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Rising wages and declining employment: The Brazilian manufacturing sector in the 90s

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DISCUSSION PAPER

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RISING WAGES AND DECLINING EMPLOYMENT: THE BRAZILIAN MANUFACTURING SECTOR IN THE 90s

Marcos Chamon



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Brasília, January 2015

RISING WAGES AND DECLINING EMPLOYMENT: THE BRAZILIAN MANUFACTURING SECTOR IN THE 90S¹

Marcos Chamon²

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2. Pesquisador visitante no Ipea.

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SUMMARY

ABSTRACT

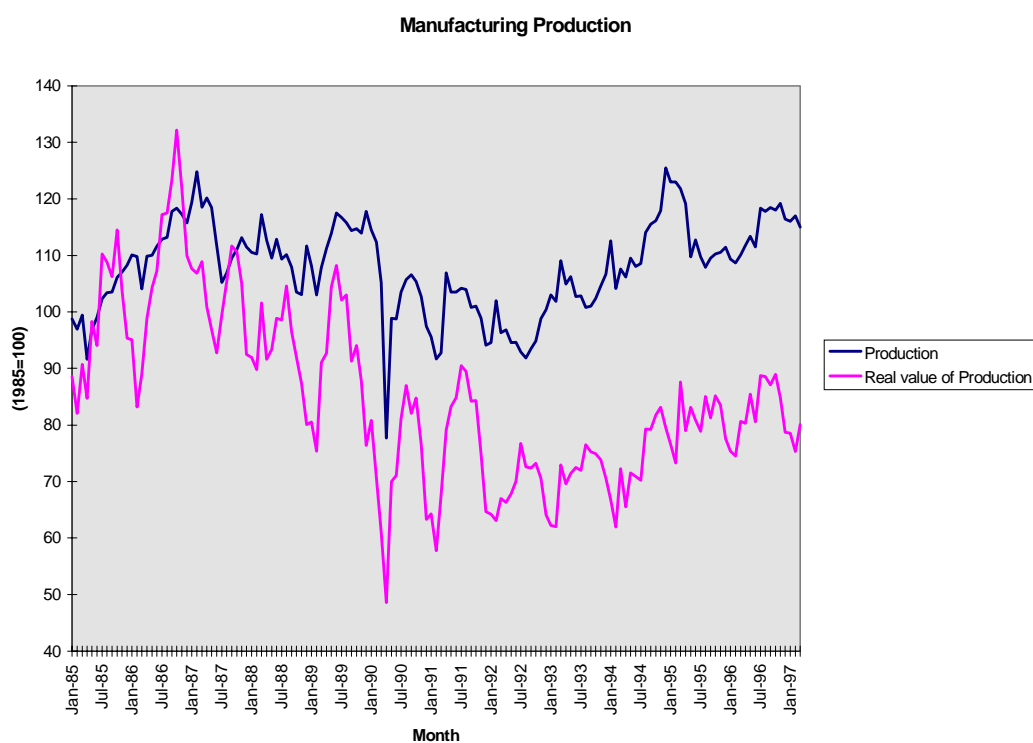
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ABSTRACT

The 90s have been quite an eventful decade in Brazilian macroeconomics. There have been recessions, recoveries, hyperinflation, trade liberalization, many failed stabilization attempts, a successful one, exchange-rate overvaluation, just to name a few. Despite all these, since the beginning of this decade there has existed a strong trend for rising wages and declining employment in the manufacturing sector, which is somewhat surprising since historically employment and wages have moved together. The very same period is marked by an astonishing productivity growth in manufacturing that can do much to explain how employment and wages behaved the way they did. This paper explores this productivity issue, making some conjectures as to its origins and how it can shed light into this problem. This paper will also address the issue of substitution of labor by capital, and to which extent it can account for the decline in manufacturing employment. While data availability prevents us from obtaining a good estimate of the substitution between labor and capital, it is still possible to obtain rough measures of the cross-price elasticity of labor and capital. With those estimates and data on relative input price changes it is possible to assess the role of factor substitution in the observed decline in employment.

1 - INTRODUCTION

Brazil's industrialization effort began during the 1930s. It can be considered as one of the most successful experiences of the now discredited Import Substitution Industrialization strategy. For most of the time the Brazilian manufacturing sector was able to sustain very high growth rates, often exceeding the overall GDP growth. From the mid 60s throughout the 70s Brazil was among the fastest growing countries in the world, with its booming industry playing a key role in the so called "Brazilian miracle". However, things started to change in the 1980s. A series of adverse shocks such as the second oil price rise, rising world interest rates, and decreasing world demand for primary exports made it clear that the country could no longer rely on external financing. The government's failure to adopt an austere fiscal policy combined with a fully indexed system propitiated an environment for inflation to soar. The external situation was deteriorating rapidly and by the end of 1982 the debt service on medium and long-term obligations reached 97% of export earnings. This adverse international scenario hurt the manufacturing sector through the rise in the price of oil and other inputs, and through a decrease in foreign demand for exports. But what hurt the sector the most were the effects of the crisis on domestic demand. By 1983 the manufacturing production had fallen more than 15% since 1980. From 1984 to 1987, the economy entered a period of recovery, reinforced in 1986 (the year of the Cruzado plan) mostly due to the domestic demand. It seemed that the manufacturing sector had resumed a growing path, but beginning in 1987 production started to fall again due to a decline in domestic demand. In 1989 the manufacturing sector did have a positive growth mostly due to real wage increases and a surge in speculative demand. Inflation was soaring, and would go over 2000% in 1990. Unlike the previous stabilization plans which were expansive, the contraction character of the two Collor plans (1990 and 1991) led the economy into a recession from which it would only start recovering in 1993, when domestic demand started to increase again. Manufacturing output kept growing under the relative stability brought by the Real in July 1994, which led to a boom in consumption. However, the fear of inflationary pressures, the growing deficits in the current account and the exchange-rate issue, which gained special attention after the Mexican crisis, led the government to adopt contractive policies. These measures had the desired effect on domestic demand, causing a sharp fall in manufacturing output in the first half of 1995. As the plot below shows, after all those years manufacturing production remained about the same level. As for its real value, it is even lower than it was ten years ago. That can be attributed to the fall in the real price of manufacturing goods, especially as the trade liberalization process gained momentum.



