is the economic impact of a policy, not the stated intention behind it, which is of interest here, we do not mention trade and industrial policies repeatedly announced from the mid-1990s on (see Bonelli, 2001). The same applies to the recently enacted Innovation Law, the effects of which have not been evaluated to date due to the short time which has elapsed since it was passed.

tradables. Low-quality infrastructural conditions and the lack of modern services (in telecommunications, for instance) were natural results of protectionism. The high cost of essential imports or of their domestic substitutes, in turn, penalized exports. Low domestic and external competitiveness and an anti-export bias were the natural outcome.

Starting in 1988, Brazil implemented import policies to foster allocative efficiency via external competition. Three rounds of tariff reductions took place in 1988-89, 1991-93 and 1994⁸⁷. Trade liberalization since 1990 has had the deepest and most lasting effects on the economy of all policies adopted to date.

Another important feature is that, after 1990, industrial policies became more horizontal and less pro-active and, indeed, the industrial targeting typical of ISI seemed to belong to the past after that period (Bonelli, Motta Veiga and Britto, 1997, *passim*). When exceptions were implemented after the mid-1990s, policy directives included sectoral priorities in a small number of cases: (i) high-technology industries (informatics, fine chemicals, precision mechanics, biotechnology and the so-called 'new materials'), considered infant industries; (ii) the car industry; and (iii) industries in 'need of restructuring'.

With the benefit of hindsight, it can be said that part of the industrial and trade policy measures adopted reflected both domestic pressures and indecision with respect to which course of action to follow. Exemption of import tariffs on capital goods, for instance, was re-enacted in 1995, in the context of the automotive agreement then concluded with Argentina due to a renewal of MERCOSUL arrangements. In 2004, taxes on sales of domestically produced capital equipment were reduced in an effort to lower the price of new investment goods.

Indeed, trade liberalization suffered a number of setbacks between 1995 and 1998 when, after the Mexican crisis of late 1994, Brazil found it difficult to finance increasing current account deficits. The swinging pendulum of tariff cuts and hikes followed a largely pragmatic course, essentially reflecting pressures from domestic producers and changing macroeconomic conditions.

As a general rule, the objectives of industrial and trade policies were subordinated to macroeconomic objectives after the Real Plan was implemented in 1994. Thus, trade policy became formally oriented towards: (i) increasing trade flows; and (ii) perfecting the control of these trade flows with the objective of ensuring adequate domestic supply, avoiding unfair trading practices and contributing to the balance of payments equilibrium. Temporary deepening of trade liberalization in late 1994 represented the final step of the process initiated in 1990. The impact on the manufacturing sector structure and performance was marked. Productivity increased substantially throughout the decade, but competitiveness suffered from exchange rate appreciation. Still, despite the policy-makers

⁸⁷ The original schedule of trade liberalization proceeded very rapidly from 1990 onwards. The logic behind it was: (i) 0 (zero) percent import tariffs applied to goods characterized by clear comparative advantages, goods involving high international transport costs, goods with no domestically produced equivalents and commodities characterized by low value added content; (ii) 5 percent import tariffs would apply to products already at that import bracket; (iii) 10 percent - agricultural products and derivatives; (iv) 10 percent, 15 percent and 20 percent to products that use in their productive chain inputs with zero import duties; (v) all the remaining product categories. The schedule was modified several times to anticipate tariff cuts. Trade liberalization was further deepened by the substantial real appreciation of the exchange rate in the aftermath or price stabilization. See Pinheiro, Bonelli and Schneider (2004).

stated preference for ‘horizontal’ instruments⁸⁸, as opposed to industrial targeting - which was clearly congruent to the priority attributed to macro stabilization - one of the main legacies of President Cardoso’s (1995-2002) industrial policy was markedly sector-oriented: the automotive agreement with Argentina.

Therefore, Brazil’s growth strategy has changed substantially since 1990. For nearly six decades beforehand economic policy had been characterized by low integration into the world economy, pervasive discretionary state intervention, and the prevalence of planning and command over market competition. From the early 1990s onwards, the economy was opened to foreign trade and to both direct and portfolio investment. In addition, a number of large SOEs were sold off and many price and output regulations discontinued. At the same time and gradually, a new regulatory framework was put in place within the context of overall market reforms and institutional change occurred at a much faster pace than before. Needless to say, trade liberalization had a strong impact on both the manufacturing sector performance and the economy: import liberalization was one of the driving forces behind the acceleration of productivity growth in the 1990s as firms, faced with the threat of increasing imports, reacted by adopting practices entailing more efficient use of resources.

4.2 Trade liberalization and growth

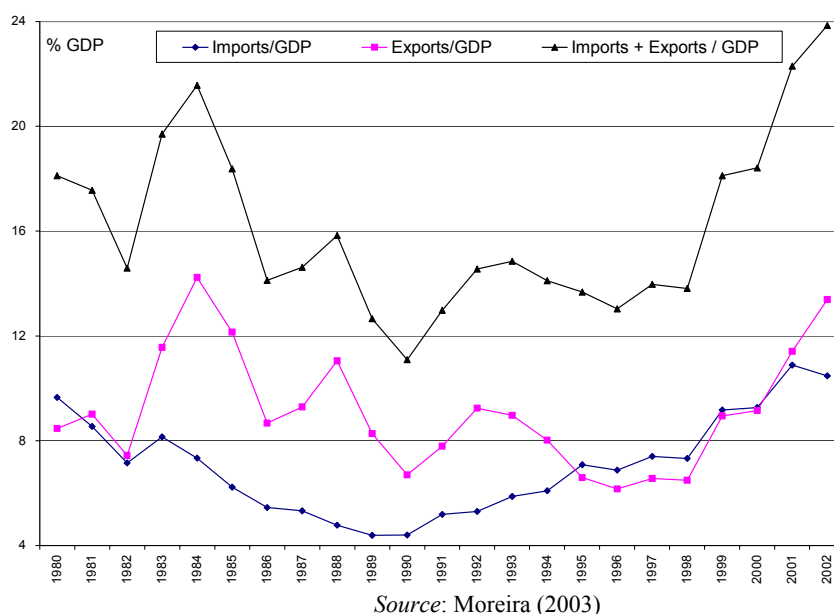
A recent appraisal of results of the liberalization process in Brazil concluded that the links between trade and growth are less obvious than they appear to be (Moreira, 2003). Indeed, Brazil’s mediocre growth performance in the 1990s contrasts with the positive results of trade liberalization experienced in the same period. The opening up of a previously much closed economy is shown in the Figure 12. Imports as a percentage of GDP (all measured in nominal terms) rose from approximately 4 percent at the beginning of the 1990s to nearly two and a half times that value in the beginning of the next decade. Total trade (exports plus imports) as a percentage of GDP rose from 10 percent in 1990 to nearly 24 percent in 2002. In 2004 it may well have reached 27-28%. But GDP growth, as noted, was on average below the 3 percent per year mark in the same period.

