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TEXTO PARA DISCUSSÃO N° 906

LABOR PRODUCTIVITY IN BRAZIL DURING THE 1990s*

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SUMMARY

SINOPSE

A década de 1990 foi um período caracterizado por mudanças fundamentais na economia brasileira, muitas das quais induzidas pela política econômica governamental. À liberalização comercial e financeira seguiram-se medidas visando à reforma do Estado, como a privatização, e a bem-sucedida tentativa de estabilização econômica com o Plano Real. Essas mudanças tiveram importantes implicações em relação a diversos aspectos do desempenho macroeconômico. Mas poucos desses aspectos foram tão bem-sucedidos quanto o que se refere ao aumento da produtividade.

Este estudo analisa esse tema. Entre seus resultados destacam-se: *a*) na década de 1990 rompeu-se a trajetória de taxas decrescentes de aumento da produtividade; o ganho de produtividade havia chegado, inclusive, a ser negativo na década de 1980; *b*) o crescimento da produtividade agregada representou uma elevada parcela do crescimento do PIB real, invertendo tendência anterior; *c*) o sacrifício em termos de emprego foi aparentemente menor do que se supunha até a recente divulgação de resultados preliminares do Censo Demográfico de 2000; *d*) quanto à incidência setorial dos ganhos de produtividade, a indústria foi o destaque — mas taxas muito elevadas de crescimento da produtividade caracterizaram também os setores de comunicações e serviços industriais de utilidade pública; *e*) nesses últimos casos, como também em setores industriais como a siderurgia e a petroquímica, o desempenho esteve fortemente associado à privatização; *f*) os retardatários foram os setores de serviços, transportes e comércio, também caracterizados por elevadas proporções do emprego total; *g*) isso coloca um problema para a melhoria da produtividade agregada no futuro, caso não se consiga elevar a produtividade desses setores de elevado volume de emprego e baixa produtividade; *h*) o estudo explorou a questão de quem se beneficiou dos ganhos de produtividade; não foi possível obter respostas abrangentes, mas foram qualificadas diversas possibilidades; e *i*) finalmente, examinou-se a relação entre liberalização comercial e aumento da produtividade. Como no item anterior, não há uma resposta única para a associação esperada: diversos padrões foram identificados a partir da base de dados construída para a pesquisa.

ABSTRACT

The Brazilian economy was characterized in the 1990s by marked changes from previous decades, many of which induced by economic policy: trade and financial liberalization, privatization, other State reform measures and the beginnings of economic stabilization with the implementation of the Real Plan in the 1990s.

Although Gross Domestic Product (GDP) growth rates for the decade as a whole have been below long-term averages, several indicators of macroeconomic and microeconomic performance turned for the better, especially between 1992 and 1997-1998. But few were so well succeeded as productivity change, both in the aggregate and at the sector level.

This paper explores the general issue of labor productivity growth in Brazil in the 1990s following a series of steps: first, adopting a long term view, by examining to what extent overall labor productivity in the 1990s progressed at rates different from those attained in all decades since the 1940s; second, by investigating productivity growth in the manufacturing industry in the long term as well; third, by concentrating the analysis on the 1990s to cover all sectors in the economy, not just the manufacturing industries; fourth, by exploring the issue of who benefited from productivity growth in the past decade; fifth, by evaluating the role of trade liberalization and rising import penetration and its association with productivity increases.

In interpreting the data assembled for the research I find that some theoretical ideas and hypothesis are not fully confirmed by the empirical results. The many qualifications and conclusions allow us to reach a better understanding of the causes and effects of productivity change in Brazil during the 1990s.

1 INTRODUCTION

Most studies on productivity growth in Brazil since the mid-1980s have concentrated on gains taking place within the manufacturing sector.[1] Although no overall agreement has been arrived at so far (and perhaps never will) on the magnitude of such gains — due to difficulties associated with the data sets such as changes in (and nature of) sample coverage, definition of variables, and other methodological issues — there is a perception, confirmed by individual industry case studies, that productivity growth rates in many manufacturing and non-manufacturing industries were very high during the 1990s.[2] In this sense, they represent a discontinuity with respect to previous experience. Beyond the controversy associated with manufacturing sector data, very little is known about what happened in the non-manufacturing sectors and activities.

The list of factors deemed responsible for the favorable productivity outcomes of the 1990s includes trade liberalization and privatization, as well as other comprehensive State reform and deregulation processes that were adopted in Brazil over the last decade. But one should not expect them to influence all industries and activities in similar ways.

This paper addresses these issues according to the following sequence: first, it focuses on overall labor productivity and presents results for the total economy in the long term (Section 2); second, it analyses labor productivity change in the manufacturing sector focusing on the developments since the mid-1980s (Section 3); third, it investigates 42 sectors covering the whole economy in the period 1990-2000 relying on data from the new Brazilian System of National Accounts (Section 4); the same data set is then used to examine who benefited from productivity growth (Section 5) and to evaluate the role of trade liberalization and rising import penetration in inducing productivity increases (Section 6). A section summarizing the main results closes the paper.

2 GDP AND LABOR PRODUCTIVITY GROWTH IN THE LONG RUN

The investigation of productivity change in the long run adds perspective to the analysis of the 1990s, to be taken up later. Table 1, documents the long-term evolution of GDP, population, *per capita* GDP and aggregate labor productivity in Brazil in terms of average annual growth rates for decades since 1940.[3] From this table, one cannot see the high variability within the selected periods. But these results allow us to discern periods of high growth from periods of low growth in a straightforward way. The four decades covering the period from 1940 to 1980 were

1. See, for instance, Considera and Silva (1993), Feijó and Carvalho (1994), Bonelli (1996), Salm, Sabóia and Carvalho (1997) and Rossi and Ferreira (1999). Recent exceptions are Bonelli and Fonseca (1998), Bonelli (2000), Pinheiro et al. (2001), Muendler (2001) and Bacha and Bonelli (2002).

2. See, for instance, McKinsey (1998). The case studies analyzed by McKinsey suggest that there is still considerable room for productivity increases in all sectors analyzed.

3. The choice of periods is in good measure dictated by the availability of population data from the Demographic Censuses. This explains why the year 1991 was adopted as a dividing year between the 1980s and 1990s.

clearly characterized by very high growth of all variables in the table — including population.[4] In contrast, after 1980 there follows a period of slow — and not infrequently negative — growth. As a result, average per capita GDP growth was negative between 1980 and 1991 (– 0.4%). This applied to labor productivity change as well (– 0.92% yearly between 1980 and 1991).

TABLE 1
GDP, Population, *Per Capita* GDP and Labor Productivity — Brazil 1940-2000
(growth rates, % per year)

Decades	GDP	Population	GDP/*per capita*	Productivity
1940-1950	5.90	2.35	3.46	4.30
1950-1960	7.38	3.06	4.20	4.40
1960-1970	6.17	2.87	3.21	3.00
1970-1980	8.63	2.48	6.00	4.70
1980-1991	1.52	1.93	–0.40	–0.92
1991-2000	2.81	1.63	1.16	1.80
1940-2000	5.35	2.39	2.89	2.90

Sources: GDP – before 1947, Haddad (1975); after 1947, National Accounts (IBGE [1990] and IBGE [2002]); Population and Employment up to 1991 (to estimate labor productivity) - IBGE, Demographic Census, various dates. Population in 2000: IBGE, Demographic Census. Employment for comparing 1991 and 2000: National Accounts, IBGE (2000,2002).

After 1991 (and, especially, after 1992) growth resumed, albeit at a slower pace than in all previous decades in the 20th century except for the 1980s. Even so, labor productivity grew at reasonably good rates (1.8%), taking into account a GDP average growth rate of 2.81% yearly from 1991 to 2000.

The average GDP growth for the whole 1940-2000 period, shown in the last line of the table above, was very high (5.35% p.a.), notwithstanding slow growth in the 1980s and 1990s. Since population grew at 2.39% yearly, *per capita* GDP grew at 2.89% in the 60-year period 1940-2000. It can also be observed from the table that productivity growth tends to accompany *per capita* GDP growth over time. The fact that for the whole period productivity and *per capita* GDP grew at approximately the same rate indicates that, on average for the 60-year period 1940-2000, employment — or, rather, occupation — and population grew at approximately the same rates in the long term.

Note, besides, that one can achieve the same *per capita* growth in the 2000s (projected 1.3% p.a. population growth in 2000-2010) with a 1.5 percentage points lower GDP growth rate than in the 1950s to 1970s, when population growth was 2.80% p.a.

We next propose an identity-based exercise to explore how productivity affects GDP.

4. Information for previous time periods, collected and organized by Maddison (2001), informs us that during the years from 1930 to 1980 Brazilian GDP grew at 5.72% annually, on average (3.03 *per capita*), while from 1891 to 1929 it had grown 3.13% per year (0.92% *per capita*). The corresponding figure for 1821-1890 is 1.95% per year (0.30% *per capita*) and, for 1500-1820, only 0.62% yearly (0.15% *per capita*).

Consider a decomposition exercise of the following kind, based on the identity:

GDP=(GDP/occupation)*(occupation/Economically Active Population)*(EAP/population)* population

or:

GDP = labor productivity * occupation rate * activity rate * population (1)

A minor digression is in order at this point, to stress the influence of labor productivity on economic growth. Both the employment (occupation) rate[5] and the activity rate depend on economic and demographic factors as well as on expectations of the population about the future. The employment rate increases if the economy is growing and decreases otherwise. The activity rate's behavior is more difficult to predict, since it changes in response to a varied range of economic and social conditions as well. But in steady state we can assume that it remains constant. Under these conditions, per capita GDP (GDP/population) depends entirely on productivity, which is sometimes assumed to be exogenous.[6]

Table 2 presents data on the variables shown in identity (1) for the past six decades.[7] *Per capita* GDP is shown in the last line and labor productivity in the line before last. Note that labor productivity in 2000 returned approximately to 1980 levels, after having fallen between 1980 and 1991.

TABLE 2
Real GDP, Employment, Economically Active Population (EAP), Labor Productivity and Population (POP)

Absolute values	1940	1950	1960	1970	1980	1991	2000
GDP (1999 prices; R$ billion)	43.9	77.8	158.6	288.6	660.1	779.7	1,001
Employment (E); 1000	14,759	17,117	22,750	29,339	42,272	55,293	64,704
EAP (L);1000	14,759	17,117	22,750	29,557	43,236	65,229	76,158
Population (POP); 1000	41,165	51,944	70,191	93,139	118,970	146,825	169,799
Productivity (1999 R$)	2,972	4,544	6,970	9,836	15,616	14,101	15,470
GDP/POP (R$)	1,066	1,497	2,259	3,098	5,549	5,310	5,895

Sources: Same as Table 1, except for demographic figures in 2000, which come from the Advanced Tables of the 2000 Demographic Census, IBGE.