Source: IBGE PIM-DG and PIM-PF.

2 - TRADE LIBERALIZATION

In addition to the macroeconomic chaos, the manufacturing sector also had to deal with a trade liberalization agenda implemented in 1990. The tariff structures, import barriers and the process of opening of the Brazilian economy is summarized in Hay (1997). The Ad valorem tariff structure introduced in 1957 changed little prior to 1988. The great majority of these tariffs came to exceed the implicit tariff (the difference between the world and the domestic prices), and were thus redundant. By 1988 while the actual tariff for the whole of manufacturing was 56% the implicit was only 16%! But in practice these tariffs became irrelevant because of the several non-tariff barriers created. Among them was Anexo C, a list of items that could not be imported and covered about 55% of industrial products. Non-tariff barriers also affected imports of capital goods, since fiscal subsidies and credit were linked to the domestic content of an investment. In 1988 there was a modest attempt of reform which did not produce significant results due to strong opposition of interest groups. Among its goals was to set tariffs at the differential of world and domestic prices. However Kume (1989) shows that tariff redundancy was still widespread.

An effective trade liberalization program started in 1990. It eliminated Anexo C, the list of products whose importation was prohibited, although tariffs for these products were raised. The program introduced a four-year schedule that would bring all tariffs under 40%, with a modal value of 20%. This schedule was completed in three years, with the last step in July 1993. According to Hay, by

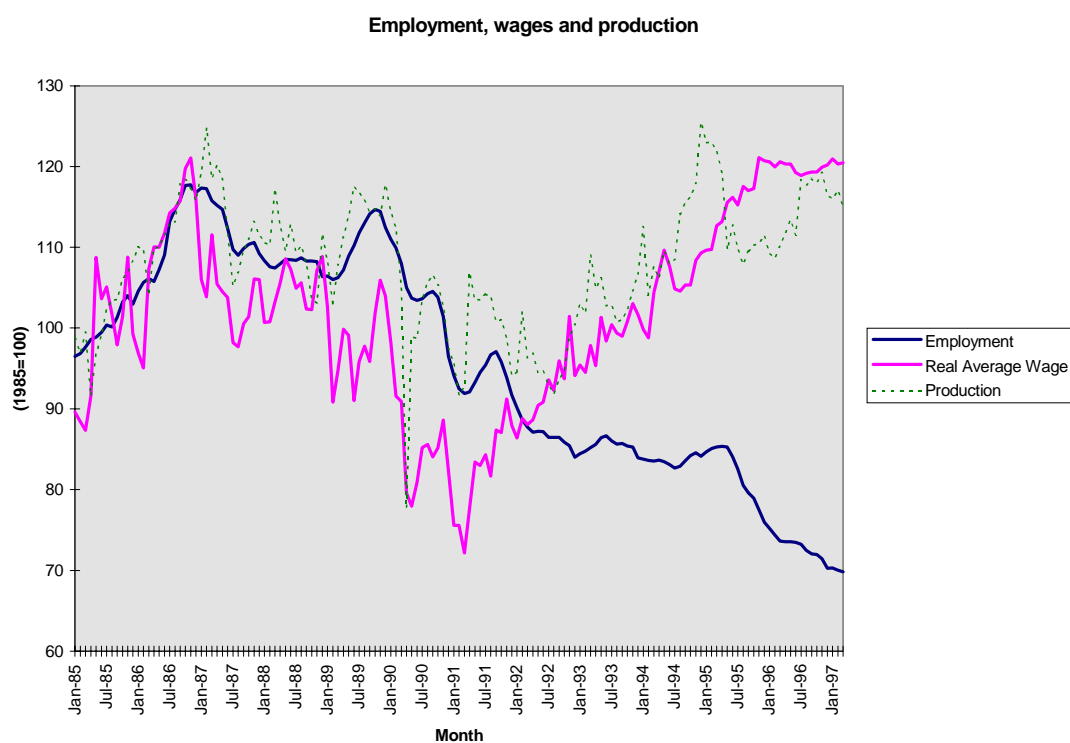
international standards the tariff reductions were neither radical nor rapid, but together with the removal of the apparatus of non-tariff barriers, they were sufficient to signal a complete change of direction and to shock the manufacturing sector into taking defensive action. How the manufacturing sector reacted to this action is an important topic of this paper, and is covered in later sections. The liberalizing measures of the Real plan and the Mercosul trade agreement contributed to the deepening of the opening process even though there were a few setbacks, especially as the current account deficit became an issue that could no longer be ignored.

3 - EMPLOYMENT AND WAGES IN MANUFACTURING: A PUZZLE

Historically employment and wages in the manufacturing industry moved together, following a path similar to that of production. However starting in 1991 this pattern was broken. Wages began to rise in a very clearly defined trend, while employment kept falling. A strong decrease in employment occurred during 1990/91. Then it remained stable from 1992 until 1995 when it started falling again. After the economic recovery beginning in 1993, manufacturing production started an upward trend similar to that of wages. From the beginning of the decade until the end of 1996 employment had decreased by 37%, while the real average wage increased by 22%.

The picture does not look very different when separate industries are observed. The Monthly Industrial Survey-PIM also has data broken down by 20 different industries of the manufacturing sector. As a general rule, production peaked either in the 1986/87 period or in 1989. As for employment, it also did fairly well during the 1986/89 period, but the tendency has been to fall ever since, sometimes despite significant increases in the output. For all twenty sectors the real wages started to go up after 1991. That suggests that whatever caused this scenario of increasing wages and declining employment must be an economy-wide effect, not one limited to specific industries.

Formal employment as a whole has also been declining. This means that most of the workers who lost their jobs could not find new ones in the formal sector, and were forced to join the informal economy. While 57% of the labor force consisted of registered workers in 1990, by 1995 that number had dropped to 48%, with the rest of the labor force either non-registered or self-employed (IBGE/PME). That explains why the unemployment has been kept at a low level, with only small increases, despite these sharp reductions in formal employment. In 1995 the unemployment rate for the manufacturing sector was only 5.76%, which is certainly low by international standards.