Different studies have confirmed empirically that trade liberalization had a positive effect on productivity growth in Brazil. The underlying (admittedly simple) model is one in which, faced with the threat of increasing imports, firms react by raising productivity. However, trade liberalization also spurred productivity growth by allowing access to better (imported) raw materials, parts and components and forcing the least productive firms out of business. The exit of low productivity firms raised average productivity levels not only by eliminating those at the bottom of their group, but also by increasing the productivity of those remaining.⁸⁹

⁸⁸ These measures include policies to reduce the “Brazil cost”, change in foreign trade practices and regimes, competition policies, etc.

⁸⁹ This point was explored by Muendler (2001).

Figure 4.12: Opening up the Economy — Imports and Exports, 1980-2002 (% of GDP)



However, issues of timing (how long does it take for the effects of liberalization to be felt in individual industries?), the degree of data aggregation (either at company or sectoral level), availability (and type) of data, and the question of how to represent empirically the liberalization process make it very difficult to directly test the hypotheses. Additional evidence on this issue follows⁹⁰.

To start with, it seems advisable to exclude producers of non-tradables from the analysis because they are less likely to be affected by import liberalization (at least directly). In the present analysis this implies the exclusion of sectors such as services, communications, construction, public utilities, commerce, transportation, government, real estate and financial intermediaries. The exclusion is also justified by the unavailability of import penetration ratios for these non-tradables sectors.

Taking data from the remaining 31 sectors we found no general association between productivity growth and indicators of trade liberalization, such as import penetration ratios, or import tariffs (e.g. rates of effective protection) and their rates of change comparing 1990 - when the liberalization process began - and 2000. This is in contrast with part of the Brazilian literature on this issue. Rossi and Ferreira's (1999) study, for instance, established that there was a close association between productivity growth and changes in import tariff protection at the two-digit level of aggregation in 18 manufacturing industries.

In order to probe more deeply into the available data, we divided the 31 producers of tradables into different groups according to the degree of import penetration at the

⁹⁰ Taken from Bonelli (2002).

beginning of the period, in 1990, and their change over time⁹¹. We identified six different groups.

The first group has six sectors and was characterized by little change over time in the (generally very low) import coefficients observed at the beginning of the 1990s⁹². All sectors in this group are closely related to agricultural and other natural resource activities: agriculture and animal production; mineral extraction (non-oil); coffee; other industrially produced vegetables (including tobacco); processed meats; and sugar refining. Unsurprisingly, import penetration ratios remained low and showed little change over time for sectors such as coffee, sugar, other industrially produced vegetables (mainly tobacco products) and processed meats—all of them sectors in which Brazil displays comparative advantage in international markets. In most of these cases, productivity growth was very low. The exceptions in this first group are mineral extraction, also a sector in which Brazil has a natural comparative advantage (mostly iron ore and manganese extraction); and agriculture, where the productivity performance was also very favourable and near the mean for all sectors (3.0% per year in the period 1990-2000). It must, however, be emphasized that this first group presented no surprises and import competition was weak, as expected, due to low import penetration ratios. There was no actual threat from imports to justify or induce better productivity performance.

Table 4.15: Import Penetration and Labour Productivity Growth, 1990-2000—First Group

Low import coefficients, little change over time	Import penetration ratios (M / M + VP)				1990-2000 p.a. % productivity
	1990	1994	1997	2000	
Agricultural and animal production	3.5	2.9	2.7	2.7	3.0
Mineral extraction (non-oil)	6.6	6.4	6.8	8.1	5.3
Coffee	0.0	0.0	0.0	0.0	2.1
Other ind. vegetables, incl. tobacco	2.5	3.9	3.8	3.1	2.4
Processed meats	2.6	1.2	1.5	0.9	0.3
Sugar refining	0.0	0.2	0.1	0.1	1.2

The second group includes nine sectors in which the import coefficients were low at the beginning of the decade, when import liberalization began and increased as the decade progressed. It includes non-metallic minerals (construction materials); steel; wood and furniture; pulp, paper, printing and publishing; clothing and accessories; footwear and leather products; milk and dairy Products; oil refining for domestic use and other food products (mostly beverages). But has this been enough to induce upwards shifts in

⁹¹ Import penetration is defined here as the ratio of imports to imports plus domestic production. Data come from the Brazilian System of National Accounts.

⁹² Import penetration is defined as the ratio of imports to imports plus domestic production. Data come from the Brazilian System of National Accounts.

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productivity? In fact, very different outcomes characterize this group. The best performance in terms of productivity change was in the steel sector (where privatization was the main driving force behind an extremely high productivity growth rate of 9.8 % yearly over a 10-year time span) and oil refining for domestic use. With the exception of non-metallic minerals (construction materials) and pulp, paper & printing and publishing, all the remaining sectors were characterized by meagre productivity performances, despite large increases in import penetration ratios between 1990 and 2000. Our suggested interpretation is that import growth was not sufficiently strong to become a real threat to domestic producers, on average, and did not induce fast productivity growth.

Table 4.16: Import Penetration and Labour Productivity Growth, 1990-2000—Second Group

Low import coefficients, some change (increased penetration)	Import penetration ratios ($M/M + VP$)				1990-2000 p.a. % productivity
	1990	1994	1997	2000	
Non-metallic minerals	1.3	2.0	3.1	2.9	3.9
Steel	1.8	1.9	2.9	3.1	9.8
Wood and furniture	0.4	0.9	2.4	2.2	1.3
Pulp, paper, printing & publishing	2.5	3.5	6.0	4.9	3.2
Clothing and accessories	0.5	1.4	3.7	2.6	-0.8
Footwear and leather products	3.5	5.4	7.1	6.5	0.2
Milk and dairy products	3.0	4.5	4.5	5.2	1.6
Oil refining for domestic use	1.0	3.4	3.1	2.4	7.6
Other food products and beverages	2.4	2.7	4.6	4.3	2.5

The two next groups are both actually single-sector categories. Firstly, considering the case of chemicals (excluding petrochemicals), it is somewhat surprising to find a high, but fairly constant, import penetration ratio together with a reasonably high rate of productivity change. Since imports increased substantially, this means that rising imports were concomitant with rising domestic production and fast productivity growth. The result seems to reveal a healthy industrial sector, where continued foreign competition was met by rising labour productivity.

Table 4.17: Import Penetration and Labour Productivity Growth, 1990-2000—Third Group

High import coefficient, little change over time	Import penetration ratios ($M / M + VP$)				1990-2000 p.a. % productivity
	1990	1994	1997	2000	
Chemicals (excl. petrochemicals)	14.2	14.1	14.1	15.5	5.2

The fourth group was also characterized by very favorable productivity levels: the extractive minerals sector (oil, gas, coals and fuels) recorded an actual market **decrease** in the share of imports in total supply during the 1990s, and the monopolist group⁹³ was able to increase productivity at a very fast rate during the decade. Import competition had little to do with this, as long-term plans were in place to increase domestic production for domestic supply security reasons.