Taking logs of GDP, GDP/E (labor productivity), E/L (occupation rate), L/POP (activity rate) and POP and subtracting the log values from two consecutive periods allows for a decomposition of GDP growth into the factors on the right hand side of identity (1). The decomposition results are shown in the Table 3.[8]

5. Note that, conceptually, the occupation rate is similar to the employment rate: its complement is the unemployment rate.

6. This is a simplification. But it has been adopted in many growth models, following Solow's seminal paper [Solow (1957)]. One alternative view is that productivity fluctuates over the cycle — a view associated, among other approaches, with Kaldor's and Verdoorn's laws. See also Basu and Fernald (2000).

7. The Demographic Census of 1940, 1950 and 1960 didn't investigate occupation levels. We implicitly assume that occupation equaled the economically active population on these dates.

8. This approach was borrowed from Bacha and Bonelli (2002). The present results are a revision of theirs.

TABLE 3
Decomposition of GDP Growth

Factors	1940-50	1950-60	1960-70	1970-80	1980-91	1991-2000	1940-2000
% Labor productivity	74.1	60.1	57.5	55.9	–61.3	37.1	52.7
% Occupation rate	0.0	0.0	–1.2	–1.8	–85.7	0.9	–5.2
% Participation rate	–14.7	–2.3	–3.5	16.4	120.6	3.8	7.2
% Population	40.6	42.3	47.3	29.6	126.3	58.2	45.3
Sum	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Sources: Same as Table 2.

Table 3 shows that productivity change has always been a major source of GDP growth, in all periods analyzed. But: *a*) its importance decreased over time; *b*) the 1980s are representative of a sudden discontinuity in the long-term trend, as productivity change was actually negative in this time period, while GDP grew by a meager 18% over a 11-year period (1.52% yearly, on average); *c*) this trend was reversed in the 1990s when, despite slow GDP growth (2.81% from 1991 to 2000, on average), productivity accounted for 37% of the observed GDP increase.

The occupation rate (which is equal to zero by definition up to 1960), decreased in both the 1960s, 1970s and especially in the 1980s, as unemployment soared in the latter decade. The finding that it represented a positive growth factor in the 1990s — although a relatively unimportant one — should be interpreted with some caution as the new Demographic Census Advanced Tabulations for 2000 imply occupational growth slightly higher than the Economically Active Population growth between 1991 and 2000 — which is very surprising, indeed.[9]

The participation rate, on the other hand, increased during the 1970s, 1980s and 1990s, even more so during the so-called "lost decade" of the 1980s, as female participation rates increased markedly in Brazil.

The last column summarizes the decomposition of GDP growth for the whole 1940-2000 period: labor productivity accounted for a little over 50% of the total gain, while population growth responded for 45%. The activity rate increased a little when end-points are considered, raising overall GDP by 7%. In contrast, the occupation rate decreased between 1940 and 2000 and contributed to some (–) 5% of GDP change. The 1980s, and only this decade, are responsible for this negative contribution.

We conclude that the experience of the 1990s was, despite slower GDP growth than historically observed, characterized by productivity gains that represented a complete reversal of the record of the 1980s. Taking into account the economy's low growth performance due to recession in the beginning and external shocks during the second half of the 1990s, the productivity record can be considered very positive, especially considering that: *a*) productivity growth resumed; and *b*) employment levels were not sacrificed to the extent believed so far.

9. One often cited feature of Brazilian labor market performance in the 1990s has been the rise in unemployment over the decade — albeit with fluctuations.

3 MANUFACTURING LABOR PRODUCTIVITY CHANGE: THE LONG AND MEDIUM TERMS

This section investigates the performance of labor productivity in the manufacturing sector in the long and medium runs. This is a necessary step in the analysis because of the sector's importance. And it is possible because data for the manufacturing industries are more easily available, frequent and have better quality than for the remaining sectors of the economy.[10] Moreover, it is a key indicator variable because the manufacturing industries are the main *loci* of productivity change.[11] Table 4 introduces the subject by presenting average results for 5-year periods taken from the Economic Manufacturing Census since 1949.[12]

It is somewhat surprising to find out that labor productivity growth rates have decreased over all decades and 5-year time spans from the late 1940s to 1990. Indeed, they even became negative in 1980-1985.[13] After 1985 the trend of (on average) negative labor productivity growth rates continued: productivity decreased by – 0.68% yearly between 1985 and 1990.

TABLE 4
Brazil — Productivity Growth Rates in the Manufacturing Industries, Selected Periods*

Periods	% per year
1949-1959	5.84
1959-1970	3.31
1970-1975	2.80
1975-1980	1.94
1980-1985	–2.83
1985-1990	–0.68
1990-1995	7.19
1995-2000	8.31
1949-2000	3.45

* Sources for the table: IBGE. Up to 1985 – Economic Census; from 1985 to 2000 – Monthly Industrial Research (PIM-PF and PIM-DG).

However, there is a marked change when we move into the 1990s, as Table 4 clearly shows. Note that the long-term average of 3.45% yearly was only exceeded in the 1950s and in the 1990s. It is worthwhile going into more detail to examine this most recent period.

Graph 1, next, summarizes productivity trends in manufacturing on a year on year basis for the period December 1986 to December 1990. It can be clearly seen

10. Census figures for agriculture also reveal the existence of substantial productivity gains in the primary sector since 1970. See, for instance, Bonelli and Fonseca (1998).

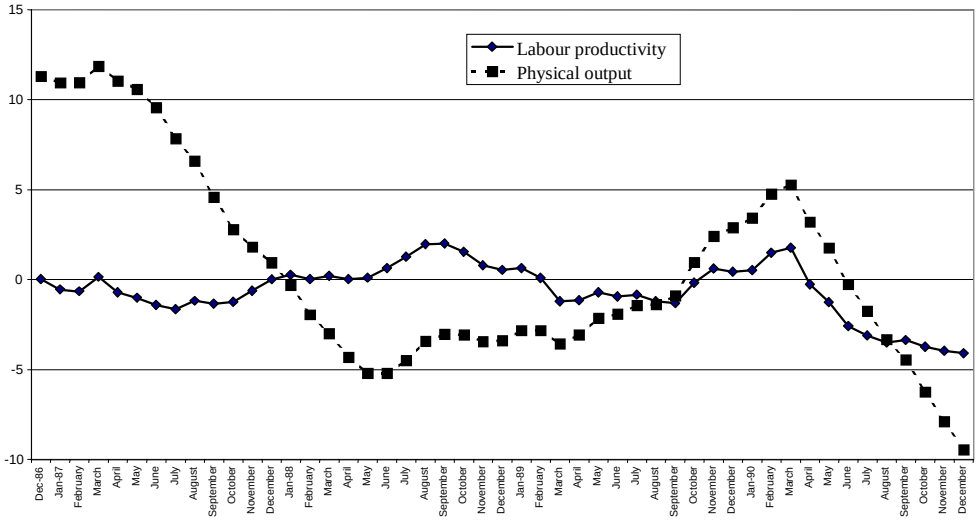
11. This has been typically the case until the 1990s. From mid-1990s onwards the activities associated with Information Technology have received considerable attention due to the (presumably) very high productivity growth rates associated with their diffusion. See, for instance, Gordon (2000) and Oliner and Sichel (2000).

12. Information from the Economic Census differ from those of the Demographic Census in that the former investigate the establishments and plants, while the latter are based on questionnaires obtained from the households — i.e., the respondents are not the firms (administrative returns), but the household heads.

13. But this may be at least partly due to the fact that the 1985 Economic Census had a degree of coverage higher than the previous one (1980), in the sense that it included activities not investigated before.

from the graph that, despite very high output growth in the mid-1980s, labor productivity growth was nearly nil: it actually fluctuated around zero during most of the 1986-1990 period. Indeed, at the end of this particular period productivity was evolving at a negative rate of almost 5% per year as a result of a failed stabilization attempt in President Collor's inauguration year, when aggregate output contracted very sharply: – 10% for manufacturing in December 1990.

GRAPH 1
Year on Year Productivity and Manufacturing Output Growth Rates (%)
Dec. 1986 to Dec. 1990



Other years registering severe output contractions were: *a*) mid to late 1992, as Collor's Stabilization Plan II went into effect; *b*) and in the first half of 1995, as a result of measures taken to defend the new currency (the Real) in the wake of the Mexican crisis. This is shown in Graph 2, which registers the same variables as Graph 1, but from December 1990 to December 1997.

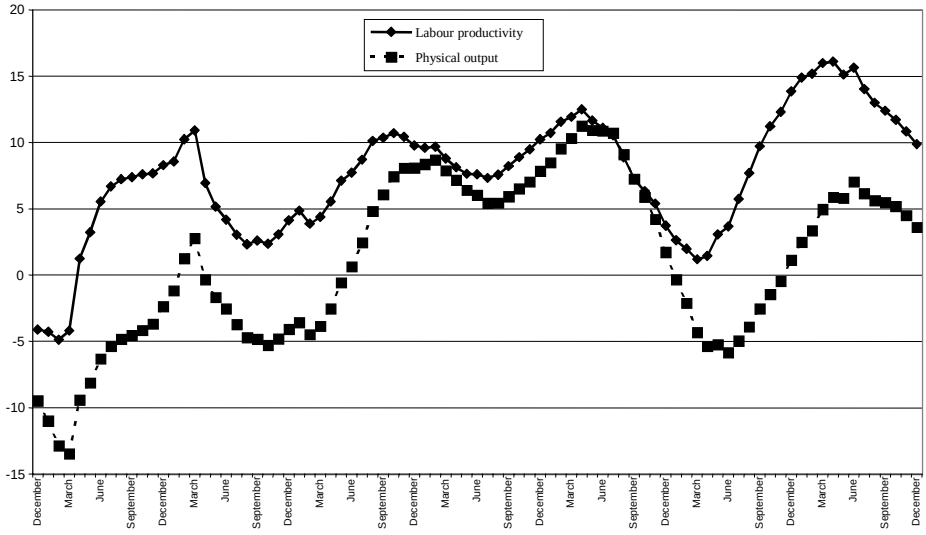
Labor productivity attained very high growth rates during most of the period shown in Graph 2. But this occurred especially in mid 1997, when it grew at a little over 15% on a yearly basis. However, at this point the effects of the Asian crisis hit Brazil. GDP and manufacturing activity started to fall due to sharp interest rate increases to defend the Real and their effects on the aggregate level of economic activity.[14]