Source: IBGE PIM-DG and PIM-PF.

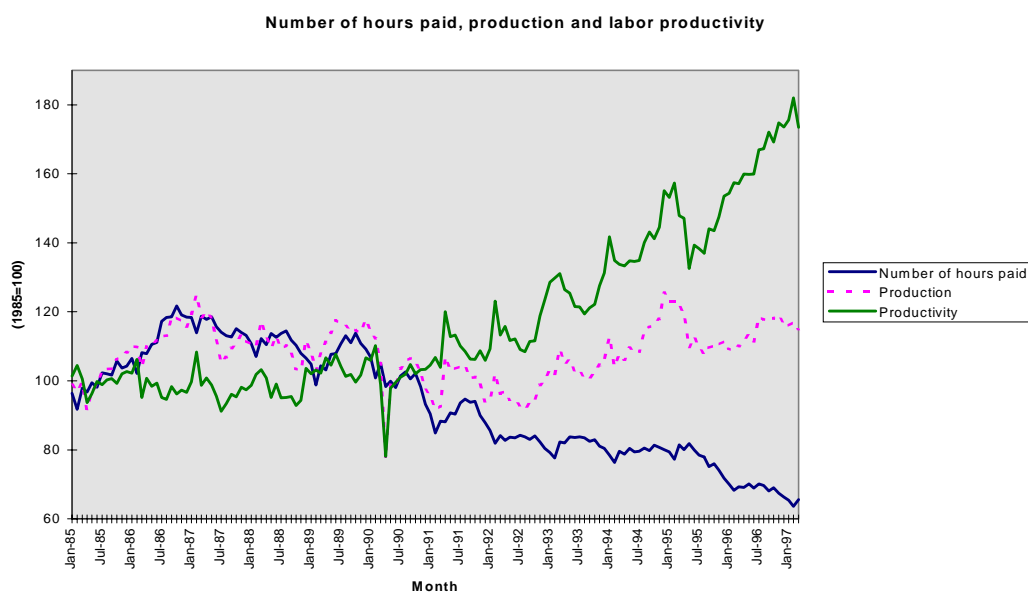
4 - PRODUCTIVITY

Productivity is the usual suspect for rising wages and declining employment. With higher productivity fewer workers are able to produce a higher output of manufactured goods. If the demand for these goods does not increase enough to accommodate for this, employment in that sector will inevitably decline. Meanwhile wages go up due to the increase in the product of labor. This explanation becomes very appealing considering the astonishing productivity growth that the manufacturing sector has been exhibiting. After a decade of stagnation, in 1990 labor productivity in the Brazilian manufacturing industry (measured as output divided by the number of hours paid)¹ began to show very high growth rates. Labor productivity was growing at an average rate of 8.5% per year during the 1990/96 period. It grew both under recessive and expansive scenarios. Up to 1992 output was falling, but employment was falling even faster. This caused productivity to rise. From 1993 on, output grew while employment either remained stable or decreased, again causing productivity to rise. The contractive policies in response to the consumption boom following the stabilization caused manufacturing output to fall. However, employment did not adjust as quickly. As a consequence there was a sharp decrease in productivity during the first half of 1995. However after mid-1995, employment started to fall. From July 1995 to the end of 1996 employment fell by almost 20%. Meanwhile

¹ Ideally we would use value added instead of output, however there is no data available for the first and we are forced to use the latter as a proxy.

output was recovering and productivity was growing at a rate faster than the one before.

These productivity gains were present throughout the whole of manufacturing. Bonelli (1996) calculated the average productivity growth rate for seven different industries (metallurgy, mechanical, electrical equipment, transport equipment, chemicals, textiles and foodstuffs) for the 1990/95 period. All sectors exhibited rates close to the manufacturing average of 7.35% (an outlier was electrical equipment which grew at an average rate of 11.83%)!



Source: IBGE PIM-DG and PIM-PF.

No consensus has been reached regarding the causes of such gains in productivity. Both Bonelli (1996) and Hay (1997) present a very thorough summary of concurring explanations. One of the first studies was Silva *et alii* (1993), where it was argued that the productivity increase observed during 1990/92 could best be explained by the recessive adjustment. They argued that there could be no significant changes in the production technology since there was very little investment during that period, that there was no clear evidence of changes in management techniques, and that the decrease in employment was due only to the recession. Moreover they predicted employment to recover after the recession, which would cause productivity to slow down. That was certainly not the case. After the economy began to recover, employment kept falling (although at a much slower rate), while productivity was still rising. Feijó and Carvalho (1994) argued that the opening of the economy stimulated firms to undergo a managerial revolution, and to acquire modern equipment. In support they point to the boom on imports of machines and equipment, which increased by a factor of three during this period. Considera (1995) suggested that some of the gains in productivity might have come from a **natural selection** process. Firms in which productivity was low were the most likely to close down and as a result the

average productivity of the remaining firms became higher. Considera also warned to the issues of subcontracting, and to the fact that some of the intermediate production may have been imported or produced by firms outside the PIM sample. He also considered the possibility of the PIM generating biased results since it is based on a same sample of industries since 1980. Finally Amadeo and Gonzaga (1996) attributed the gains in productivity and decline in employment to three forms of reaction towards foreign competition: The first is the diffusion of new managerial techniques with the optimization of logistic process and introduction of labor saving technologies. The second is the increasing tendency towards subcontracting. Although the PIM data refers to all workers **related to production** whether or not they are registered employees of the firm, the omission of activities indirectly related to production such as security, cleaning and maintenance could still have generated some bias. The third is the increasing penetration of imported intermediate goods as a consequence of trade opening and exchange rate appreciation, which further increases the gap between production and value-added, upward biasing the productivity estimates. Furthermore that could account for the decline in employment that is generally attributed to subcontracting and to the adoption of labor saving technologies.