Table 4.18: Import Penetration and Labour Productivity Growth, 1990-2000—Fourth Group

High import coefficients coupled with import substitution	Import penetration ratios ($M / M + VP$)				1990-2000 p.a. % productivity
	1990	1994	1997	2000	
Extractive minerals: oil, gas, coal, fuels	49.0	43.9	39.0	21.2	4.8

The fifth and sixth groups are ones in which import penetration ratios were already above average at the beginning of the decade and increased markedly over time due to trade liberalization. They were the main sectors affected by rising imports. The fifth group consists of **metals** and the **metal-processing** industries⁹⁴ and includes eight sectors: non-ferrous metals; metal products; machinery & equipment and tractors; electrical equipment; electronic equipment; cars, trucks and buses; other vehicles and the category, miscellaneous products.

The sixth group, also formed by sectors in which import penetration showed strong increases during the decade includes: (i) the group of **chemical** industries, formed by six sectors: rubber products; oil-refining and petrochemicals; miscellaneous chemicals; pharmaceuticals, cleaning and related products; plastics (processing); and (ii) the group of textiles industries. These industrial groups will be examined in turn below.

In the metals and metal-processing group we find that, except for the very heterogeneous category of miscellaneous and metal products, all the remaining sectors faced increased import competition with very rapid productivity change. Therefore, they behaved as expected by a priori hypotheses of sector and firm reaction to increased competitive imports. It must be noted that most sectors in this group are characterized by the presence and leadership of transnational corporations (TNCs).

⁹³ This is not entirely true, though: there are firms operating in the mineral extraction sector (coal-mining, for instance) that do not belong to the Petrobras group.

⁹⁴ Electronic Equipment and Materials are usually included in the Metal-Mechanics group. Note also that the Miscellaneous industries in Brazil include Precision Equipment and related industries. It is a very heterogeneous sector.

Table 4.19: Import Penetration and Labor Productivity Growth, 1990-2000—Fifth Group

High import penetration 1: Metals & Equipment	Import penetration ratios ($M / M + VP$)				1990-2000 p.a. % productivity
	1990	1994	1997	2000	
Non-ferrous metals	4.7	7.5	10.4	11.3	6.8
Metal products	1.3	2.5	5.5	5.2	2.6
Machinery and tractors	12.6	17.8	27.1	20.4	4.7
Electric equipment	8.9	14.2	19.3	22.8	8.6
Electronic equipment	18.5	35.1	40.0	53.4	4.4
Cars, trucks, buses	0.5	14.2	12.8	11.8	8.3
Other vehicles	9.0	12.8	19.5	24.9	6.1
Miscellaneous	6.8	14.5	21.2	20.2	1.6

The results for the sixth sub-group (chemicals, including textiles) are not as clear : only the first three sectors shown in the next table (rubber products; oil-refining and petrochemicals and miscellaneous chemicals) performed as expected, facing rising import competition via strong productivity growth. The pharmaceuticals, cleaning and related products is representative of a sector dominated by foreign firms which, contrary to the performance of the first sub-group, displayed only modest productivity increases. Plastics are a very small and heterogeneous sector and it is difficult to predict what its performance should have been, due to the extreme variety of products it produces. Finally, the textiles sector was strongly affected by rising imports up to the second half of the decade, but has also been able to withstand competition, showing modest productivity increases over the decade.

Table 4.20: Import Penetration and Labor Productivity Growth, 1990-2000—Sixth Group

High import penetration 2: Chemicals and Textiles	Import penetration ratios ($M / M + VP$)				1990-2000 p.a. % productivity
	1990	1994	1997	2000	
Rubber products	4.9	8.0	10.8	11.8	7.1
Oil-refining and petrochemicals	3.7	7.1	8.9	9.9	9.2
Miscellaneous (chemicals)	5.9	9.3	11.3	13.9	4.8
Pharmaceuticals, cleaning and related products	7.1	12.0	14.1	18.6	1.7
Plastics (processing)	2.2	4.8	7.2	8.9	-1.0
Textiles	2.4	7.8	11.7	10.0	1.7

It seems therefore safe to conclude that productivity growth has been the answer to increased import competition in only a limited number of sectors. The Brazilian experience in this respect has been one of extremely varied responses, ranging from the well known case of import substitution under the aegis of a (monopoly) State firm to

cases where increased import penetration in competitive sectors had no apparent impact on productivity change. To some extent this reflects the fact that it is difficult to single out the effects of trade liberalization, privatization and other reforms on performance. Nevertheless, it is tempting to attribute the improved productivity results of selected sectors to the (incomplete) reforms of the 1990s, such as privatization and trade liberalization. The high volatility in output growth, exchange and interest rates that characterized the 1990s may also have affected individual sectors differently.

Looking at average growth rates of labor productivity in separate periods we see some evidence in support of this view. The first period includes the beginnings of trade liberalization and coincides, in part, with the recession of the early 1990s. It is followed by a period that includes the first years after the launching of the Real stabilization plan. The third period covers the aftermath of the Asian, Russian and Argentinean crises, as well as the change in the exchange rate regime that took place in 1999 and the related fall in output growth. Productivity growth varied considerably across periods and sectors:

[1] Around the average expansion rate of 0.33 percent in labor productivity between 1990 and 1993 we find a group of manufacturing sectors with high rates of labor productivity growth. As the previous analysis suggested, many of these were either subjected to increased competition from imports or sectors characterized by privatization.

[2] Between 1993 and 1997, productivity performance improved, in part as a result of stabilization, in part due to privatization (public utilities). Trade liberalization is thought to have played a relatively smaller role during this particular period. For the economy as a whole labor productivity increased 2.6 percent per year, although very high rates were recorded in the areas of public utilities, steel, electronic equipment, cars, and rubber products.

[3] Between 1997 and 2001, in turn, the productivity performance was mediocre and virtually stagnant for the economy as a whole. The only success story in this particular period was agricultural sector. This confirms the conclusion that the impact of reforms on productivity change was not sustainable - in the sense of continuing labor productivity growth over time. One possible (admittedly partial) explanation has to do with the substitution of imported raw materials, components and machinery and equipment by domestically produced ones, characterized by lower quality and performance, in general.

Therefore, the mid-1990s were marked by intense labor productivity growth, especially when compared to the 1980s (when the productivity record was less than mediocre), helping to boost aggregate output growth in this period. A group of manufacturing industries was primarily responsible for this improved performance, backed up by public utilities and, especially, telecommunications. Privatization, import competition and an improved macroeconomic performance were the main determining factors thus indicating that reforms were behind the success cases.

De Negri (2003), for instance, found out that TFP gains associated with increasing scale economies are positively associated with the export orientation of Brazilian industrial firms. He also found out that the scale efficiency of exporting firms was higher than that of non-exporting firms: 0.71 and 0.41, respectively, for total manufacturing. This means that, on average, exporting firms achieved 71% of the TFP reached by the most productive scale estimated for each particular industry. In the case of non-exporting

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firms, their productivity was only 41% of the TFP reached by the optimal scale. Higher-scale efficiencies were also found for exporting firms in all manufacturing sectors.