Productivity continued to grow at very high rates after the Asian crisis, although the overall trend from that date onward is a clearly decreasing one. Graph 3 documents this aspect from late 1997 to late 2000, showing a disturbing picture of slowing labor productivity gains in the latter part of the period. The severe output swing observed in the middle of this last period was one of the results of the exchange rate devaluation of early 1999, which initially caused a strong contraction in the level of economic activity followed by a very fast recovery from mid-1999 onwards, as

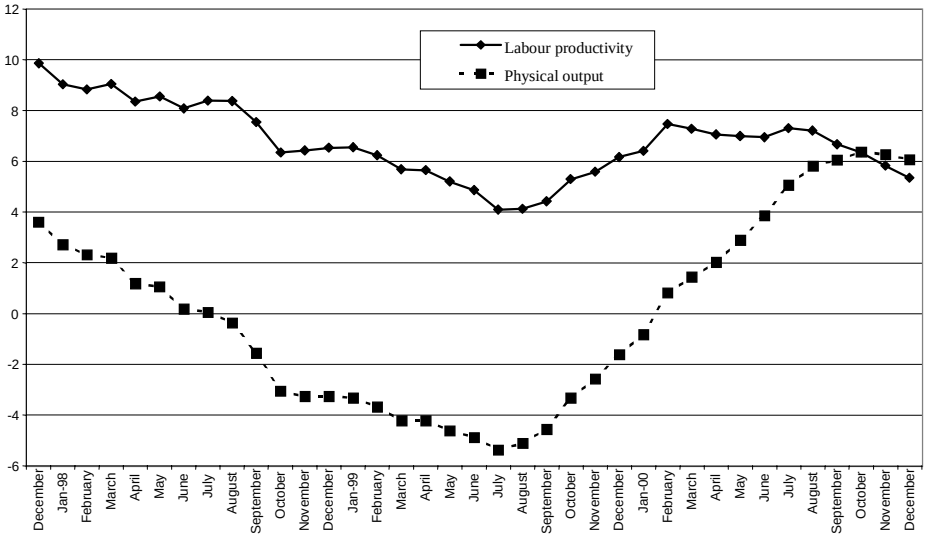
14. The pattern for individual industries is not the same as the sector total's. But, except for a few industries, the growth patterns are similar. Information on patterns of productivity change from the mid-1980s to 2000 for individual industries comes from the same source.

manufacturing activity reached nearly 6% per year growth in late 2000, after having been of – 6% yearly only 18 months before.[15]

GRAPH 2
Year on Year (%) Growth Rates, Productivity and Manufacturing Output
Dec. 1990 to Dec. 1997



GRAPH 3
Year on Year Productivity and Output Growth Rates (%)
Dec. 1997 to Dec. 2000



Note also that after the turn of the decade productivity tends to move in line with output — something that clearly did not happen in the second half of the 1980s, as Graph 1 amply demonstrates. In particular, the results for the end of 2000

15. Preliminary information for the period after December 2000 suggests that labor productivity growth rates in the Brazilian manufacturing sector continued to slow down in 2001.

show that employment levels in manufacturing began to recover for the first time in a long time.[16]

Figures on which the above results are based have been subject to criticism on many grounds, among them: *a*) the surveys upon which they are based do not properly take into account increasing outsourcing (procurement of materials, parts and services from other firms — instead of intra-firm procurement — or de-verticalization of production at the firm level) that took place especially during the first half of the 1990s and affected many manufacturing industries performance in a presumably strong way; *b*) the productivity data are obtained as the quotient of output and employment series which come from different samples;[17] *c*) a proper measure of labor inputs should be constructed in terms of the number of hours actually worked, and not on employment levels; *d*) the monthly survey samples investigate the productive performance of firms at the plant level by investigating physical output, or gross production, not value added. Therefore, if an increasing amount of raw materials, parts and components is imported, instead of being domestically produced, the "physical output productivity" measure will result in a (upward) biased measure of productivity growth.[18] This is especially likely to happen during periods of import liberalization, as Brazil experienced in the first half of the 1990s.[19]

These objections can be answered as follows:

a) The "outsourcing" issue: it is certainly true that substantial outsourcing (from domestic sources) occurred, especially during the first half of the 1990s, as many reports from the specialized press showed at the time. But: *a*) most outsourcing occurred in services related to manufacturing activities (administration and accounting, security, catering, maintenance, cleaning, etc), and not in the industrial processes themselves; and *b*) the industrial surveys explicitly investigate employment in production activities. Therefore, the available figures should, in principle, be representative of real labor inputs used in production.

b) The "conceptual sample bias" issue: little can be said on that. The output series have been accepted as being of better quality than the employment series because it is easier to keep track of the output of large firms than to investigate the performance of a large number of large, small and medium firms. Furthermore, it is a fact that small and medium size firms have exit rates well above large firms, and it is not clear if the former are properly replaced in the employment samples that

16. Employment increases if the output growth curve is above the productivity growth curve. It decreases otherwise.

17. In particular, the output series come from "intentional samples" which investigate the largest producers in each manufacturing industry in a way such that the firms are chosen for inclusion in the samples so as to represent a sizeable proportion of total output in a base year. The employment series come from "stratified samples" that are constructed to represent the behavior of plants of all sizes. These criteria are adopted to take into account the fact that output is much more concentrated in the large plants than employment. Therefore, a representative figure for employment in manufacturing should take into proper account the performance of large as well as medium and small firms.

18. This may be seen as a variant of (*a*): it is also due to outsourcing.

19. See, for instance, the pioneering figures and analysis of Moreira and Correa (1998). More on this below.

originate the series.[20] Therefore, it is likely that the resulting productivity growth rates are overstated.

c) The "head count *versus* hours worked" issue: our defense for using employment in production instead of hours worked is two-fold. First, the head count is less subject to reporting errors than the alternative concept; second, the measures make little difference when longer time spans are considered. Of course, in examining short term results the "hours worked" concept is clearly more precise and, thus, superior. But in the medium to long term the fluctuations in the duration of working time matter little.

d) The "physical output *versus* value added" issue: this is, clearly, one of the most serious objections for using the usual physical output (gross production) series, particularly in the first half of the 1990s. Unfortunately, there are no easily available long term value added (VA) and comparable employment data at the sector level in the long term.

However, recent Brazilian National Accounts estimates investigate real VA per occupied person in 42 sectors that cover the whole economy. Most of these sectors belong to the manufacturing industries.[21] Although the results have to be considered with caution, they surely provide a more complete picture of labor productivity trends in the 1990s.[22] The following three sections explore this new set of data.

4 A BROADER PICTURE OF THE ECONOMY IN THE 1990s

Table 5 presents data on labor productivity growth rates of 42 economic sectors between 1990 and 2000 in average percent per year,[23] divided in three groups of sectors: high, low and negative productivity growth, using the mean as a dividing line. A number of observations can be drawn from these results.

1. Total average labor productivity (VA per worker) grew at 1.53% yearly from 1990 to 2000, a figure slightly smaller than GDP per occupied person shown in Table 1 — which was 1.8% yearly from 1991 to 2000.[24] But there was a sizeable

20. An indirect indication that this has been the case is that IBGE has recently re-designed its short-term surveys on employment, wages and related data based on a new selection of firms.

21. See IBGE (2000 and 2002). The data include both formal and informal occupation. Therefore, they differ from the ones used in the previous analysis on manufacturing.

22. Note that the results are still preliminary. A number of empirical inconsistencies appeared when we analyzed yearly figures from these series, particularly in the mid to late 1990s. Therefore, we preferred to work only with data for the series' initial year (1990) — when these inconsistencies do not seem to be great — to the last year available (2000) — when recent revisions imply better results than for the years in the middle of the decade.

23. Unfortunately, it is not possible to breakdown the period into sub-periods with different economic policy characteristics: the revisions made so far cover only the years 1998 to 2000.

24. The difference is due to the fact that Table 1 figures are based on GDP at market prices, while Table 5 is based on VA at "basic prices of the previous year", a concept similar to VA at factor cost. Note that these results differ from those in Table 2, which, as noted, use the new occupation data from the Advanced Tables of the 2000 Demographic Census.

variation of productivity growth rates across individual industrial sectors, around the average of 3.49%.[25]

TABLE 5
Labour Productivity Growth Rates — 1990-2000

17 high productivity growth > 3.50% p.a.	% per year	19 low productivity growth 0< p < 3.0% p.a.	% per year	6 negative productivity growth p< 0% p.a.	% per year
Communications	10.62	Paper and printing & publishing	3.18	Commerce	–0.17
Steel	9.84	Real estate	3.12	Services to firms	–0.10
Public utilities	9.50	Agriculture	3.01	Services to families	–0.45
Oil refining and petrochemicals	9.23	Metal products	2.65	Clothing and accessories	–0.82
Electric equipment	8.62	Other food and beverages	2.52	Plastics (transformation)	–1.03
Cars, trucks, buses	8.31	Other ind vegetals and tobacco	2.39	Private non profit services	–1.81
Oil refining, domestic use	7.61	Coffee	2.07		
Rubber products	7.06	Financial institutions	2.03		
Non ferrous metals	6.82	Textiles	1.75		
Other vehicles	6.12	Pharmaceuticals, cleansing	1.72		
Mineral extraction (non-oil)	5.28	Public administration	1.57		
Chemicals, non petrochemicals	5.23	Miscellaneous	1.57		
Miscellaneous (chemicals)	4.80	Milk and dairy products	1.57		
Extract min: oil, gas, coal, fuels	4.75	Wood and furniture	1.31		
Machinery and tractors	4.67	Construction	1.26		
Electronic equipment	4.36	Sugar refining	1.18		
Non metallic minerals	3.85	Transportation	0.80		
		Prepared meats	0.34	Unweighted average	3.49
		Footwear and leather	0.17	Weighted average	1.53

2. Defining as high productivity growth sectors (HPGS) all those characterized by above average PG, we observe that of the 17 HPGS in Table 5, no less than 15 belong to manufacturing industries, although the leading and third sectors are non-manufacturing: Communications and Public Utilities. The top few sectors were all characterized by substantial privatization of assets in the 1990s (this includes, besides Communications and Public Utilities, Steel in second place and Petrochemicals in fourth).