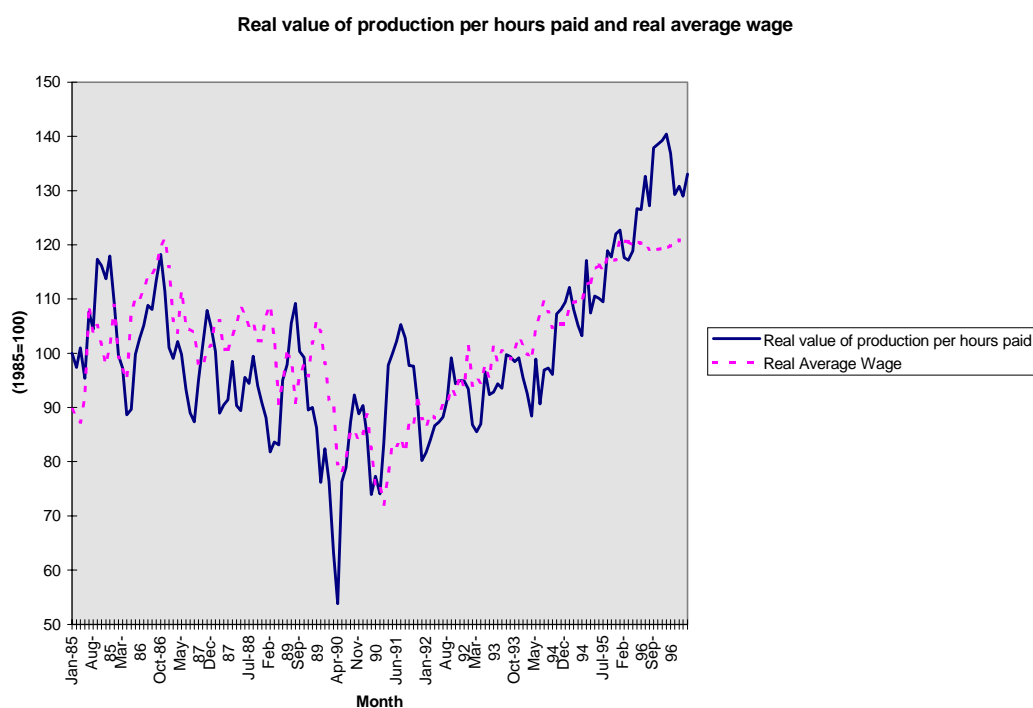
Measuring productivity as the ratio of output and hours paid does not help much in understanding where those gains came from. To what extent did the adoption of new management techniques and modern technologies translate into TFP (Total Factor Productivity)? How big a role did the trade opening process play? Hay (1997) is the first study that attempts to establish the relative importance of trade liberalization, recession and recovery on productivity, using pooled data from the 1986-1994 period.² His empirical model used a Cobb-Douglas technology, and also included year dummies and variables for protection (he used the log of the effective protection rates calculated by Kume) and the real exchange rate. By assuming the year dummies to capture TFP he obtained an increase of more than 55% from the low of 1990 to the high of 1994, but warned for the empirical difficulties of distinguishing in this value the effects of the economic cycle and of protection/real exchange rates. From his results, the effect of the decrease in protection on TFP had on average a magnitude of 11%.

5 - PRODUCTIVITY AND WAGES

Such astonishing labor productivity gains can account for much of the rise in wages in the manufacturing sector. With accumulated gains in labor productivity since the beginning of the decade exceeding 60%, one should expect wages to rise even on a very imperfect and segmented labor market such as the one in Brazil. It is likely the case that the productivity estimates are upward biased due to problems such as subcontracting and increasing import penetration of intermediate goods. But even if the actual number turned out to be half the estimated one, it would still be an impressive figure and capable of explaining much of the increase in wages.

² His data source was the IBGE-PIA (Annual Industrial Survey) whose data after 1994 is yet unavailable

When addressing this issue of rising wages we should pay attention not only to labor productivity, which is production per hours paid, but also to the value of production per hours paid. The former should be more closely related to the wages since it is a proxy for the value of the product of labor. The plot below shows the evolution of real wages and real value of production divided by the number of hours paid. It reveals an extremely strong link between the two, suggesting that labor was given its share of the gains, and that this increase in the value of labor production provides a fairly satisfactory answer for the increases in wages.



Source: IBGE PIM-DG.

The real wage has risen across all sectors since the beginning of the decade, just like labor productivity. Table 1 shows the ratio of the average wage in 1996 to that of 1990 for the main industries. These are the same industries Bonelli (1996) used to show the productivity gains were felt throughout the whole of manufacturing, and account for over 70% of the Brazilian manufacturing output. The figures are relatively close to each other. The differences may be attributed to issues related to labor market segmentation, skills, and import penetration.

While productivity seems to provide a satisfactory explanation for the increase in wages we should take other issues into account when trying to explain why employment behaved the way it did. Among other issues perhaps the most important one is the extent to which factor substitution has occurred.

Table 1

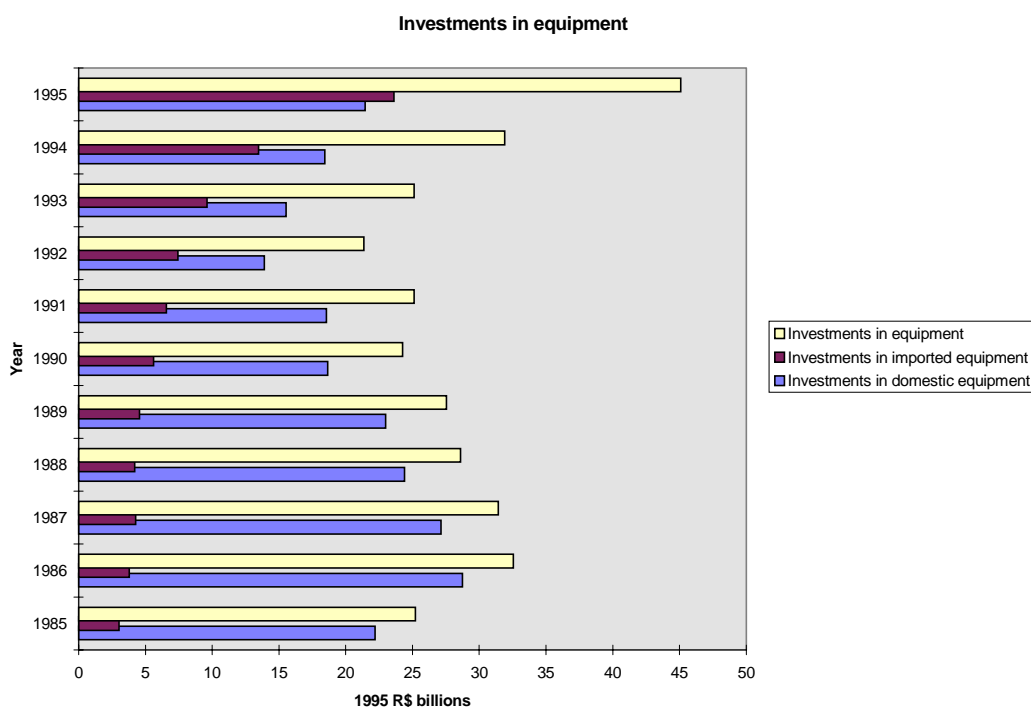
Ratio of 1996 to 1990 Real Average Wages for the Main Manufacturing Industries