The 1990s also witnessed the introduction of new and modern management and organizational techniques, especially in manufacturing. The timing of the two phenomena (liberalization and adoption of modern management and organizational techniques) coincided, leading firms in nearly all sectors to restructure, further contributing to raising productivity – albeit at the cost of a substantial reduction in manufacturing employment (Bonelli, 1999a). By focusing on protecting market shares rather than seeking to expand activities, the restructuring activities led to a concentration of investment on modernization initiatives. Investment in expanding productive capacity was to a great extent postponed because activity levels were low until very recently.

Another important issue is the effect on productivity of the change in the exchange rate system in to a free-float regime in early 1999. At that point, imports of capital equipment - one of the sources of productivity growth in the preceding years - were drastically curtailed both as a result of increased prices in domestic currency and as an outcome of output deceleration following the exchange rate devaluation in 1999 and other years since then (notably 2001 and 2003). As we have shown, labour productivity continued to grow in 1999 and 2000, but faltered in 2001-2003. Growth resumption in 2004 and reasonably good prospects for 2005 suggests that this trend may have changed.

4.3 Sectoral Composition of Gross Investment and Productivity

The sectoral composition of gross investment has been evolving since the 1980s towards an increasing share of construction in its total. Since productivity is more closely associated with machinery and equipment absorption than with expenditures on construction, the recent results are suggestive of constraints to productivity growth. This is illustrated by the data in Table 4.21, which clearly shows a very high share of construction in total gross investment: it reached a high of 70% of fixed investment in 1998. Machinery and equipment were, typically, around 30% of fixed investment in the 1990s and early 2000s.

In the late 1990s and early 2000s imports of capital goods represented only approximately 20% of total imports (US\$ 10.3 billion out of total imports of US\$ 48.3 billion in 2003).

Table 4.21: Structure of Gross Investment Expenditures, 1990-2003 (%)

Structure of Investment Expenditures	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fixed Investment	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
Construction	64,2	66,0	66,6	67,5	64,7	62,3	67,3	68,4	70,1	69,3	67,1	64,0	64,4	62,6
Machinery and Equipment	33,2	31,3	27,0	26,2	29,1	31,4	27,4	26,8	25,2	25,3	27,6	30,5	30,0	31,5
Other	2,6	2,7	6,4	6,3	6,2	6,3	5,2	4,8	4,7	5,3	5,3	5,5	5,5	5,8

Source: Brazil, National Accounts

Imported machinery and equipment represent a variable proportion of total use of machinery and equipment, as shown in Table 4.22. Part of total imported equipment

substitutes domestically produced goods, a sizeable proportion of which is made up of parts and components. Imported equipment represented an increasing share of the total until the exchange rate devaluation in 1999 (when it accounted for nearly half the total).

If we are prepared to accept that imported machinery and equipment is ‘more productive’ than the domestic equivalent, the figures in the table suggest that - following trade liberalization - the capital equipment became more clearly geared to productivity growth, but at the same time the construction sector’s share in the total increased, counterbalancing the former effect. After reaching a share of 48% of total imported machinery and equipment, the proportion began to decrease and had declined to on 28% in 2003.

There are no regulations which limit investment in physical capital such as equipment and machinery and no problems with the availability of the required foreign currency for capital goods imports. The trends observed, therefore, reflect mainly price and finance considerations.

Table 4.22: Shares of Domestic and Imported Equipment in Total Investment in Machinery and Equipment, 1990-2003 (%)

Year	Domestic %	Imported %
1990	89,41	10,59
1991	78,58	21,42
1992	74,89	25,11
1993	75,53	24,47
1994	74,66	25,34
1995	68,71	31,29
1996	65,05	34,95
1997	60,98	39,02
1998	59,26	40,74
1999	52,04	47,96
2000	57,68	42,32
2001	57,81	42,19
2002	63,29	36,71
2003	71,87	28,13

Source: Brazil, National Accounts 2003

Evidence from the 1960s and 1970s reveals that sectors that relied more heavily, in relative terms, on imports of materials inputs, machinery, equipment and technology were those with the highest TFP growth⁹⁵. The age of the capital stock had the same positive effect on TFP: lower levels represent ages of firms, or higher proportions of output accruing to newer firms characterized higher TFP gains in both decades⁹⁶.

⁹⁵ Bonelli (1975) and Pinheiro (1989).

⁹⁶ Ibid.

4.4 State Reform — Privatization⁹⁷

Privatization led to substantial changes in Brazil's economic landscape since it was implemented over the past two and a half decades. Total revenues were close to 83 billion dollars as almost 170 SOEs were transferred or sold to the private sector. Privatization entered the economic policy agenda in 1981, when the Special Privatization Committee (*Comissão Especial de Desestatização*) was created. Overall, 38 companies were privatized in the period 1981-89, grossing US\$ 723 million in revenues. A number of other small SOEs were closed down or transferred to local governments⁹⁸. Most of the sales in the 1980s were carried out by the BNDES, whose motivation for privatizing was more the need to free itself from loss-making companies than to a positive attitude to privatization on the part of the government

In 1990 the President Collor administration launched the Brazilian Privatization Program (PND), significantly widening the scope of privatization. This process was bundled together with the stabilization programme launched at the time, to the extent that the logic behind both programmes was closely connected⁹⁹. As the failure of the government's stabilization plan became increasingly evident, the administration started to rely on the PND as proof of its commitment to structural change. To a large extent, this reflected international pressures from multilateral organizations and foreign investors in general.

Although representing a substantial expansion with respect to the 1980s, the scope of privatization in the early 1990s was severely limited by rising inflation and slow GDP growth which reduced the already compressed levels of domestic and foreign investment. In all, 33 companies were privatized under the governments of Presidents Collor and Franco (1990-94). Almost all companies were in manufacturing, with revenues concentrated in steel, petrochemicals and fertilizers. The companies selected for sale had in common the fact that they belonged to relatively competitive sectors or to ones for which trade liberalization would create a competitive environment. The privatization of the state monopolies was not even considered at the time.

The Brazilian privatization programme reached its peak during President Cardoso's first term (1995-98), when 80 companies were sold, grossing US\$ 73.3 billion in total proceeds. In only five years (1996-2000), the state greatly reduced its participation in telecommunications, electricity, railways, ports, roads, water and sanitation. The telecommunications and railroad sectors and most port terminals were completely privatized. In the electricity industry, private participation rose from almost nil to 63 percent in distribution and 22 percent in generation. Private participation remains less significant in roads, water and sanitation, but there too it has expanded quite remarkably, considering the nature and structure of these sectors.

⁹⁷ Taken and adapted from Pinheiro, Bonelli and Schneider (2004).

⁹⁸ In this same period six companies in a bankrupt situation were incorporated by BNDES in the context of the so-called 'hospital operations'.

⁹⁹ One of the pillars of the 1990 stabilization plan was the freezing of public securities in the Central Bank for 18 months. The main idea was to encourage a swap between frozen public debt securities and SOE shares, at once reducing public indebtedness and creating a captive demand for the privatization programme. But the synergy between stabilization and privatization did not succeed due to problems in both programmes.