Thus, it seems safe to say that HPG and privatization were concomitant. Although it is tempting to conclude that privatization "caused" HPG, one needs to exercise more caution before doing so: in at least two cases (Communications and Public Utilities), output growth had been occurring at very rapid rates for some time even before privatization began, but it is not clear if the same growth process characterized productivity.

3. Table 5 shows that there were 19 low — albeit positive — productivity growth sectors (LPGS) in the 1990s. Among these, it is worth mentioning that: *a)* Real Estate is not a "productive" sector — its "output" are rents (paid and imputed)

25. The fact that the simple average (3.49%) is greater than the weighted average (1.53%) indicates that some of the slow productivity growth sectors are responsible for a sizeable proportion of total employment. This aspect will be explored below.

and the corresponding employment is given by the number of employees in real estate agencies and related activities; *b)* agriculture saw rapid productivity growth in the decade, but below the average; this agrees with previous trends which show the primary sector as one characterized by still very low but rapidly increasing productivity levels;[26] *c)* the productivity of public administration is crudely estimated; *d)* of the remaining 14 LPGS, no less than 11 belong to the manufacturing sector — the three remaining ones being financial services, construction and transportation. Note that slow productivity change in financial services occurred despite privatization of local (state) banks and the entry of foreign banks during the decade.[27] Privatisation of the railway system, in the same vein, was not enough to increase the productivity of the transportation sector as a whole.

4. Negative productivity change occurred in six sectors, four of which relate to services.[28] This poses an additional problem to employment policies because sizeable proportions of total occupation are concentrated in these sectors. This aspect can be seen in the following table, which presents the employment levels and employment structure in 1990 and in 2000. Note that some of these sectors also possess low absolute productivity levels.

Table 6 shows that changes in the structure of employment were particularly unfavorable to manufacturing, public utilities, mining and financial institutions. The loss in agriculture was expected, given the sector's modernization and technological advances over the decade. Almost all of the structural employment gains were accrued by the services and commerce sector, as data in Table 6 clearly demonstrate.

TABLE 6
Levels and Structure of Employment

Sectors	1990	2000	1990	2000
	(1000s)		(%)	
Agriculture and animal production	14,911.4	14,886.6	25.46	23.04
Mineral extraction	335.3	236.7	0.57	0.37
Manufacturing industries	9,079.5	7,978.4	15.50	12.35
Public utilities	324.0	204.7	0.55	0.32
Construction industry	3,936.0	4,075.3	6.72	6.31
Commerce	7,619.2	9,759.7	13.01	15.10
Transportation	2,087.3	2,473.8	3.56	3.83
Communications	174.2	213.8	0.30	0.33
Financial institutions	1,005.9	711.3	1.72	1.10
Real estate	313.4	296.9	0.54	0.46
Public administration	5,713.8	5,672.5	9.76	8.78
Services	13,070.8	18,107.6	22.32	28.02
Sum	58,570.8	64,617.3	100.00	100.00

Sources: Same as Table 5.

26. See, for instance, Bonelli and Fonseca (1998).

27. One possible explanation for low average productivity growth in this case rests on the fact that after the implementation of the Real Stabilization Plan the banking sector could not rely on inflationary earnings and gains as it did before, despite the 30% reduction in employment (Table 6).

28. Actually, in commerce and services to firms the average growth rate was nearly nil.

We next perform an exercise to decompose total labor productivity change into two factors to separate out the effect of changes in the structure of employment from changes due to pure productivity increases.

Let $Y[t]/N[t] - Y[0]/N[0]$ be the total productivity change between time periods 0 and t (1990 and 2000), where Y and N are output and employment.

Total productivity change can also be written as:

$$\Sigma\, a\,[i,t].P\,[i,t] - \Sigma\, a\,[i,0].P\,[i,0] \qquad (1)$$

Where:

$a\,[i,0]$ and $a[i,t]$ are sector *(i)* employment shares in times 0 and t;

$P\,[i,0]$ and $P\,[i,t]$ are sector *(i)* productivity levels in 0 and t in constant prices.

The difference (1) can also be written, after some algebraic manipulation, as the sum of two parts:

$$\Sigma P\,[i,t].(a\,[i,t] - a\,[i,0]) \qquad (2)$$

and:

$$\Sigma a\,[i,0].(P\,[i,t] - P\,[i,0])$$

The first term (2) above can be called the structural effect: it can be interpreted as the productivity change that would take place if productivity levels remained constant at end-period levels and all change were due to relative reduction of employment in low productivity sectors and increase in high productivity sectors. The second term can be called the technological effect: it measures the productivity change that would take place if employment shares remained constant at the beginning-of-the-period levels and all change were due to productivity deepening, or sector productivity increases.

Applying the above expressions to productivity levels and employment structures of the 42 sectors in the economy yields the results shown in the Table 7.

TABLE 7
Decomposition of Aggregate Productivity Change — 1990-2000
(%)

Structural change effect	–139.8
Technological change effect	239.8
Total	100.0

The decomposition results show that the structural effect was highly negative (–140%). Therefore, all observed labor productivity gain in the 1990s came from the technological effect, or productivity deepening (+240%). In other words, labor shifted in the 1990s primarily towards low productivity sectors (services and commerce, as we saw above) and away from high productivity ones (mostly in mining, manufacturing and public utilities; especially in manufacturing, due to its employment levels). The only high productivity sector that benefited from positive labor shifts was communications. On the other hand, low productivity sectors such as agriculture and construction made a positive contribution to overall productivity

change because their employment shares decreased between 1990 and 2000. In addition to that, productivity growth was concentrated in sectors that, except for agriculture, have low employment levels.

This last point naturally leads to the issue of convergence of productivity levels over time: has convergence occurred in Brazil in the 1990s? Although no one would expect that productivity in all sectors converged to a common level, it is desirable that some convergence occurs, so that low productivity sectors progressively close the gap relatively to the high productivity ones.

This issue can be approached in different ways. First, for instance, by examining the evolution of ratios of productivity levels between pairs of sectors over time. The Table 8 shows the ratios of the six highest productivity level sectors to the lowest six in 1990 and 2000.[29]

TABLE 8
Ratio of Six Highest to Six Lowest Productivity Levels — 1990 and 2000

Pairs of sectors		1990	2000
1	Oil refining and petrochemicals *versus* private non profit services	113	327
2	Extractive minerals: oil, gas, coal, fuels *versus* clothing and accessories	113	195
3	Chemicals, non petrochemicals *versus* agriculture and animal production	27	33
4	Public utilities *versus* services to families	12	31
5	Communications *versus* footwear and leather products	10	26
6	Steel *versus* commerce	8	21

The above comparisons reveal that, as far as the highest and lowest productivity sectors are concerned, there was no convergence of productivity levels during the 1990s. Quite the contrary, productivity gaps widened over time by a ratio of approximately 2.5 times for most sectors shown in the table (except for the third comparison, due to Agriculture's relatively favorable labor productivity performance).

A more complete and formal test of the convergence hypothesis can be performed by running a regression of sector productivity growth rates from 1990 to 2000 on productivity levels in the initial year (1990). If productivity levels converged, one would expect an estimated negative coefficient for the independent variable (1990 productivity level). We would expect a positive coefficient in case divergence occurred. The estimated regression results are shown next.

OLS regression

Dependent variable: productivity growth rates, average 1990-2000

Independent variable: productivity level in 1990

Number of observations: 42

$R^2 = 0.078$

Estimated coefficients (t-values in parenthesis):

Constant = 2.848 (4.95)

Prod. Level = 0.136 (2.11)

29. We omitted from the comparisons the Real State sector, the highest labor productivity level among all, for reasons already discussed.

Both the small magnitude of the correlation coefficient and the sign of the estimated independent variable coefficient allow us to reject the convergence hypothesis for the time period under consideration: there was no convergence of productivity levels for the whole sample data. In fact, the opposite is closer to the truth, as exemplified by the increasing ratios between high and low productivity sectors over the decade shown before. Note that the estimated regression coefficient has a sign that is the opposite from the expected by the convergence hypothesis and is significantly different from zero at the 5% level of confidence — implying that some "divergence" took place among at least a sub-group of sectors. As seen, it characterized at least the highest *vis-à-vis* the lowest productivity level sectors.

5 WHO BENEFITED FROM THE DIFFERENTIATED PRODUCTIVITY GAINS IN THE 1990s?

Productivity gains may benefit a number of social groups, including: *(a)* consumers (or buyers of a sector's output, in general); *(b)* workers in each sector, via rising real wages; *(c)* firms, via increased shares of profits in sector income or Value Added. The following three sub-sections consider each in turn. A final sub-section integrates the analysis into a single framework.

5.1. Consumers are the main beneficiaries of productivity increases if the gains are reflected in lower relative prices for the sector's output. A regression of productivity growth on relative prices [30] was run to test if this was the case during the 1990s. The answer was no. That is, there is no observed correlation, or general association, between relative price changes and productivity gains *(p)* between 1990 and 2000 (regression results below). Note, besides, that the estimated coefficient is positive, contrary to the expected hypothesis — but not significantly different from zero.

OLS regression

Dependent variable: productivity growth rate, average 1990-2000

Independent variable: 2000 relative price index (1990 = 1)

Number of observations: 42

$R^2 = 0.022$

Estimated coefficients (t-values in parenthesis):

Constant = - 6.19 (0.78)

Relative prices = 0.553 (0.33)

However, if we break the sample into sub-groups, we note that for many sectors a negative relationship holds. This was particularly the case for the nine sectors listed in the Table 9.

30. The index of sector relative prices for the decade is given by the accumulated ratios of yearly relative sector prices. These last series are obtained by dividing each sector's deflator by the overall price deflator.

TABLE 9
Relative Prices and Productivity

High *p* growth, decreased relative prices (9)	2000 relative prices	Productivity growth % per year
	1990 = 1	1990-2000
Agriculture and animal production	0.909	3.01
Mineral extraction (non-oil)	0.715	5.28
Non metallic minerals	0.810	3.85
Non ferrous metals	0.684	6.82
Electric equipment	0.439	8.62
Electronic equipment	0.740	4.36
Other vehicles	0.734	6.12
Rubber products	0.772	7.06
Miscellaneous (chemicals)	0.647	4.80

In a few cases, very high productivity growth was accompanied by unchanged relative prices, as reported in Table 10.

TABLE 10
Relative Prices and Productivity (cont.)