Industry	Ratio
Textiles	1.31
Metallurgy	1.33
Chemicals	1.39
Mechanical	1.39
Foodstuffs	1.39
Electrical equipment	1.39
Transport equipment	1.46

Source: IBGE PIM-DG.

6 - FIRM BEHAVIOR, INVESTMENTS, AND THE FAILURE OF EMPLOYMENT TO RECOVER

Perhaps the most striking aspect of these productivity gains as well as of our puzzle of declining employment and raising wages is that they occurred both under recession and expansion of the economy. It is hard to believe that the forces driving these phenomena were the same at both times. Despite limited data on firm behavior and investments, it may be possible to construct some conjectures.



Source: IBGE/DECNA.

Most of the jobs were lost during the 1990/91 period, when manufacturing employment decreased by almost 20%, while production fell by less than 2.5%. Afterwards the employment level remained fairly stable up to mid-1995 when it started to fall again. Thus firms were being able to produce roughly the same output with much smaller labor input. Considering the low level of investment during that period, there must have been a huge increase in TFP as Hay's calculations suggest. Of course we are ignoring the issues of subcontracting and imports of intermediate goods, which can surely water down a lot of these gains. But in the absence of a better explanation we are forced to accept the diffusion of modern managerial techniques as the cause. Indeed buzzwords such as total quality, strategic planning, and things of the sort came to enjoy great popularity among Brazilian managers. Perhaps the greatest problem with this explanation is the fact that the productivity has been rising for the past seven years! One should expect a sharp increase in productivity as a consequence of the introduction of these new management techniques, but not a persisting one. If they were so amazingly efficient, firms would be quick in adopting them. After a couple of years they would have reached the great majority of manufacturing, and productivity gains associated to these techniques would slow down. Thus it is extremely likely that other factors came into play after the early 1990s.

As the economy started to recover in 1993, investments were on the rise. It is particularly interesting to note the boom in acquisitions of foreign equipment, especially after 1994. Part of this boom may be due to the overvalued Real, which made importing a more attractive option than before. Investments in imported equipment tripled from 1992 to 1995. This increase in imports of capital goods

continues to date. Note that despite this boom in imports, the domestic production of capital goods during this period also has increased. It is likely that this increase in investments was the main factor responsible for the continuity of the rise in labor productivity. These productivity gains were large enough to prevent the employment from rising even though output was growing throughout this period, pushed by the rise in domestic demand. The data on Table 2 shows that most of the investment was made to replace equipment and to reduce costs. Only a relatively small portion was used in the creation or expansion of plants. Thus this was predominantly a capital deepening investment, with firms substituting capital for labor.

Table 2

What Were the Predominating Types of Investments?

(%, Multiple answers were allowed)

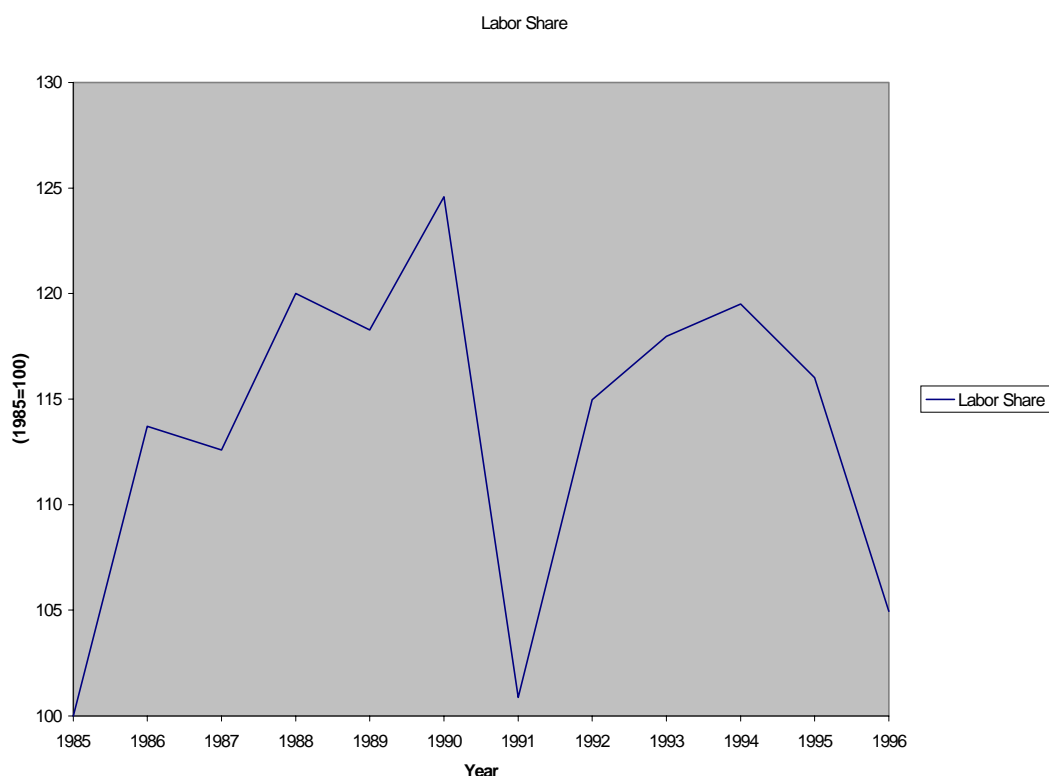
Investment type	1992/94	1995/96
Replacement of equipment	57.3	55.2
Desobstruct bottlenecks	30.2	43.4
Reduce costs	52.2	61.9
Expand plants	33.3	41.7
New plants	11.4	20.4
New products	27.1	39.2

Source: CNI/CEPAL.