The privatization programme was a major source of attraction for new FDI. The share of foreign investors in overall privatization proceeds increased substantially over time¹⁰⁰, from only 4.2% up to 1995 to over 30% in 1997 alone¹⁰¹. As mentioned, part of the recent success in attracting FDI is due to changes in the legislation governing such flows. This is particularly true of changes in the legislation related to the Brazilian privatization programme, which abolished previously existing restrictions on the levels of foreign capital allowed in privatization.

The most successful case of privatization cum regulatory reform is, undoubtedly, in the telecommunications sector. When privatization took place, the entire regulatory infrastructure was already established and the regulatory agency responsible for the sector was fully operational. Lately regulation has been weakened by the constant recourse of concessionaries to the judiciary to resolve disputes.

Implementation of regulatory reform in the electricity sector was much less successful. The sequence of events tended to restrict the capacity of the regulatory agency to operate and, as a result, limited its prestige in the eyes of the public at large. Moreover, in the electricity regulation process, there was no clear division of responsibilities among the various agencies involved, thereby reducing the accountability of the different institutions. In 2001, a severe power shortage revealed many flaws in the regulatory framework of the electricity sector, and led to a virtual paralysis of the reform process.

In the transportation sector, regulatory reform was more successful in some segments than in others. Privatization of highways was closely based on franchise bidding as an alternative to economic regulation. In federal privatization auctions, a minimum set of investments was defined, including the upgrading and expansion of the existing network, and the concession was granted to the bidder who proposed the lowest toll rate. Once this was decided, regulation was limited to inspection of investment and operation activities and the annual tariff adjustments. The Brazilian states - which as a group privatized nine times as much as the federal government - followed a similar model, although some of them charged a fixed price for the right to participate in the concession process. Most of the road network, however, still remains in state hands and its concession to private operators has been delayed by implementation and political problems.

In the privatization of ports, the emphasis was on container terminals, since private terminals already handled most bulk and liquid cargo. Container terminals in all Brazil's major ports were privatized.

Water and sanitation are the sectors in which least progress was accomplished by way of regulatory reform and privatization. Although there have been privatizations in several municipalities, some initiatives were aborted and none of the large SOE companies have yet been sold. There is an enormous regulatory *imbroglio* (confusion) in this sector, with both states and municipalities claiming the right to award (i.e. sell) concessions.

¹⁰⁰ There were restrictions on the levels of foreign capital allowed in the (federal) privatization programme up to 1995.

¹⁰¹ SOBEET, an institute devoted to the study of TNC performance in Brazil, suggests the following profile of FDI flows into Brazil in the mid-1990s: TNCs already based in Brazil were responsible for 40-45% of total FDI; share due to privatization, 30-35%; other M&A by TNCs, 15-20% and investment by new TNCs, non-privatization related, 5-10%. The prospects were that investments of approximately US\$ 60 - 80 billion would flow into the country between 1998 and 2000, mainly due to privatization (all levels of government).

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Curiously enough, privatization of sanitation seems to be high on the recently elected government's agenda, although it is unclear how it plans to overcome the problems that have hindered its progress to date.

The evidence is that the privatizations completed (mainly infrastructure) considerably boosted investment and productivity. Yet only a minor part of the rise in productivity translated into lower prices for consumers, apparently due to the absence of significant competition in infrastructure.

It is very difficult, as already mentioned, to single out the effects of privatization and other reforms on productivity performance in manufacturing industries. The improved productivity results of sectors such as steel and petrochemicals can, however, be attributed to privatization. In these cases strong gains were observed in the 1990s. In effect, of the 17 sectors (of a total of 31) in which above-average productivity growth was recorded no fewer than 15 belong to the manufacturing industries, although the leading and third sectors were non-manufacturing: communications and public utilities. The top sectors were all characterized by a substantial privatization of assets in the 1990s (including, in addition to communications and public utilities, steel in second and petrochemicals in fourth places).

Thus, high productivity growth and privatization were concomitant. Although it is tempting to conclude that privatization "caused" productivity growth, there is a need for caution here: in at least two cases within the infrastructure sectors (communications and public utilities), output had been growing very rapidly before privatization began. This pattern also applied to productivity.

BOX: *A Note on Regulatory Reform*¹⁰²

Until the mid 1980s, ownership of state firms and the economic policy of the military regime made economic regulation of lesser importance. In key sectors of the economy, such as infrastructure and finance, SOEs were dominant, and 'regulation' was exercised through the appointment of the main executives of SOEs. Whenever in operation, regulatory agencies were weak and 'in the capture' of the firms they were supposed to monitor. In most other modern sectors, the state controlled much of the private sector's investment through fiscal and credit incentives, tight entry controls, and direct supervision by sectoral ministries and agencies.

The return to democracy and state retrenchment that followed called for a new regulatory apparatus. The same may be said of price stability and the need to achieve fiscal discipline, which required institutional changes and imposed limitations on former regulatory practices that depended on access to fiscal subsidies. Most sectors in the economy have been subjected to some kind of regulatory reform in the past two decades.

Since the 1990s Brazil has been adopting initiatives to increase competition in domestic markets by freeing firms and markets from controls introduced during the ISI phase and by strengthening competition agencies. A first set of measures was implemented through the Federal Deregulation Programme: no less than 113,752 presidential decrees were revoked of a total of 123,370 decrees issued in the previous century. Other initiatives included the end of public export and import monopolies on certain staples; the abolition of prior export and import approvals for certain products (i.e. steel); the reduction in the minimum national content level for a project to qualify for public credit; the streamlining of bureaucratic procedures for the public with a substantial simplification of documentary, tax, and utility billing procedures and a overall simplification of foreign trade formalities. Despite these initiatives, however, the burden of bureaucracy in Brazil is still perceived as greater than that of other developing countries.

Another set of measures was aimed at strengthening anti-trust and consumer protection policies. In 1991, the anti-trust law dating back to 1962 was reinforced by new and more stringent legislation. In the same year, a consumer protection legislation was enacted. In 1994, a new anti-trust law was passed, consolidating the legislation on competition, while establishing harsher penalties and more expeditious enforcement procedures.

Other measures focused on the elimination of legal restrictions limiting entry into several non-tradable sectors. Foremost among these were the constitutional amendments that discontinued public monopolies in oil and infrastructure and the differential treatment accorded to domestic and foreign companies. The oil sector was opened up to new entrants and a new regulatory agency was created (ANP – Agência Nacional de Petróleo). The gas sector was also liberalized, after a constitutional amendment discontinued the public monopoly introduced by the 1988 Constitution. Other distinctions, such as the restrictions imposed on the access of foreign firms to public credit, were also discontinued. Competition was also encouraged by the ending of legal restrictions limiting entry and establishing price controls in a number of sectors such as civil aviation, ports, interstate and international road transportation, the distribution of fuels and the distribution and transportation of steel. Nationwide fuel price equalization was discontinued.

The end of the high inflation era in mid-1994 exposed the deficiencies of bank supervision in Brazil, and triggered a process of reform that produced better and more stringent regulation, particularly regarding minimum capital requirements. Corporate governance law was also changed and CVM, the agency responsible for regulation and supervision of capital markets, was restructured and strengthened, becoming more autonomous from the government.