High *p*, unchanged relative prices (3)	2000 relative prices	Productivity growth % per year
	1990 = 1	1990-2000
Cars, trucks, buses	1.033	8.31
Oil refining for domestic use	1.008	7.61
Communications	1.013	10.62

But for another group of sectors the opposite occurred: high productivity growth rates were accompanied by increases in relative prices, defined as positive changes in excess of 8%. This was the case in the following sectors (Table 11):

TABLE 11
Relative Prices and Productivity (conclusion)

High *p*, increased relative prices (7)	2000 relative prices	Productivity growth % per year
	1990 = 1	1990-2000
Extractive minerals: oil, gas, coal, fuels	1.382	4.75
Steel	1.087	9.84
Machinery and tractors	1.087	4.67
Paper and printing and publishing	1.222	3.18
Chemicals, non petrochemicals	1.525	5.23
Oil refining and petrochemicals	1.127	9.23
Public utilities	1.082	9.50

This behavior may be explained by market power in the hands of the incumbent leading firms, due to increased concentration of production in a small number of

firms, which may lead to oligopolistic pricing. But in some cases it may also reflect the influence of international prices and the exchange rate.

Note that most of the other sectors, except for those in Tables 9 to 11, had low rates of productivity growth in the 1990s. Their performance in terms of price movements shows no consistent pattern and do not allow us to make any firm conclusions on the association between productivity and price movements.

Thus, consumers were the main beneficiaries of productivity growth in only a small number of cases. Several qualifications and explanations are needed in order to explain the behavior of the remaining ones, including the role of demand shifts — which may have been substantial over a ten year period.

5.2. The sectors' workers are the main beneficiaries of productivity change if their average real earnings rise faster than productivity. This hypothesis can be tested by comparing productivity change with the evolution of real wages or product wages.[31] Different patterns emerge, depending on which of these two wage concepts is adopted for the comparison. In the case of the former, real average wages [32] increases were observed in five sectors only in the 1990s (see Table 12). Noteworthy among them is the communications sector, with a 58% real wage increase between 1900 and 2000. The three first sectors in the table were also characterized by very high rates of productivity change, as already shown. Public administration, as mentioned, is a peculiar case in terms of productivity measurement.

TABLE 12
Real Wage Gains — 1990-2000
(% Change)

Cars, trucks, buses	6.9
Public utilities	7.3
Communications	57.6
Real estate	15.7
Public administration	7.7

In four other cases, the real wage in 2000 stood at approximately the same level it was in 1990, defined as a relative percent change between – or + 5% (see Table 13). Note that only one sector in the table displayed high rates of productivity change over the decade (other vehicles: + 6.1% per year), the remaining were characterized by average (agriculture) or mediocre results.

31. As in the previous case, no association was found when running a regression of productivity change on either real wages or product wages.

32. Real wages are defined as nominal wages deflated by the overall consumer price index, or by the GDP implicit deflator, a proxy for the former. We adopted this option here.

TABLE 13
Real Wage Gains — 1990-2000 (conclusion)
(% Change)

Agriculture and animal production	–3.1
Other vehicles	–2.9
Pharmaceuticals and cleansing products	4.9
Financial institutions	3.4

In the remaining 33 sectors, the real wage in 2000 was below its 1990 level. On average, the estimated decrease reached an accumulated 24% in the decade, with extreme values ranging from – 8% (non metallic minerals) to – 41% (footwear and leather).

A slightly different picture emerges when product wages are examined.[33] The following table summarizes the evidence for fourteen sectors in which product wages either increased or, at a minimum, did not fall between the beginning and the end of the 1990s.[34]

TABLE 14
Product Wage Change — 1990-2000
(% Change)

Agriculture and animal production	6.7
Mineral extraction (non-oil)	4.5*
Non metallic minerals	13.3*
Non ferrous metals	–4.5*
Metal products	–1.9
Electric equipment	60.6*
Wood and furniture	–2.3
Rubber products	–0.9*
Miscellaneous (chemicals)	27.0*
Plastics (transformation)	10.9
Textiles	31.5
Clothing and accessories	–2.0
Commerce	8.6
Transportation	10.1

* Above average productivity growth.

No clear relationship appears as far as wage and productivity gains are concerned. Note also that the sectors in Table 14 are not the same as in the previous ones (Tables 12 and 13), due to differentiated relative price changes, which generated different real and product wage changes.

It seems safe to conclude, therefore, that, as far as wage behavior is concerned, there is no clear-cut answer to the question of who benefited from productivity growth in the 1990s.

5.3. The incumbent firms in a given sector are the main beneficiaries of productivity change if the profits to VA ratio increase over time, that is, if the

33. Product wages are nominal wages deflated by own-sector price indices. They differ from real wages in that these, being deflated by cost of living indices, measure changes in welfare while the former reflects costs to the firms.

34. Decrease means a greater than 5% negative change.

functional distribution of income changes in favor of profits, and against labor compensation.

Again, running a regression of productivity growth rates on profit ratios (or their complement, the labor compensation ratios) change can provide a test for this hypothesis. The regression results (not shown here) show no association. Note that, since VA is divided into either employment compensation or gross profits, this hypothesis is identical to the previous one when product wages were considered as the wage indicator. In other words, either employees were the beneficiaries of productivity growth via higher earnings or firms were the main beneficiaries via increased profits to sector income ratios and decreased product-wages.

Table 15 shows the basic 1990 and 2000 data for the 20 sectors in which the labor share of value added decreased. Note that there is some relationship between labor/VA change (decreases) and productivity growth in a number of sectors: eleven sectors in the table had above average productivity growth, as shown in Table 5. The incumbent firms were, therefore, the main beneficiaries of higher than average productivity growth. This was the case of mineral extraction (oil), steel, non ferrous metals, machinery and tractors, electronic equipment, cars, trucks and buses, rubber products, chemicals (non-petrochemicals), Oil refining and petrochemicals, oil refining for domestic use, and public utilities.

TABLE 15
Decreased Labor Shares

20 sectors	Labor compensation on total remuneration	
	1990	2000
Agriculture and animal production	0.183	0.155
Mineral extraction (non-oil)	0.501	0.399
Steel	0.252	0.102
Non ferrous metals	0.229	0.168
Metal products	0.752	0.705
Machinery and tractors	0.448	0.272
Electronic equipment	0.288	0.255
Cars, trucks, buses	0.383	0.255
Pulp, paper and printing & publishing	0.604	0.398
Rubber products	0.325	0.253
Chemicals, non petrochemicals	0.292	0.112
Oil refining and petrochemicals	0.145	0.092
Footwear and leather products	0.691	0.669
Sugar refining	0.423	0.337
Oil refining for domestic use	0.226	0.146
Other food products and beverages	0.514	0.425
Miscellaneous	0.369	0.329
Public utilities	0.556	0.333
Construction industry	0.391	0.197
Real estate	0.056	0.025
Total	0.616	0.515

But note also that in some cases the productivity performance was good and the labor share increased during the decade (Table 16), indicating that some firms did

not benefit from productivity increases in terms of increasing profit shares. Of the 22 sectors in Table 16, this was the case in the following six sectors: extractive minerals (oil, etc), non metallic minerals, electric equipment, other vehicles, miscellaneous (chemicals), and communications.

TABLE 16
Increased or Constant Labor Shares

22 sectors	Labor compensation on total remuneration	
	1990	2000
Extractive minerals: oil, gas, coal, fuels	0.114	0.099
Non metallic minerals	0.350	0.370
Electric equipment	0.456	0.489
Other vehicles	0.291	0.497
Wood and furniture	0.574	0.593
Miscellaneous (chemicals)	0.410	0.424
Pharmaceuticals and cleansing products	0.287	0.282
Plastics (transformation)	0.364	0.644
Textiles	0.269	0.506
Clothing and accessories	0.772	0.931
Coffee	0.333	0.166
Other industrialized vegetal, inc. tobacco	0.352	0.351
Prepared meats	0.426	0.587
Milk and dairy products	0.277	0.280
Commerce	0.633	0.813
Transportation	0.700	0.884
Communications	0.504	0.329
Financial institutions	0.351	0.706
Services to families	0.872	0.947
Services to firms	0.630	0.672
Public administration	1.000	1.000
Private non profit services	0.981	1.000

Overall, the hypothesis holds true for 11 out of 20 sectors (increased profits share with high productivity growth, indicating that firm profits were the main beneficiaries of productivity growth), but it does not hold in six out of 22 cases (where there were decreased profits shares with high productivity growth).

It is safe to conclude that, although no clear answer could be given, in a number of cases the hypothesis that firms were the main beneficiaries of fast productivity change has proven true. There are many other sectors, however, in which this was not the case: either profits increased but productivity didn't (nine out of 20) or profits decreased but productivity increased quickly (six out of 22 cases).

5.4 The investigation on who benefited from productivity change in the 1990s can be integrated into a single framework by using a decomposition exercise such as the following one.[35] Consider a mark up ratio by sector i, $m[i]$, constructed as the

35. I thank E. Bacha for having suggested this decomposition.

ratio of total income generated to workers' compensation.[36] It is, by definition, equal to

$$V[i]*P[i]/W[i]*L[i] \qquad \text{or any time period } t \tag{1}$$

where $V[i]$ stands for real Value Added (VA), $P[i]$ is the sector price level, $W[i]$ is the average level of wages and salaries (workers' compensation) and $L[i]$ is employment. Multiplying and dividing the right hand side (RHS) by P, the general price level, and rearranging, yields:

$$V[i]/L[i] = X[i] = m[i] * \{ W[i]/P / \{ P[i] / P \} \tag{2}$$

where:

$X[i]$ is labor productivity;

$W[i] / P$ is the real wage level; and

$P[i] / P$ is the relative price, sector i.

Dividing this expression in time period t by the expression in period 0, taking logs of the quotient and rearranging yields:

$$\log X[i,t] - \log X[i,0] = \{\log m[i,t] - \log m[i,0]\} + \{\log (W[i,t]/P[t]) - \log (W[i,0]/P[0])\} + \{\log (P[i,0]/P[0]) - \log (P[i,t]/P[t]) \} \tag{3}$$

or, suppressing the time symbols,

$$\Delta\log X[i] = \Delta\log m[i] + \Delta\log (W[i]/P) - \Delta\log (P[i]/P) \tag{4}$$

The LHS is productivity change between 0 and t. The first term on the RHS represents mark up changes. A positive difference indicates that firms increased the share of profits on VA between the initial and final years — i.e., that firms appropriated from productivity gains in an amount given by the ratio of this change, $\Delta\log m[i]$, and $\Delta\log X[i]$.