It is possible that the strong institutional build up in favor of labor brought by the 1988 Constitution played an important role in this capital deepening process. Caballero and Hammour (1997) present a model in which attempts of labor to appropriate quasi-rents from capital lead to a substitution away from labor in the long run. Due to technological embodiment capital is more exposed to appropriability in the short run. However, an attempt at appropriating capital would cause firms to prefer capital intensive technologies, substituting away from labor in the long run. While their paper focused primarily on European countries it is possible to apply some of the lessons in the Brazilian context. It is likely that the labor benefits introduced in the 1988 Constitution appropriated capital, and that part of the capital deepening process that has occurred during this decade is a response to that appropriation. Caballero and Hammour pointed to the fact that opening to trade facilitates specialization, and therefore potential factor substitution. Moreover, it is now easier than ever to import machinery and new production technologies. While developed countries had to develop their own capital intensive technologies, a country like Brazil faces a large set of already available technologies and opportunities for capital deepening. Thus trade liberalization made it much easier for firms to undergo this capital deepening process, and react to whatever appropriations they had suffered in the past. Also

trade liberalization itself may have eliminated several labor rents associated with the protection of inefficient industries.

The plot below shows the evolution of the labor share, obtained by dividing the product of employment and average real wages by the real value of the manufacturing production.³ The labor share does start to rise beginning in 1988. However it is likely that much of this rise was due to the recession. Wages and employment adjust much slower than output, which causes the labor share to rise in the initial stages of a recession. But eventually the effects of the recession took their toll on the labor share, which fell sharply in 1991. The labor share was recovering until 1994, but then started falling again. This period after 1994 is when capital deepening investments, especially in imported equipment, were intensified. However we should pay attention to the fact that we are using the value of production as opposed to value added when calculating the labor share. That becomes a serious issue especially when considering the rise in the imports of intermediate goods, which decreases the relation between production and value added. Moreover these figures do not take into account non-wage benefits, which increased substantially after the 1988 Constitution. Therefore our labor share estimates are probably downward biased, which severely weakens any evidence they can provide.



³ Again, ideally we would be using value added instead of production.

The Table 3 below shows the yearly average of the labor share for the main manufacturing industries. The data do not seem to reveal any industry type (capital or labor intensive) pattern. That is probably due to the bias in our labor share estimate, which becomes an even more serious issue when comparing estimates across industries, since the amount of intermediate goods used varies from industry to industry.

Table 3
Labor Share for the Main Manufacturing Industries (1985=100).

Industry	1990	1991	1992	1993	1994	1995	1996
Electrical equipment	101.44	70.44	81.20	76.87	67.02	55.98	48.13
Textiles	119.07	83.94	82.12	80.31	90.04	93.74	76.66
Mechanical	102.06	85.59	92.99	98.09	84.48	74.78	70.69
Transport equipment	115.11	102.45	121.25	107.10	112.75	118.68	103.09
Chemicals	116.58	99.40	115.15	121.86	116.83	117.77	108.02
Metallurgy	87.32	69.23	86.49	87.62	89.00	95.44	92.35
Foodstuffs	100.25	95.48	107.22	106.72	116.69	118.05	116.42
All industries	123.37	99.89	113.86	116.83	118.35	114.89	103.93

7 - SUBSTITUTION BETWEEN LABOR AND CAPITAL

Capital deepening investments may have played a major role in preventing industrial employment to recover. In order to properly address this issue it is necessary to have an estimate of the elasticity of substitution between labor and capital for the Brazilian manufacturing industry. This is a great empirical challenge since data on the capital stock of manufacturing firms is extremely limited. However there are some production functions for which we can estimate the price elasticity of labor with respect to capital without using the value of the capital stock, but instead the price of capital.

Consider a Generalized Leontieff (GL) cost function with n inputs and constant returns to scale technology:⁴

$$C = Y \cdot \left[\sum_{i=1}^n \sum_{j=1}^n d_{ij} (P_i P_j)^{1/2} \right]$$

where $d_{ij} = d_{ji}$. The input price P_i and the output Y are assumed to be exogenous but the input quantity X_i and the total cost C are assumed to be endogenous. This is a flexible cost function which is a desirable property since one should expect the elasticity of substitution between inputs to be changing, especially during the 1990s because of trade liberalization. The cost minimizing demand for input i can be obtained by employing Shephard's Lemma:

⁴ This follows closely Berndt (1990 section 9.2).

$$\frac{\partial C}{\partial P_i} = X_i = Y \cdot \left[\sum_{j=1}^n d_{ij} (P_i P_j)^{1/2} \right] , \quad i = 1, \dots, n$$

Let a_i denote the optimal input-output demand:

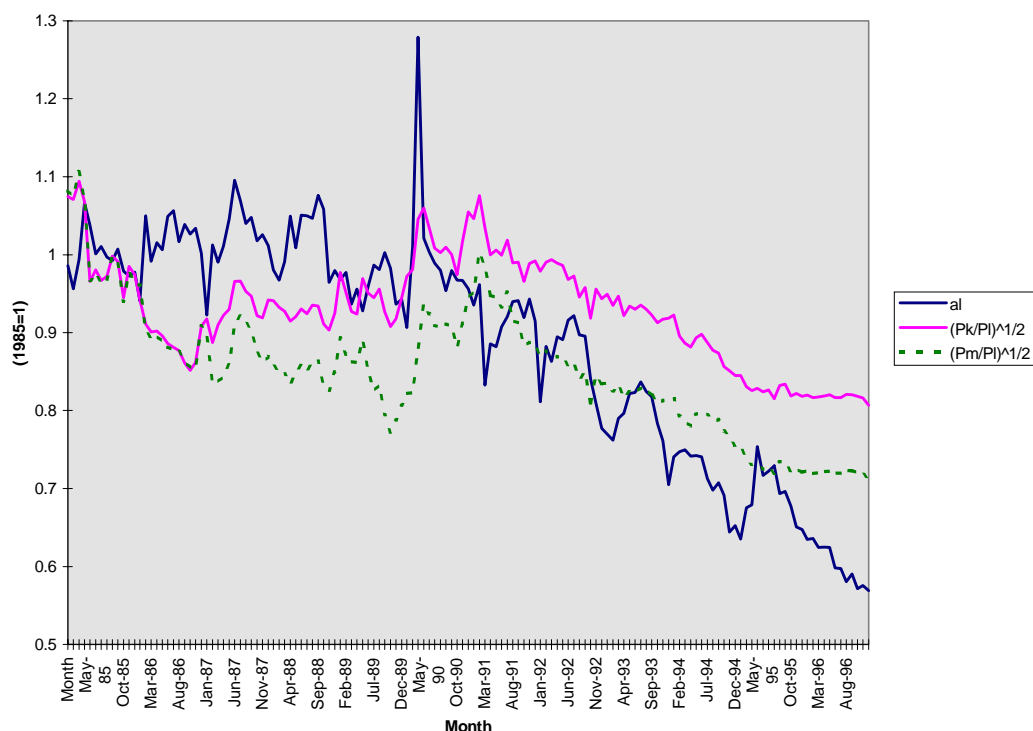
$$a_i \equiv \frac{X_i}{Y} = \sum_{j=1}^n d_{ij} \left(\frac{P_j}{P_i} \right)^{1/2} , \quad i = 1, \dots, n$$

Consider the case in which there are three inputs: capital (K), labor (L) and intermediate goods (M). The appropriate measure of Y will be total output, not value added, since M was included. That is a very desirable feature of this model since as discussed previously there is no data available for value added, only for total output. In this three input model the cost-minimizing input-output equations will be:

$$\begin{aligned} a_K &\equiv \frac{K}{Y} = d_{KK} + d_{KL} (P_L / P_K)^{1/2} + d_{KM} (P_M / P_K)^{1/2} \\ a_L &\equiv \frac{L}{Y} = d_{LL} + d_{KL} (P_K / P_L)^{1/2} + d_{LM} (P_M / P_L)^{1/2} \\ a_M &\equiv \frac{M}{Y} = d_{MM} + d_{KM} (P_K / P_M)^{1/2} + d_{LM} (P_L / P_M)^{1/2} \end{aligned}$$

While each equation has three parameters, the three cross-equation symmetry constraints reduce the number of free parameters from nine to six. Ideally we would employ the SUR estimator. Unfortunately as mentioned before there is no data for the capital stock.⁵ The equation for labor can still be estimated individually. However single equation estimation will not be able to force the cross-equation symmetry constraints. Even if we ignored these constraints, the SUR estimator would still yield more efficient estimates than single equation estimation. But in the absence of any other options, single equation estimation for the demand for labor is our best alternative. We will be using the number of hours paid from the PIM-DG as L , the index of industrial production from the PIM-PF as Y , the WPI for equipment and machinery as P_K , the WPI for raw materials as P_M and the real average wage index from the PIM-DG as P_L . The frequency is monthly.

⁵ The IBGE-PIA has annual data on the capital stock, but data after 1994 is yet unavailable. It is possible to construct monthly values as well as figures for the missing years with the PIA data available and data on investments. However the quality of these estimates would be very poor and it would probably do us more harms than good!



Source: IBGE PIM-DG and IGP.

The plot above shows the evolution of our three variables. Note the huge spike in the plot of a_L around March 1990. That can be attributed to the sharp decline in industrial output following the inauguration of President Collor. To account for that shock we added a dummy variable named **Collor** whose value equals one for March and April 1990 and zero at any other time. Besides that spike, a_L is relatively stable during the 1985-1990 period. After that there is a clear downward trend. The relative price variables follow paths similar to each other. The correlation between them is 0.87! Thus we should expect high standard errors for our regression coefficients.

In addition to those, a variable named **time** was included in order to capture effects that would change the demand for labor even if the relative price of all inputs remained constant. This variable can be considered among other things as a very rough approximation for TFP effects. We also did a Koyck lingering effects transformation by adding a lagged dependent variable to the regression. That way the regression coefficients give us their respective variable immediate effect on labor demand. As for the long-run effect it can be obtained by dividing this coefficient by one minus the coefficient of the lagged dependent variable. Results are summarized in Table 4:

Table 4
Summary of Regression Results

a_L	(1) OLS	(2) Cochrane-Orcutt *	(3) OLS
d_{LL}	0.861 (0.075)	0.813 (0.120)	0.381 (0.092)
d_{KL}	1.451 (0.147)	1.387 (0.251)	0.695 (0.163)
d_{LM}	-1.230 (0.160)	-1.107 (0.268)	-0.566 (0.164)
Time	-0.004 (0.0002)	-0.004 (0.0003)	-0.002 (0.0003)
Collor	0.103 (0.037)	0.145 (0.030)	0.044 (0.032)
$a_L(t-1)$	0.527 (0.072)
R-squared	0.900	0.711	0.927
DW-stat	0.695	2.15	**

* Statistics refer to the r-transformed variables.

** The DW statistic cannot be used in models with lagged endogenous variables. Instead we used a Durbin h statistic which did not reject the null hypothesis of no serial correlation.