Regulatory reform was most significant in the area of infrastructure where changes started in the early nineties. The first critical steps were taken only in 1995, when a Concessions Law was approved and the constitution amended to end public monopolies in telecommunications and pipeline gas distribution and discontinue the restrictions on foreign investment in some key sectors, including electricity generation in particular. In addition to the privatization initiatives, these sectors also experienced the dismantling of their regulatory framework, which in some cases had been in place for half a century.

¹⁰² Taken and adapted from Pinheiro, Bonelli and Schneider (2004), p. 21-22.

V Concluding remarks

Actions that could be taken to overcome at least part of the constraints to productivity improvement examined in the previous sections are summarized next. The summary is intended to further assist the country in striving for increased productivity growth in the context of joint efforts with UNIDO¹⁰³.

It is fair to recognize that some impediments to productivity growth, especially those arising from macroeconomic constraints, probably cannot be directly addressed by policy actions and efforts in joint initiatives with UNIDO. This is true, for instance, of issues such as the currently high tax burden and public debt in Brazil.

Nevertheless, the list of policies and actions examined below should take the overall objective of reducing the tax burden and public debt into account, as well as implicitly considering the effectiveness of macro constraints to productivity growth. In other words, it is difficult to imagine that policies that explicitly or implicitly contribute to raising debt and taxation levels can be implemented at present or in the near future. Therefore, ingenuity is needed in structuring the aforementioned joint initiatives.

Any account of productivity change in Brazil will necessarily conclude that the influence of economic policy and performance on productivity change has been quite significant: in general, periods of fast output growth have been accompanied by rapid productivity growth¹⁰⁴. We therefore found evidence that productivity is pro-cyclical, in line with the theoretical suggestions of Kaldor-Verdoorn. This is due to the hidden productivity-enhancing characteristics associated with output growth, the most well-known of which are scale economies. Therefore, all policies and measures that are successful in accelerating output growth will also contribute to productivity growth. This applies with particular force to the determinants of and constraints to capital accumulation. Since macroeconomic performance in Brazil has been uneven over time, with wild fluctuations in output in the last quarter century - and macro uncertainty is a powerful obstacle to investment, growth and productivity change - this opening statement seems amply justified. There are, however, noteworthy exceptions.

Consider, firstly, labor productivity in manufacturing. Our analysis has shown that, except for a brief interregnum in the mid-1960s, associated with the recession that characterized the end of the old regime and the beginnings of military rule, productivity grew rapidly from 1960 (and beforehand) until 1974. Output deceleration up to 1980 was also followed by a (proportionately much larger) fall in productivity average growth rates. A long and turbulent period followed until 1990-92, in which average labour productivity in manufacturing was actually negative.

Thus, the 'long lost decade' of the 1980s also left deep scars on Brazil's productivity performance, as expected from a period marked by macro turbulence. What is somewhat

¹⁰³ We think that the main Brazilian counterpart in future dialogues with UNIDO should be the Ministry of Development and Foreign Trade.

¹⁰⁴ A simple regression of GDP growth on TFP growth with a dummy variable to account for years of recession yields the result that nearly 20% of GDP growth is due to productivity.

surprising is to find that the 1990s were years of faster-than-ever labour productivity change in manufacturing and strong productivity growth in the economy as a whole¹⁰⁵.

The 'surprise' is attributed to the fact that the 1990s were, on average (and except for selected sub-periods such as 1993-97), a decade of slow GDP growth. Nonetheless, very important economic policy developments took place, especially in the areas of trade and financial liberalization, stabilization and state reform (particularly privatization and deregulation). Faced with stiff competition, firms reacted with the introduction of many of the latest organizational and managerial techniques, importation of state-of-the-art machinery and equipment and the adoption of innovative activities. In this sense competitive pressures were unleashed at the same time as reforms were enacted. These pressures called for strong reactions from the more competitive and efficient firms and productivity growth was one of the results – although many less healthy firms became victims of this transition process.

The evidence on TFP change in manufacturing confirms this overall picture: higher than average TFP growth occurred concomitantly with high GDP growth. But the 1990s - as has been repeatedly stated - witnessed a recovery of with little GDP growth. The same occurred with aggregate labour productivity which increased at 4.1% yearly between 1960 and 1980 and at 1.6% on average between 1991 and 2000. No growth whatsoever was recorded in the intermediate years.

Recourse to UNIDO's database, besides confirming results from previous aggregate TFP estimates, allowed us to probe more deeply into the causes of TFP change. Indeed, one remarkable finding is that technical change was positive most of the time in the 1960s and made a significant contribution to TFP change during that decade. Technical change also displayed strong growth after 1991, following two decades of lacklustre performance. This is evidence of the role of innovation in raising TFP during these particular periods of time. Furthermore, after 1991 it occurred at unprecedented rates: all recent TFP change was due to technical change, reflecting the importance of innovative initiatives in the more recent period.

Efficiency change, on the other hand, was, on average, positive only during the high growth periods 1968-74 and, to a lesser extent, 1975-80. It must be noted that these were precisely the years in which the fixed capital stock expanded most, as repeatedly indicated in this report. This association suggests, as many studies have pointed out, that gross investment is a major vehicle for efficiency change, although further research is necessary before more empirically solid conclusions can be reached. In the remaining years covered in UNIDO's database, the indicator of efficiency change was, on average, negative. This was true of the period 1962-67, from 1981 onwards and after 1992 in particular and suggests that there was little evidence of catching up on technological progress in this latter period.

The analysis of the main determinants of productivity focused on factors and dimensions that enhanced or - conversely - hampered productivity change in the past. Productivity change could, therefore, be enhanced by technical cooperation services provided by

¹⁰⁵ Not surprisingly, labour productivity in manufacturing grew strongly in 2004, at about 6.0%, following output growth (at 8.3%).

UNIDO in fields related to the determinants and constraints examined in the present report. These determinants and constraints have been identified as follows:

(i) Low levels of capital accumulation: The low levels of capital accumulation in the past 20 years were caused by increased prices of investment goods (relative to the GDP deflator), decreased savings (up to 1999) and dwindling capital productivity (up to 1992). This last aspect, in turn, was similar to trends observed worldwide since the mid-1970s (probably associated with the energy crises of the 1970s), inefficiencies in the domestic production of capital goods and the increased share of the construction sector in total fixed investment. Since productivity is more closely associated with machinery and equipment absorption than with expenditures on construction (a large share of which is residential construction), the investment structure changes that took place since the 1980s are also suggestive of constraints to productivity growth. Changes in the opposite direction can, however, only take place as a result of growth itself, as demand for machinery and equipment is likely to grow faster, for instance, than the demand for housing.