The second term on the RHS shows the change in real wages (nominal wages deflated by the general price level). Therefore, it indicates the extent to which workers benefited from sector productivity change via real wage gains. Its measurement is a proportion given by $\Delta\log (W[i]/P) / \Delta\log X[i]$.

The last term in the RHS represents relative price changes. From (3) it can be easily seen that a positive contribution to productivity change occurs if relative prices decrease over time: $P[i,0]/P[0] > P[i,t]/P[t]$. Since the main beneficiaries of relative price decreases are consumers of the sector's output, the contribution of relative prices to productivity change can be written as $\Delta\log (P[i]/P) / \Delta\log X[i]$.

Applying the decomposition formula to individual sector data in 1990 and 2000 yields the results shown in the following tables. To continue, the sectors were divided in groups according to the relative importance of each of the three components just mentioned. The cases where comparable size contributions were found are shown in separate. The same happens with the few sectors in which productivity levels *decreased* between the initial and final years.

36. *m[i]* expresses the distribution of income between profits and wages. It can de written as (1 + *G/W*), where *G* stands for gross profits and W for workers' compensation.

Consider first the cases in which relative price reductions were the main component of productivity change, indicating that *consumers* were the main beneficiaries.[37] There are 11 sectors is such a case, as Table 17 shows. In some of them price movements explained nearly the whole of productivity change, because the contributions of the remaining components were either negative or small: electric equipment, wood and furniture, miscellaneous (chemicals) and transportation.[38]

TABLE 17
Consumers Were the Main Beneficiaries via Decreased Relative Prices

Sectors		Productivity	Decomposition of productivity change (%)		
		% per year	Mark up	Real wages	Relative prices
1	Metal products	2,65	25	–51	126
2	Electric equipment	8,62	–9	9	100
3	Electronic equipment	4,36	29	1	70
4	Wood and furniture	1,31	–25	2	122
5	Miscellaneous (chemicals)	4,80	–7	14	93
6	Textiles	1,75	–364	92	372
7	Footwear and leather products	0,17	196	–1205	1109
8	Other industrialized vegetables, inc. tobacco	2,39	2	23	75
9	Miscellaneous	1,57	73	–197	224
10	Transportation	0,80	–292	–170	562
11	Financial institutions	2,03	–348	64	384

But the relative price contribution was also sizeable in the following sectors: metal products, electronic equipment, other industrialized vegetables (tobacco) and financial institutions. Note that there appears to be no relationship between the size of the contributions and the speed of productivity change across sectors, as four of them had rates of productivity growth near or below the average of 1.53% per year and only three had rates above 4%.

Turning next to the cases in which the main component of productivity growth were mark up increases — that is, sectors where *firms* were the main beneficiaries of productivity change — Table 18 shows that this occurred in 9 sectors, but mainly in steel, machinery, pulp and paper, chemicals (non petrochemicals) and construction. To a smaller extent, this was also the case of agriculture, coffee, other food products (including beverages) and real state. Except for the construction industry, all the other eight sectors had higher than average productivity increases.

The decomposition for the economy as a whole indicates that mark up increases were the main factor behind overall productivity change. But note that, by definition, relative price changes have a null contribution for this grand total.

37. A negative contribution indicates that the corresponding change was in the direction contrary to the direction of productivity change.

38. Note also that when the rate of productivity change (shown in the first column in the next and remaining tables in this section) is small, the contributions reach very high figures.

TABLE 18

Firms Were the Main Beneficiaries via Increased Mark Up

		Productivity	Decomposition of productivity change (%)		
		% per year	Mark up	Real wages	Relative prices
1	Agriculture and animal production	3,01	58	10	32
2	Steel	9,84	97	12	–9
3	Machinery and tractors	4,67	109	9	–18
4	Pulp, paper and printing and publishing	3,18	133	31	–64
5	Chemicals, non petrochemicals	5,23	188	–5	–83
6	Coffee	2,07	340	99	–339
7	Other food products and beverages	2,52	76	19	5
8	Construction industry	1,26	549	–248	–201
9	Real estate	3,12	265	58	–223
	TOTAL	1,535	118	–18	0

There are six sectors in which *workers* were the main beneficiaries of productivity increases, via increased real labor compensation. They are shown in the Table 19. In all of them the contribution of increased labor compensation was far larger than the remaining ones.

TABLE 19

Workers Were the Main Beneficiaries Via Increased Wages

		Productivity	Decomposition of productivity change (%)		
		% per year	Mark up	Real wages	Relative prices
1	Extractive minerals: oil, gas, coal, fuels	4,75	32	138	–70
2	Other vehicles	6,12	–90	138	52
3	Pharmaceuticals, soaps, parfums and related products	1,72	11	198	–109
4	Prepared meats	0,34	–956	782	273
5	Milk and dairy products	1,57	–6	118	–12
6	Public administration	1,57	0	86	14

Of the remaining 16 sectors, 10 had relevant contributions of two components and 6 had negative productivity change. Beginning with the case in which *workers* (via increased wages) *and firms* (via increased mark ups) were the main beneficiaries of productivity growth, Table 20 shows that all sectors except one (sugar refining) displayed very high rates of productivity growth between 1990 and 2000. Indeed, most of the leading productivity growth sectors are included here. In all of them relative prices rose over time, indicating that consumers did not benefit directly from productivity gains. But it should also be noted that the (negative) contributions of relative prices are very small in all cases except sugar refining.

TABLE 20
Workers and Firms Were the Main Beneficiaries

		Productivity	Decomposition of productivity change (%)		
		% per year	Mark up	Real wages	Relative prices
1	Cars, trucks, buses	8,31	51	53	–4
2	Oil refining and petrochemicals	9,23	52	61	–14
3	Sugar refining	1,18	194	216	–310
4	Oil refining for domestic use	7,61	60	41	–1
5	Public utilities	9,50	56	52	–9
6	Communications	10,62	42	59	–1

For the next three sectors, *consumers and firms* were the main beneficiaries of productivity growth. There is a slight predominance of the former group, because the contribution of relative price decreases is higher than the contribution of mark up increases in all sectors in the Table 21. But in rubber products all contributions are on the same order of magnitude.

TABLE 21
Consumers and Firms Were the Main Beneficiaries

		Productivity	Decomposition of productivity change (%)		
		% per year	Mark up	Real wages	Relative prices
1	Mineral extraction (non-oil)	5,28	44	–9	65
2	Non ferrous metals	6,82	46	–4	58
3	Rubber products	7,06	36	26	38

The next sector was characterized by sizeable and positive contributions of increased labor compensation and relative price decreases of the same order of magnitude, suggesting that both *workers and consumers* benefited from productivity growth (Table 22).

TABLE 22
Workers and Consumers Were the Main Beneficiaries

		Productivity	Decomposition of productivity change (%)		
		% per year	Mark up	Real wages	Relative prices
1	Non metallic minerals	3,85	–15	59	56

Finally, the last six sectors are characterized by negative productivity change from 1990 to 2000. The interpretation of the results is not straightforward here because in most cases productivity change was very small between 1990 and 2000. This is the case of commerce, services to firms, services to families, and clothing and footwear. As we have seen, this usually implies very high percent contributions of the explanatory factors. But it can be observed that in all sectors except for private non profit services the direction of relative price changes was opposite to productivity change, i. e., relative prices decreased over time.

Private non profit services is an interesting special sector because all three components contributed to the 1.81% per year productivity decrease over time: mark ups were reduced, real labor compensation decreased and relative prices increased. It represents the least desirable of all situations in the exercise (Table 23).

TABLE 23
Negative Productivity Change

		Productivity	Decomposition of productivity change (%)		
		% per year	Mark up	Real wages	Relative prices
1	Plastics (transformation)	–1,03	549	–81	–369
2	Clothing and accessories	–0,82	226	430	–556
3	Commerce	–0,07	3545	2250	–5695
4	Services to families	–0,45	183	323	–406
5	Services to firms	–0,10	660	1027	–1588
6	Private non profit services	–1,81	11	22	67

To sum up, the decomposition exercise allows for the following conclusions:

a) In most cases (11 out of 42) *consumers* of the sector's output were the main beneficiaries of productivity growth; if we add the three sectors in which both *consumers and firms* benefited most, in approximately equal measure, and the case in which both *consumers and workers* were the principal beneficiaries, the total number of sectors reaches 16; this is almost half the number of sectors with positive productivity change (36), suggesting that the process of productivity growth in the 1990s was to a large extent beneficial to a substantial part of the economic system via relative price reductions.

b) In nine cases *firms* were the main beneficiaries of productivity change; if we add the six cases in which the joint effect of mark up and increased labor compensation and the three cases in which *firms and consumers* jointly benefited most, we arrive at a total of 18 (out of 36 sectors with positive productivity change in the 1990s); again, it is a sizeable proportion, indicating that firms also benefited strongly from the process of labor productivity change.

c) In six cases workers were the main beneficiaries of productivity growth; if we add the six cases in which both workers and firms benefited most, plus the case in which workers and consumers were the joint main beneficiaries, we arrive at a total of 13 sectors; again, it represents a high proportion of the number of sectors characterized by positive productivity change in the 1990s.

It is therefore tempting to conclude that the benefits of productivity growth were spread over the agents in the economy, if not evenly, at least in a not too much concentrated fashion.

6 WHAT IS THE RELATIONSHIP BETWEEN PRODUCTIVITY CHANGE AND IMPORT LIBERALIZATION?

The issue of productivity change and import liberalization is an important one because the accepted view on the subject is that one of the main causes of, or motivations for, Brazilian productivity change in the 1990s was the import

liberalization process that began in the late 1980s and accelerated in the first half of the 1990s. The underlying (admittedly simple) model is one in which under the threat of increasing imports, firms are forced to react to decreased market shares by raising productivity.

But among the many desirable outcomes of liberalization processes,[39] the positive impact of import liberalization on productivity growth was not only due to direct effects on product markets in terms of increased competition from goods produced abroad, which forced the domestic firms to increase productivity so as to compete. It was also due to the higher quality of increasingly imported raw materials, parts and components made available by liberalization. It may also be the case that import competition forces the least productive firms out of business. The exit of low productivity firms has the effect of increasing the productivity of the remaining ones.[40]

However, issues of timing (how long does it take for the effects of liberalization to be felt on individual industries?), degree of data aggregation (either at the firm or at the sector level), availability (and type) of data, and how to represent empirically the liberalization process make it very difficult to perform direct tests of the hypotheses.