As expected labor and capital are substitutes, while labor and intermediate goods are complements. Also the coefficients in Regression 2 are indeed very close to their respective coefficients in Regression 3 divided by one minus the coefficient of the lagged variable (which gives the long-run effect). It is not possible to obtain the elasticity of substitution from those coefficients and the data available. However it is possible to obtain the cross-price elasticities:

$$\varepsilon_{LK} = \frac{1}{2} \cdot \frac{d_{LK} (P_K / P_L)^{1/2}}{a_L}, \quad \varepsilon_{LM} = \frac{1}{2} \cdot \frac{d_{LM} (P_M / P_L)^{1/2}}{a_L},$$

$$\varepsilon_{LL} = -\left(\frac{1}{2} \cdot d_{KL} \cdot (P_K / P_L)^{1/2} - \frac{1}{2} \cdot d_{LM} \cdot (P_M / P_L)^{1/2} \right) / a_L$$

Table 5
The Average Cross-Price Elasticity (based on Regression 2):

Year	ϵ_{LL}	ϵ_{LK}	ϵ_{LM}
1985-1989	-0.159	0.650	-0.491
1990	-0.201	0.700	-0.490
1991	-0.203	0.767	-0.563
1992	-0.229	0.768	-0.539
1993	-0.241	0.811	-0.570
1994	-0.250	0.857	-0.607
1995	-0.249	0.835	-0.587
1996	-0.280	0.937	-0.653

All three elasticities had their magnitudes increased since the beginning of this decade. However the increase in the magnitudes of ϵ_{LL} and ϵ_{LK} were stronger than the one in ϵ_{LM} (especially ϵ_{LK}). That combined with the increase in wages and the decrease in the price of machines and equipment can account for much of the decrease in the demand for labor. With our results we can estimate how changes in the relative price of each input affected a_L . We can also determine the effect of our **time** variable:

Table 6
Changes in a_L *

Period	Total change in a_L	Change in a_L due to changes in P_K/P_L	Change in a_L due to changes in P_M/P_L	Change in a_L due to the time tren.	Residual
1985-1990	0.000	-0.007	0.138	-0.240	-0.085**
1991-1993	-0.122	-0.094	0.127	-0.096	-0.058
1993-1996	-0.188	-0.123	0.114	-0.144	-0.035
1991-1996	-0.310	-0.271	0.241	-0.240	-0.040

*Based on the coefficients from Regression 2.

Taking into account the dummy **Collor.

While the change in the a_L averages from 1985 to 1990 was insignificant, there was a strong decrease from 1991 to 1996. From Table 6 it is clear that the main responsible for this difference were changes in the relative price of capital and labor. As mentioned previously the price of capital goods has been declining, to a great extent due to the trade liberalization. In the same period wages were rising, which led to a major shift in the relative price of capital and labor, giving firms incentives to substitute capital for labor. However, there is not much difference in the strength with which the relative price of capital affected a_L during the recessive (1991/93) and the expansive periods (1993/96). That is rather surprising, and serves to remind us that all this model is doing is to capture the effect of changes in the relative price of inputs on a_L . The decrease in the relative price of

capital and labor has been an ongoing process since the beginning of the trade liberalization (although it seems to stop in 1996), and that's why it has a similar strength during both recessive and expansive periods. But the difference is that during the recession, output was stagnant and thus employment was falling, while during the expansive period output growth was strong enough to allow employment to remain stable up to mid-1995 despite the continuing fall in a_L . After mid-1995 employment starts falling again because of the strong contractive policies implemented that year. It is interesting to note the strong negative effect of the time trend term. In our model even if all factor prices had remained the same throughout the 1991/96 period, a_L would have decreased by 24%. That would mean an average gain in labor productivity of 4.7% per year. This figure may include gains in TFP as well as time effects that did not directly affect input prices (which may be associated to events such as increasing foreign competition, trends in the labor market, the business cycle, among others). But we should be careful since our residuals were pretty significant.

This model has its flaws but the suggestive evidence it provides points in the direction of substitution of labor by capital as the main responsible for the decrease in employment. Moreover it is possible that these new capital intensive technologies require more skilled labor. That way, the unskilled labor that was laid off would be forced to leave the manufacturing sector. This segmentation would prevent these laid off workers from pulling the manufacturing wages down, and since labor productivity was rising, manufacturing wages would rise despite the decline in employment.

The model also points to an extremely strong tendency of the labor and output ratio to fall with time. That way it is necessary a constant increase in output only to prevent labor from decreasing. What that means is not clear. Part of it may be capturing the introduction of new production techniques that require less labor. Part of it may also be generated by the diffusion of subcontracting. Thus an important part of our question remains unanswered.

8 - CONCLUSION

There has been an enormous increase in labor productivity since the beginning of this decade, and it seems that wages were given their fair share of these gains despite a very imperfect and segmented labor market. There are a series of issues that could cause the productivity estimates to be upward biased. But the figures are so impressive that even if the actual values turned out to be half the estimated ones they would still be a significant result, and capable of explaining much of our puzzle. No one is really sure of where these labor productivity gains came from. However as far as explaining wage growth is concerned we can take these gains as given, and their origin does not matter much.

When addressing the issue of employment, the origin of the productivity gains becomes important. A distinction must be made between the periods of recession and expansion. From 1990 to 1992 there was a huge decrease in employment with

very little impact on production. The diffusion of modern management techniques stimulated by the opening of the economy was proposed as one of the causes of the gains in productivity that allowed production to remain stable while employment was decreasing at a very fast pace. In the absence of any better explanations we can consider that the adoption of these techniques propitiated TFP gains which were able to keep the output level constant despite the decline in employment. One would expect employment to recover once the economy entered a period of expansion, with a rising domestic demand causing an increase in manufacturing output. That was not the case. Output grew but labor productivity was growing even faster than before, preventing the employment from recovering. Much of the new investments were on capital intensive technologies with relatively little being spent on the creation or expansion of plants. These capital deepening investments and the increase in imports of intermediate goods are likely the main factors responsible for employment not recovering despite the strong output growth. Moreover these capital-intensive investments propitiate an environment in which the distinction between skilled and unskilled labor gains greater importance. That may have allowed skilled workers to extract greater rents for their higher labor productivity, which may be an important effect driving wages up. This labor market segmentation between skilled and unskilled workers introduced by these new capital intensive technologies could also help explaining the wage behavior in the sector. If the new technologies require skilled labor, the unskilled workers who became unemployed will not drive manufacturing wages down. Without this downward pressure, wages will rise because of the higher labor productivity due to the new technologies, despite the decrease in employment.

While the evidence presented supports the conjectures made, they are by no means conclusive, and much work is yet to be done in order to fully explain the problem. Recently, wage growth seems to have slowed down and hopefully employment will be able to stabilize itself. However, it will only recover from the huge losses suffered if a very strong manufacturing output growth persists, and with a greater investment in the expansion and creation of new plants.

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