Seen from another angle and with regard to investment financing, low capital accumulation was also been the outcome of low financial intermediation. Although this was associated with high inflation elsewhere, what seems specific to Brazil is the ongoing low level of intermediation after stabilization in the last ten years. It is acknowledged that part of the blame rests on high real interest rates - another powerful macro constraint to new productive investment, accumulation and productivity - and on high taxes levied on financial transactions. But it is also fair to say that the Brazilian financial system is far from competitive. UNIDO could also assist in providing advice on how to improve competition and competitiveness in the banking and financial sectors. Needless to say, one of the main impediments to faster capital accumulation, the currently high level of real interest rates, cannot be easily dealt with due to the monetary policy implications in the context of an inflation-targeting regime such as the one currently in place in Brazil.

Still in the realm of capital accumulation, another area in which UNIDO could assist Brazil is in providing expertise aimed at improved regulation of infrastructure. As we have seen, electrical energy, transportation and telecommunications are the segments that most closely influence GDP and productivity growth. Good regulation and enforceable legal procedures are called for in order to improve the climate for new investment. Given the emphasis that has recently been put on PPPs - private public partnerships, UNIDO's experts could supply technical, managerial and legal advice to Brazilian agencies in the Ministry of Planning responsible for administering the evaluation and implementation of these new arrangements.

(ii) Brazil is also characterized by the below-average quality of its labour force, despite recent advances in formal and on-the-job training and improvements in schooling facilities. Obviously the process of formal education takes time, but training can be achieved in the short to medium-terms. This is another area in which UNIDO could provide assistance in consultation with the Ministry of Development to identify the most urgent training needs. The Brazilian private sector already provides training in manufacturing and services in specific areas of expertise through para-state bodies. This could be complemented by advice from UNIDO's experts after careful selection of appropriate training activities.

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The current labour legislation does not help to enhance the efficiency of the workforce and unemployment is persistently high (at about 10%, on average, in the major metropolitan areas). New forms of labour management could be put into place with assistance from UNIDO in order to improve present conditions. UNIDO could also collaborate on devising measures to improve workforce flexibility in the context of a badly needed labour market reform. In addition, the prevalence of the informal workforce indicates that initiatives should address new labour legislation and reform because, as indicated, labour market regulations are a strong impediment to productivity growth: rigid laws result in less recruitment, slower output and productivity growth.

(iii) From the point of view of technology adaptation and diffusion, low levels of process and product innovation in Brazil have been a hindrance to faster productivity growth, despite recent advances. A recently enacted law on innovative activities will probably help to foster technological progress. The federal government has been active in trying to find creative solutions in this area, and UNIDO might be a source of information and suggestions on new legislation. The below-average quality of manpower is also a powerful impediment to innovation. In-house training programs could be devised under UNIDO's supervision and in consultation with the Ministry of Development to help improve specific activities.

This importance of the area is worth stressing: process and product innovation have had a powerful effect in raising TFP growth, as our analysis has shown. In order to increase the potential for further future gains, UNIDO could assist the country in screening processes and products with good prospects of fast demand growth, given Brazilian capabilities and strengths. Dynamic comparative advantages could best be achieved if Brazil could rely on technical advice from UNIDO in the areas of market screening for its more technologically advanced products.

(iv) Technology transfers from abroad, often associated with TNC performance, have been of variable importance, depending on the time period considered. Trade and financial liberalization contributed to increased TNC presence in Brazil, and this has also brought about improved technology performance. The well known association between export orientation and TNC presence suggests that enhanced TNC performance and – through competition – an increased level of foreign technology transfer were behind the recent export surge. In this connection, UNIDO could assist the country in identifying new technologies and channels to facilitate their transfer as well as supervising contracts for such transfers. Since technological change incorporated in new machinery and equipment, especially imported state-of-the-art equipment, is a powerful vehicle for productivity change, UNIDO could advise on the adoption of new processes and equipment in areas in which Brazil can build up a dynamic comparative advantage on the basis of its previous industrial history, abundance of natural resources and availability of raw materials, parts and components.

(v) A deficient infrastructure, particularly in more recent years, can be blamed for delays and inefficiencies that hampered productivity growth. Help from UNIDO could come in the form of suggestions for new and creative regulatory measures related to the establishment of Public-Private Partnerships, as previously mentioned. Inadequacies in the country's institutional framework, such as excessive and inefficient regulation, especially in the area of infrastructure, also share the responsibility for a less than optimal productivity performance. Here too Brazil could benefit from UNIDO expertise.

(vi) Factor allocation has not been productivity-enhancing, at least since 1990. In part, this has been due to the difficulties of increasing formal employment relations in the services sector of the economy. Advice from UNIDO's experts on ways and means to enact labour reform in order to expand the use of formal labour relations would be helpful.

(vii) Large income and asset inequality have hampered productivity growth. Taking into account that changes in income and asset distribution usually take time to yield results - and since this is a sensitive issue – suggestions as to possible areas of intervention by and advice from UNIDO must be made with care. The so-called 'social programs' sponsored by the federal government were successful in reducing the share of poor families in the population, after the huge decrease observed after the Real stabilization plan was implemented in 1994. Income and asset inequality have, nonetheless, proven to be very resistant.

A sizeable part of income inequality stems from the labour market and is associated with wage inequality. Another possible area for UNIDO assistance could be the provision of advice to the Brazilian government on educational reform. Wage inequality is strongly influenced by the educational level of workers and the number of private persons returning to formal education in Brazil is very high and even increasing among the upper income levels of the population. New methods and teaching instruments (such as the internet) could be used to encourage more people to improve their educational status. UNIDO could perhaps provide its expertise to devise public campaigns to disseminate new educational programmes.

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Annex: A note on manufacturing employment, output and labor productivity from 1959 to the early 2000s

Data on manufacturing output in Brazil are based on quantum indices of physical output. These indices, of varying sub-sector quality - but essentially good as far as total manufacturing output is concerned - were computed on an annual basis by the Getulio Vargas Foundation (FGV) from 1947 to 1971. Beginning in 1971, the best evidence comes from the Brazilian statistical agency (IBGE) in the form of monthly indices of physical output. The methodology adopted in their calculations has gone through changes since the initial years to improve the quality of their records which are deemed to be rather good as far as the total is concerned. A set of estimates based on value added in manufacturing is also available from the National Accounts for the years 1990 to 2003. However, contrary to the remaining series, these include output from informal activities.

Good quality data for manufacturing employment in Brazil come only from the Industrial Census (1949, 1959, 1970, 1975, 1980 and 1985) for all categories of workers (i.e. blue and white collar) and for production workers only (blue collar). The coverage is supposedly the same in all the Industrial Censuses, but there is a concern that, in 1985, the classification was broader than in the other years. There are also reliable figures for production workers (i.e. blue collar) based on monthly surveys since 1985 and from which annual averages can be derived¹⁰⁶. For the remaining years the estimates are more unreliable¹⁰⁷. The following procedures were adopted, always using Industrial Census data for production or blue-collar workers as benchmarks. Therefore, these estimates are entirely reliable for Census years and are used to anchor the remaining years' estimates.