It seems clear that only sectors producing tradables should be considered in testing for the influence of trade liberalization on productivity change. This means that we should exclude all non-tradables from the analysis: services, communications, construction, public utilities, commerce, transportation, government, real estate, and financial intermediaries. Thus, only 31 sectors were considered in what follows.[41]

For the regression analysis we adopted the vector of productivity growth rates between 1990 and 2000 as dependent variable, as has been documented above and explored in this paper. A number of possibilities were considered for the independent variables:[42]

- The absolute and relative changes in the level of effective protection between the late 1980s and the late 1990s.
- The absolute and relative changes in the level of nominal protection between the late 1980s and the late 1990s.
- The level of protection (nominal or effective) in the final year.
- Import penetration ratios and their rates of change.

In all cases, no association was found between productivity growth and indicators of trade liberalization and/or import penetration ratios and their respective rates of change. This came as a surprise and deserves closer scrutiny, since Rossi and

39. This issue has been tackled by, among others, Hay (1997), Rossi and Ferreira (1999), Muendler (2001) and Lisboa et al. (2002). Except for Rossi and Ferreira, all the other authors rely on micro data (at the firm level) to test to what extent the increased use of imported material in production led to productivity increases. The answers are positive in all studies cited, but emphasize different aspects of increased imported inputs use.

40. This point was explored in detail by Muendler (2001).

41. The reader is referred to the Appendix for the list of sectors considered and trade-related selected indicators.

42. Except for the fourth group, all the other information came from Kume, Piani and Braz de Souza (2000).

Ferreira's (1999) pioneering study established that there was a close (negative) association between productivity growth[43] and changes in import tariff protection at the two-digit level of aggregation for 18 manufacturing industries.

Initially, we divided the 31 tradables-producing sectors into different groups according to the degree of import penetration and their change over time.[44] We were able to identify six different groups, which will be analyzed next according to the import to total supply behavior displayed during the 1990s.

The first group of sectors was characterized by little change over time in the (generally low) import coefficients. All the sectors included in this group are close to the agriculture and natural resources economic base. Unsurprisingly, import penetration ratios remained small and showed little change over time for sectors such as coffee, sugar, other industrialized vegetables (tobacco, mainly) and prepared meats — all are sectors in which Brazil is believed to possess comparative advantage in international markets. In all these cases productivity growth was very small.

The exception in this first group is the mineral sector, also one in which Brazil has a natural comparative advantage (iron ore and manganese extraction, mostly). Agriculture's productivity performance was favorable and near the simple average for all sectors (3.5%). But, in essence, this first group presented no surprises: 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 24).

TABLE 24
Import Penetration and Productivity Change

Low import coefficients, little change	Import penetration ratios (M / M + VP)				1990-2000 p.a. % productivity
	1990	1994	1997	2000	
Agriculture 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 industrialized vegetables, inc. tobacco	2.5	3.9	3.8	3.1	2.4
Prepared 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 sectors in which the import coefficients were low in the beginning of the decade, when import liberalization began, and increased as the decade progressed. But has this been enough to induce upwards shifts in productivity? Table 25 suggests that this was not necessarily so. In fact, very different outcomes characterize this group.

The best performance in terms of productivity change was in the steel (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

43. Their measure of labor productivity is the same as the one examined in Section 4. Their measure of import protection is similar to ours (see Appendix). As noted, the productivity indicator adopted in this section is VA per occupied person.

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

use sectors. In the latter case, Brazil is virtually self-sufficient in all popular types of oils, the increased import penetration being due to special types not-produced domestically. Therefore, in both cases it is not easy to explain good productivity performance on the basis of the imports competition motive.

TABLE 25
Import Penetration and Productivity Change (cont.)

Low import coefficients, some change	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 and 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

With the exception of non metallic minerals (construction materials), all other sectors had a meager productivity performance, despite large increases in import penetration ratios. All the same, imports were not sufficiently high to become a real threat to domestic producers, on average, and did not induce fast productivity growth.

The two next cases are one-sector groups. First, take the case of chemicals (except petrochemicals). It is surprising to find in this case a high, but constant, import penetration ratio together with a reasonably high rate of productivity change. Since imports increased substantially, this means that rising imports were concomitant to rising domestic production and fast productivity growth. The result seems to reveal a healthy industrial sector, where continued foreign competition was met by rising labor productivity (Table 26).

TABLE 26
Import Penetration and Productivity Change (cont.)

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

The next group shows an unexpectedly favorable performance: oil and gas extraction is a sector in which the share of imports in total supply decreased markedly during the 1990s, and the incumbent monopolist [45] 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 effect to increase domestic production for national security reasons (Table 27).

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

TABLE 27
Import Penetration and Productivity Change (cont.)

High import coefficients, 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

We next come to the groups of sectors for 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 to be affected by rising imports. We divided this group into two sub-groups: the first is composed by metals and the so-called metal-mechanic industries,[46] the second is formed by the chemicals group of industries. Their respective performances are shown in the Table 28.

TABLE 28
Import Penetration and Productivity Change (cont.)

High M 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

Except for the very heterogeneous miscellaneous and metal products sectors, all the remaining faced increased import competition with very fast productivity change. Therefore, they behaved as expected by a priori hypotheses of sector and firm reaction to increased competitive imports. Note that most sectors in this group are characterized by the presence and leadership of transnational corporations (TNCs).

The results for the chemicals and textiles group are not as clear as for the previous one: only the first three sectors shown in the table below behaved as expected, facing rising import competition via strong productivity growth.

The Pharmaceuticals, cleansing and related products is representative of a sector dominated by foreign firms which, contrary to the group shown in Table 28, displayed only modest productivity increases. Plastics are a very small and heterogeneous sector: it is difficult to predict what its behavior should have been, due to the extreme variety of products it produces (Table 29).

46. Electronic equipment and material are usually included in the metal-mechanics group. Note that the miscellaneous industries in Brazil include precision equipment producers and related industries.

TABLE 29
Import Penetration and Productivity Change (conclusion)

High M penetration 2: chemicals group	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, cleansing and related products	7.1	12.0	14.1	18.6	1.7
Plastics (transformation)	2.2	4.8	7.2	8.9	–1.0
Textiles	2.4	7.8	11.7	10.0	1.7

Finally, the domestic textiles sector has been strongly affected by rising imports up to the second half of the decade. But it has also been able to withstand competition, displaying modest productivity increases over the decade.[47]

It seems safe to conclude that productivity growth has been the answer to increased import competition in only a limited number of sector cases. 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.

7 CONCLUSION

The long term analysis conducted in the first part of the paper aimed at providing some historical perspective on the issue of labor productivity change in Brazil.[48] The main conclusion from this part was that productivity change has been a major source of GDP growth in Brazil since the 1940s, at least. But: *a*) its importance decreased over time, particularly in the 1980s, when productivity change was negative, on average; *b*) in the 1990s, despite slow GDP growth, productivity accounted for almost 40% of the observed GDP increase.

We conclude that the experience of this last decade was, despite slower GDP growth than historically registered, characterized by productivity gains that represented a reversal of the record of the 1980s. Therefore, one could claim that one of the "prices paid for stabilization" in the 1990s — as some critics labeled lower than average long term GDP growth during the present government — was not excessive, especially considering that: *a*) the economy was severely hit by external shocks in the second half of the decade; *b*) productivity growth resumed; and *c*) employment levels were not sacrificed to the extent believed so far.[49]

47. Again, it is unfortunate that we cannot split the decade into different sub-periods: this would allow time patterns of productivity change to emerge, showing the response of individual industries to increased competition.

48. Note that there are other measures of productivity, besides the labor productivity indicators analyzed in the paper. A non-comprehensive list of studies on Brazil that use alternative measures (total factor productivity) includes: Bonelli (1975), Braga and Rossi (1988), Pinheiro (1989), Abreu and Verner (1997), Bonelli and Fonseca (1998), Gomes (2001), Muendler (2001), Pinheiro (2001) and Bacha and Bonelli (2002).

49. But it is accepted that the *quality* of employment has deteriorated, as a higher than before proportion of the labor force is presently occupied in the informal sector .

The second part of the paper concentrated on productivity gains in the manufacturing industries, the main *loci* of productivity change. In evaluating the period since the late 1940s to the present, we found that labor productivity growth rates decreased over all decades from the late 1940s to 1990. Indeed, they even became negative in 1980-1985.

After 1985, the trend of negative productivity growth rates continued: productivity decreased by – 0.7% yearly between 1985 and 1990. Actually, despite very high output growth in the mid-1980s, labor productivity growth was nearly nil and fluctuated around zero during most of the 1986-90 period. At the end of this period productivity evolved at a negative rate of almost 5% per year as a result of a failed stabilization attempt in President Collor's inauguration year, when aggregate output contracted very sharply.

There is a marked change when we move into the 1990s, when productivity growth reached very high rates. In mid 1997, labor productivity in the manufacturing sector was growing at 15% on a yearly basis. At this point, the effects of the Asian crisis hit Brazil. Productivity continued to grow at very high rates after the Asian crisis. But the overall trend from that date onward is a clearly decreasing one. Even so, the long-term (1949-2000) labor productivity average growth rate of 3.45% was only exceeded in the 1950s and in the 1990s.

But the series on which manufacturing productivity results are based have been subject to criticism on many grounds. Especially important among them is the fact that they are not based on value added, but on physical output indicators. Therefore, if an increasing amount of raw materials, parts and components is imported, instead of being domestically produced, the "physical output productivity" measure will result in a (upward) biased measure of productivity growth. The same happens when there is outsourcing to the service sector.

This is precisely what happened in Brazil in the 1990s, because of import liberalization. Unfortunately, there were no easily available long term value added (VA) and comparable employment data at the sectoral level until recently, when Brazilian National Accounts began reporting real VA per occupied person in 42 sectors of the economy. These estimates provide the basis for the last three previous parts of the paper, which offer a more complete picture of the economy in the 1990s.

Our first finding in the first of these was that labor productivity grew at 1.53% yearly between 1990 and 2000. But there was a sizeable variation of productivity growth rates in individual sectors, around the simple arithmetic average of 3.49%.

Defining as high productivity growth sectors (HPGS) all those characterized by above average productivity growth, we found that among the 17 HPGS, no less than 15 belong to manufacturing, although the leading and third sectors are non-manufacturing ones (communications and public utilities). The top four HPGS were all characterized by substantial privatization of assets in the 1990s. Thus, it seems safe to conclude that HPG and privatization were concomitant, at the very least.