The procedures adopted in the remaining years:

1959-1970: Yearly estimates were based on a constant elasticity of manufacturing employment (workers in production, or blue collar only) relative to manufacturing output, or production (= 0.57) taken from endpoint data (Industrial Census). This constant elasticity was multiplied by yearly manufacturing output growth rates to yield the employment growth rates. These employment growth rates were then applied to the 1959 Industrial Census employment (production workers) results to yield the series up to 1970.

1970-1984: Estimated by IBGE from yearly surveys, made comparable to Industrial Census manufacturing figures (Table A.1, below). Figures for 1971 and 1972 were estimated by the author due to sampling errors in IBGE procedures in 1972 and to the fact that no annual survey was taken in 1971. Relative changes from IBGE original data (column 3)¹⁰⁸ were then applied to Industrial Census figures in column 2.

¹⁰⁶ Beginning in 1996, a new annual industrial survey conducted by IBGE (PIA – Pesquisa Industrial Anual) presents data on many variables in the manufacturing activities, including employment, but they do not seem to be strictly comparable over time.

¹⁰⁷ There are also yearly estimates from 1990 to 2003 which, like the output data mentioned above, include informal employment.

¹⁰⁸ See IBGE (1990) *Estatísticas Históricas do Brasil, Séries Econômicas, Demográficas e Sociais, 1550 a 1988*, 2ª edição, revista e atualizada. IBGE, Rio de Janeiro.

**Table A.1: Estimates of Number of Workers, 1970-1984
(made comparable to Industrial Census manufacturing data)**

Years	Production Workers (total) (estimated)	Production Workers (in plants w/ 5+ workers) (IBGE)
1970*	2170639	2101444
1971	2329300	2255047
1972	2499558	2419878
1973	2723253	2636442
1974	2842749	2753173
1975*	3140982	3070130
1976	3296445	3222086
1977	3432725	3355292
1978	3653523	3571109
1979	3811067	3725100
1980*	4083471	4003835
1981	3661204	3589803
1982	3872138	3675369
1983	3484718	3278321
1984	4036970	3517394

* Census years

1985-2003: Original indices from monthly surveys of annual averages of workers employed in production (blue-collar workers) compounded on 1985 Manufacturing Census employment (4,138, 412 workers). These indices are shown in Table A.2 (1991=100)

**Table A.2: Manufacturing Employment Indices,
Production Workers, 1985-2003 (1991=100)**

1985	107,09
1986	118,87
1987	120,24
1988	115,23
1989	117,61
1990	111,28
1991	100,00
1992	92,35
1993	90,63
1994	88,60
1995	86,92
1996	77,22
1997	72,77
1998	66,12
1999	61,28
2000	61,67
2001	61,58
2002	60,96
2003	60,56

The final manufacturing employment estimates are shown in Table A.3, where Industrial Census results are highlighted. Note that a severe decline in manufacturing employment since the late 1980s is shown in the results. Its interpretation and implication for productivity growth are among the objectives of the report.

Table A.3: Brazil — Manufacturing Employment Levels, 1959-2003

1959	1 390 043	1968	1912005	1977	3432725	1986	4593331	1995	3358970
1960	1473541	1969	2033493	1978	3653523	1987	4646303	1996	2983958
1961	1566621	1970	2170639	1979	3811067	1988	4452796	1997	2812143
1962	1639055	1971	2329300	1980	4083471	1989	4544911	1998	2554939
1963	1637044	1972	2499558	1981	3661204	1990	4300053	1999	2367881
1964	1683903	1973	2723253	1982	3872138	1991	3864274	2000	2383159
1965	1639141	1974	2842749	1983	3484718	1992	3568789	2001	2379632
1966	1747525	1975	3140982	1984	4036970	1993	3502367	2002	2355731
1967	1769488	1976	3296445	1985	4 138 412	1994	3423909	2003	2340383

Given these estimates and output indices for manufacturing output, as described above, one can compute labor productivity indices from the late 1950s onwards. The labour input, manufacturing output and labour productivity series are shown in the next table as index numbers (1991=100).

Table A.4: Brazil — Labour Input (L), Manufacturing Output (Y) and Labour Productivity (Y/L) Indices, 1959-2003 (1991=100)

Years	L	Y	Y/L	Years	L	Y	Y/L	Years	L	Y	Y/L
1959	36,0	20,6	57,3	1968	49,5	35,6	72,0	1977	88,8	84,5	95,2
1960	38,1	22,8	59,7	1969	52,6	39,6	75,3	1978	94,5	89,7	94,9
1961	40,5	25,3	62,4	1970	56,2	44,3	78,9	1979	98,6	95,8	97,2
1962	42,4	27,4	64,5	1971	60,3	49,6	82,3	1980	105,7	104,6	99,0
1963	42,4	27,3	64,5	1972	64,7	56,5	87,4	1981	94,7	93,7	98,9
1964	43,6	28,7	65,9	1973	70,5	65,9	93,5	1982	100,2	93,6	93,4
1965	42,4	27,4	64,5	1974	73,6	71,0	96,5	1983	90,2	87,9	97,5
1966	45,2	30,5	67,5	1975	81,3	73,7	90,7	1984	104,5	93,5	89,5
1967	45,8	31,2	68,2	1976	85,3	82,6	96,8	1985	107,1	101,3	94,6

Years	L	Y	Y/L	Years	L	Y	Y/L
1986	118,9	112,8	94,9	1995	86,9	113,7	130,8
1987	120,2	113,8	94,7	1996	77,2	115,0	148,9
1988	115,2	110,0	95,4	1997	72,8	119,1	163,7
1989	117,6	113,1	96,2	1998	66,1	115,3	174,3
1990	111,3	102,4	92,0	1999	61,3	113,4	185,0
1991	100,0	100,0	100,0	2000	61,7	120,3	195,0
1992	92,4	95,9	103,9	2001	61,6	121,9	197,9
1993	90,6	103,7	114,4	2002	61,0	122,5	201,0
1994	88,6	111,8	126,1	2003	60,6	122,3	201,9

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A simple inspection of the figures in Table A.4 shows two apparently anomalous results, both in the labour input series: (i) an unexpectedly high growth rate in 1975, which is difficult to explain given that this was a year of strong output deceleration, associated with the energy crisis of the mid-1970s; this “doorstep” result can be explained by a possible sampling error in the 1974 IBGE’s survey coupled with the fact that the 1975 figures come directly from the Industrial Census; (ii) a sampling error can also be blamed for the huge employment growth rate in 1984 (15.8% in a single year!), followed by a very modest 2.5% in 1985, based on another Industrial Census figure. This suggests that care should be taken when interpreting results associated with both 1974 and 1984. Averages of longer periods, including these years, are, however, probably free of measurement errors.

Figure A.1 presents the series on output and productivity in manufacturing from 1959 to 2003. Note that two phases of vigorous productivity growth are identified: from 1959 to 1974 (when productivity growth reached 3.5% p. a.) and from 1991 onwards (when productivity growth reached 6.0% p. a.). The productivity curve remained essentially flat in the remaining years, despite solid output growth in some sub-periods.

Figure A.1: Manufacturing Output and Labour Productivity in Brazil, 1959-2003 (1991=100.0)