There were 19 low — albeit positive — productivity growth sectors (LPGS) in the 1990s. Among them, no less than 11 belong to the manufacturing sector as well. This shows that manufacturing was almost equally distributed between high and low

productivity growth sectors. But there were two manufacturing sectors which had negative productivity growth rates in the decade, confirming the extreme heterogeneity of sectoral performance.

Negative productivity change occurred in six sectors, four of which are in services. This poses an especial problem because sizeable proportions of total occupation are concentrated in these sectors. Moreover, these sectors also have low absolute productivity levels.

An exercise to decompose total labor productivity change was performed next. It separates overall productivity gains into two factors to reflect: *a*) changes in the structure of employment; *b*) changes due to sector productivity increases. The decomposition results show that the structural effect, due to changes in the structure of employment was highly negative: all productivity gain in the 1990s came from productivity increases. This means that labor shifted primarily towards low productivity sectors and away from high productivity ones. This implies that Brazil was not able to benefit in the 1990s from a classical source of productivity growth: the relative labor shifts towards high productivity sectors.

This last point naturally leads to the issue of convergence of sector productivity levels over time: did convergence occur in Brazil in the 1990s? Although nobody would expect that productivity levels in all sectors converged to a common level, it is desirable that some convergence occurs, so that LPS progressively close the gap relatively to HPS.

We approached this issue in two different ways. First, by examining what happened between the ratios of productivity levels of selected pairs of sectors among those taken from the extremes of the distribution. It was found that productivity gaps widened over time by a ratio of approximately 2.5 times for five out of the six pairs of sectors compared.

Second, a formal test of the convergence hypothesis was performed by running a regression of productivity growth rates from 1990 to 2000 on productivity levels in the initial year (1990). If productivity levels converged, one would expect an estimated negative coefficient for the independent variable. But the regression results pointed to the opposite, actually, with some "divergence" taking place among at least a sub-group of sectors.

Next we proceeded to identify who benefited from the differentiated productivity gains in the 1990s: *a*) consumers; *b*) workers in each sector, via rising real wages; *c)* firms, via increased shares of profits in sector income. This was done in two steps: first, by analyzing each group individually; second, via a decomposition exercise to evaluate the relative importance of each in a single framework.

Consumers are the main beneficiaries of productivity increases if the gains are reflected in lower relative prices for the sector's output. A regression of relative prices on productivity growth was run to test if this was the case during the 1990s. The result was negative: there is no overall observed correlation between relative price changes and productivity growth. The relationship holds for a sub-sample of sectors, though. Thus, in general, consumers were the main beneficiaries of productivity growth in only a small number of cases.

The sectors' workers are the main beneficiaries of productivity change if their average real earnings rise faster than productivity. This hypothesis can be tested by comparing productivity change with the evolution of real wages and/or product wages. The conclusion from the comparison was that, as far as wage behavior is considered, there is no clear-cut answer to the question of who benefited from productivity growth in the 1990s.

The incumbent firms in a given sector are the main beneficiaries of productivity change if the profits to generated sector income ratio increase over time. Running a regression of productivity growth rates on profit ratios change (or their complement, the labor compensation ratios) provided a direct test for this hypothesis. The regression results show that there was no association.

A case-by-case analysis showed that, although no definitive answers could be given, in a number of cases the hypothesis that firms were the main beneficiaries of fast productivity change has proven true. There are many other sectors, however, in which this was not the case: either profits increased but productivity didn't (9 out of 20 sectors) or profits decreased but productivity increased quickly (6 out of 22 sectors).

A decomposition exercise was performed next, in trying to separate out the relative importance of three groups of agents — firms, consumers, workers — in explaining productivity change. We concluded that the benefits of productivity growth were spread over the agents in the economy, if not evenly, at least in a not too much concentrated fashion.

Finally, we analyzed the relationship between productivity change and import liberalization. The issue of productivity change and import liberalization is an important one, because the accepted view on the subject is that one of the main causes of productivity change is the import liberalization process: under the threat of increasing imports, firms are forced to react to decreased market shares by raising productivity. Only sectors producing tradables were considered in testing for the influence of trade liberalization on productivity change.

No overall association was found between productivity growth and several indicators of trade liberalization and/or import penetration ratios and their respective rates of change. To proceed, we divided the tradables producing sectors in different groups according to the degree of import penetration and its change over time. We were able to identify six groups.

The first one was characterized by little change over time in the (generally low) import coefficients. All the sectors included in this group are close to the primary economic base. Not surprisingly, import penetration ratios remained small and showed little change over time. In all these cases productivity growth was very small, with the exception of mining. In general, 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.

The second group includes sectors in which the import coefficients were low in the beginning of the decade, when import liberalization began, and increased as the

decade progressed. But this has not been enough to induce substantial upward productivity shifts.

The two next cases are one-sector groups. In the case of chemicals (except petrochemicals), it is surprising to find a high, but constant, import penetration ratio together with a reasonably high rate of productivity change. Since imports increased substantially, this means that rising imports were concomitant to rising domestic production and fast productivity growth. The result seems to reveal a healthy industrial sector, where foreign competition was met by rising labor productivity.

The next one-sector group shows an unexpectedly favorable performance: oil and gas extraction is a sector in which the share of imports in total supply decreased markedly during the 1990s, and the incumbent monopolist 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 effect to increase domestic production.

The last two groups of sectors had above average import penetration ratios at the beginning of the decade and these ratios increased markedly over time. They were the main sectors to be affected by rising imports. The first group is composed by Metals and the so-called metal-mechanic industries; the second is formed by the chemicals group of industries.

In the first of these, and except for the very heterogeneous miscellaneous and metal products sectors, the remaining sectors faced increased import competition with very fast productivity change. Therefore, they behaved as expected by the hypotheses of sector and firm reaction to increased competitive imports. In the second group the results are not as clear as for the previous one: only half the sectors behaved as expected, facing rising import competition via productivity growth.

It seems 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 sum up: the 1990s were a period of intense productivity change in Brazil, as compared to the previous decade. Productivity growth represented a sizeable proportion of aggregate output increase without sacrificing aggregate employment levels as much as believed so far. A group of manufacturing industries were the main responsible for this, aided by public utilities and communications. But many other sectors lagged behind, mostly in services, transportation and commerce. Since these are sectors that command a high share of total employment, their disappointing recent performance poses problems for economic and social policies if Brazil is to improve its overall labor productivity performance in the future.

APPENDIX
Selected Sector Indicators

Sectors	% p.a. labor productivity	% Imports on (Imports + value of prod)				% Change relative prices 2000 to 1990	Nominal tariffs (%)		Effective tariffs (%)	
		1990	1994	1997	2000		1988	1998	1988	1998
Agriculture and animal production	3.01	3.6	3.0	2.8	2.8	–9.1	17.0	9.9	14.8	9.9
Mineral extraction (non-oil)	5.28	7.0	6.9	7.3	8.8	–28.5	19.7	6.4	15.0	4.2
Extractive minerals: oil, gas, coal, fuels	4.75	96.0	78.3	64.0	27.0	38.2	5.6	0.0	–2.9	–2.2
Non metallic minerals	3.85	1.3	2.0	3.2	2.9	–19.0	39.2	13.6	46.2	15.4
Steel	9.84	1.8	2.0	2.9	3.2	8.7	29.0	10.2	36.3	14.2
Non ferrous metals	6.82	5.0	8.1	11.6	12.7	–31.6	30.6	11.7	28.0	11.9
Metal products	2.65	1.4	2.5	5.8	5.5	–28.1	45.8	18.9	59.2	24.8
Machinery and tractors	4.67	14.5	21.6	37.2	25.6	8.7	46.8	17.7	50.2	18.6
Electric equipment	8.62	9.7	16.6	23.8	29.5	–56.1	50.0	19.5	61.6	24.5
Electronic equipment	4.36	22.6	54.1	66.8	114.4	–26.0	48.6	17.4	51.2	17.9
Cars, trucks, buses	8.31	0.5	16.6	14.7	13.4	3.3	65.0	38.1	201.3	129.2
Other vehicles	6.12	9.9	14.7	24.2	33.1	–26.6	42.8	18.5	43.9	20.5
Wood and furniture	1.31	0.4	0.9	2.5	2.3	–14.7	30.3	14.0	28.9	15.1
Pulp, paper and printing & publishing	3.18	2.5	3.7	6.4	5.2	22.2	32.1	14.2	30.1	14.7
Rubber products	7.06	5.1	8.7	12.1	13.4	–22.8	49.3	14.8	58.5	16.0
Chemicals, non petrochemicals	5.23	16.5	16.5	16.4	18.4	52.5	31.4	21.1	30.9	24.2
Oil refining and petrochemicals	9.23	3.9	7.6	9.8	11.0	12.7	33.8	5.4	70.0	5.7
Miscellaneous (chemicals)	4.80	6.2	10.3	12.7	16.1	–35.3	34.7	10.9	44.9	12.5
Pharmaceuticals, soaps, parfums and related products	1.72	7.6	13.6	16.4	22.9	20.4	45.3	10.8	51.8	10.0
Plastics (transformation)	–1.03	2.3	5.0	7.8	9.8	–31.8	57.1	18.2	72.1	21.9
Textiles	1.75	2.5	8.4	13.2	11.2	–47.5	57.3	19.4	83.9	24.9
Clothing and accessories	–0.82	0.5	1.4	3.9	2.6	–36.9	76.0	22.8	94.3	26.1
Footwear and leather products	0.17	3.7	5.7	7.7	7.0	–16.8	41.0	17.2	39.8	19.4
Coffee	2.07	0.0	0.0	0.0	0.0	100.4	35.0	15.0	36.2	15.4
Other industrialized vegetals, inc. tobacco	2.39	2.6	4.1	3.9	3.2	–16.3	42.0	14.8	86.0	20.8
Prepared meats	0.34	2.6	1.2	1.5	0.9	–8.8	29.8	12.2	29.6	12.1
Milk and dairy products	1.57	3.1	4.7	4.7	5.4	2.0	40.3	23.0	41.6	24.4
Sugar refining	1.18	0.0	0.2	0.1	0.1	44.0	29.3	19.0	24.8	19.9
Oil refining for domestic use	7.61	1.0	3.5	3.2	2.4	0.8	20.5	11.5	24.1	12.0
Other food products and beverages	2.52	2.5	2.8	4.8	4.5	–1.2	51.8	17.9	98.5	24.1
Miscellaneous	1.57	7.3	16.9	27.0	25.3	–29.5	49.1	16.4	64.0	17.9

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