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Fábio Veras
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The Impact of Trade Liberalisation on the Informal sector in Brazil*

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Abstract

We assess whether or not the trade liberalisation process in Brazil had any effect on both the reduction in the wage differential between registered and non-registered (roughly formal and informal) workers and the fall in the proportion of registered workers. We discuss the channels through which trade liberalisation could affect these two variables and put forward three empirical approaches to test the existence of any correlation between them. Our results suggest that the fall in the wage gap between registered and non-registered workers was affected by trade-related variables, particularly, by the import penetration ratio. However, we do not find robust evidence that trade liberalisation had a substantial effect on the fall in the proportion of registered workers.

JEL codes: F16, J31, 017.

Keywords: Trade Liberalisation, Wage differential, Informal Sector, Developing Countries.

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1 Introduction

A common feature of several middle-income developing countries in the late 1980's and early 1990's was the undertaking of several structural reforms, particularly trade liberalisation measures. Many recent studies have tried to assess the impact of these reforms on the labour market of these countries. Basically, researchers have looked for evidences of any of the Hecksher-Ohlin/Stolper-Samuelson (HOS) framework's implications in developing country labour markets[1]. More specifically, they have looked for evidence that trade liberalisation has triggered the following sequence of events: 1) increases in the relative price of unskilled intensive products/firms/industries; 2) a positive effect of these price increases on the demand for unskilled workers; 3) a reduction in the wage premium of skilled workers, leading to lower wage inequality in these countries[2], and finally 4) an increase in the share of skilled workers in all sectors due to the increase in the relative price of unskilled workers. Besides this interest on the distributional consequences of trade liberalisation based on the HOS framework, researchers have also tried to measure the impact of trade liberalisation on employment and on the wage structure as a way to assess the importance of rent-sharing in the protected sectors[3].

Despite these numerous studies on the impact of trade liberalisation on developing country labour markets, several questions remain to be explored. In particular, as pointed out by Behrman (1999), the impact of trade liberalisation on the "informal" manufacturing sector and the existence of possible spillover effects on the rest of the economy have been overlooked[4]. This is important because if dual labour markets are important in developing countries, then to overlook the implications of trade liberalisation for the wage differential between "formal" and "informal" workers and on their mobility pattern[5] may yield an incomplete description of its impact on the entire labour market.

The aim of this paper is to start filling this gap on the empirical literature using the Brazilian trade liberalisation experience as a quasi-natural experiment. We assess whether trade liberalisation can be considered a serious candidate to explain both the fall in the wage differential between registered (formal) and non-registered (informal) workers, and the fall in the proportion of registered workers in the economy. The episode of trade

[1]Most of these studies have been motivated by the attempt to find the "reverse picture" of the effects of trade liberalisation on developed countries. A large literature has argued that globalisation or the increase in trade flows between developed and developing countries throughout the 1980's and 1990's can explain at least part of the increase in wage inequality in developed countries (See Wood (1997)). If this were the case, then one should also observe a lower inequality in developing countries as a result of the increase in trade flows.

[2]See for example Robbins and Gindling (1999) for Costa Rica, Robbins and Gindling (2001) for Costa Rica and Chile, Hanson and Harrison (1999) for Mexico, Beyer et al. (1999) for Chile, Green et al. (2001) and Gonzaga et al. (2002a) for Brazil.

[3]See for example Curie and Harrison (1997) for Morocco, Revenga (1997) for Mexico, Marquez and Pages (1997) for a panel of Latin American and Caribbean countries, Menezes-Filho and Arbache (2002) and Arbache and Corseuil (2003) for Brazil.

[4]Goldberg and Pavcnik (2003) is the first paper to the best of our knowledge to focus on this issue. They find that in Colombia trade liberalisation seems to have led to an increase in the manufacturing informal sector, but in Brazil there was no impact. They attribute such differences to the fact that the Brazilian labour market is more flexible (in terms of regulation) than the Colombian.

[5]Maloney (1997) associates some changes in the mobility pattern among Mexican workers, particularly the increase in the proportion of "contract" workers with the trade liberalisation in that country.

liberalisation in Brazil is particularly interesting for this task because it implied a huge fall in tariff and non-tariff barriers and it occurred during a short period of time, basically within 3 years. Besides, the schedule of tariff reduction announced in 1990 was brought forward several times, making a strong case for the exogeneity of the trade reforms[6].

The structure of the paper is as follows. First we will describe the evolution of the manufacturing sector during the 1980's and 1990's. Second, we will discuss the literature on the impact of the trade liberalisation on the labour market of developing countries, and the channels through which trade liberalisation could affect both the wage differential between registered and non-registered workers and the proportion of registered workers. Third, we will describe the main features of the trade liberalisation reform in Brazil. Fourth, we will put forward different procedures to identify whether or not trade liberalisation had any impact on the fall in the wage differential between registered and non-registered workers and on the increase of the proportion of non-registered workers. These procedures are based on: 1) exploiting industry variation of trade-related measures such as effective tariffs, import penetration and export orientation ratios for a panel of 17 tradable manufacturing industries; 2) exploiting regional variation of industry dispersion within the country, so that we will be able to test the impact, if any, of trade liberalisation on the entire labour market and not only in the manufacturing sector (spillover effect); 3) adding the non-tradable sector and cohort variation to the analysis. This latter approach allows us to use additional variation in industry-cohort cells in order to assess the impact of trade liberalisation on the tradable sector when compared to the non-tradable sector.

Our results suggest that trade liberalisation had a statistically significant impact on the reduction of the wage differential between registered and non-registered workers in the manufacturing sector. However, we do not not find evidence of spillover to entire economy. As for the impact on the proportion of registered workers, the results are not very robust, and in our opinion, it is not possible to make a strong case for the link between trade liberalisation and this phenomenon.

2 Registered and Non-registered Workers in the Manufacturing Sector in Brazil

The proportion of non-registered workers increased –at least, for non-farming activities – and the wage differential between the two groups diminished during the 1990's. As non-registered workers are less likely to be found in the manufacturing sector, one could associate the fall in the proportion of registered workers with the reduction in the number of workers in the manufacturing sector[7]. A lower proportion of "manufacturing jobs" would lead to a higher proportion of non-registered jobs in the whole economy. However, Figure 1 shows that the decrease in the proportion of registered workers was also observed in the manufacturing sector. From 86% in 1981, it was down to 77% in 1999.

As for the wage differential between registered and non-registered workers in the manu-

[6]Some commentators of the Brazilian trade liberalisation point out that the reform was launched much more as an auxiliary tool in the combat against the hyper-inflationary process witnessed by the Brazilian economy in the early 1990's. See Muendler (2001) and Kume et al. (2000).

[7]The number of workers employed in the manufacturing sector peaked in 1989.

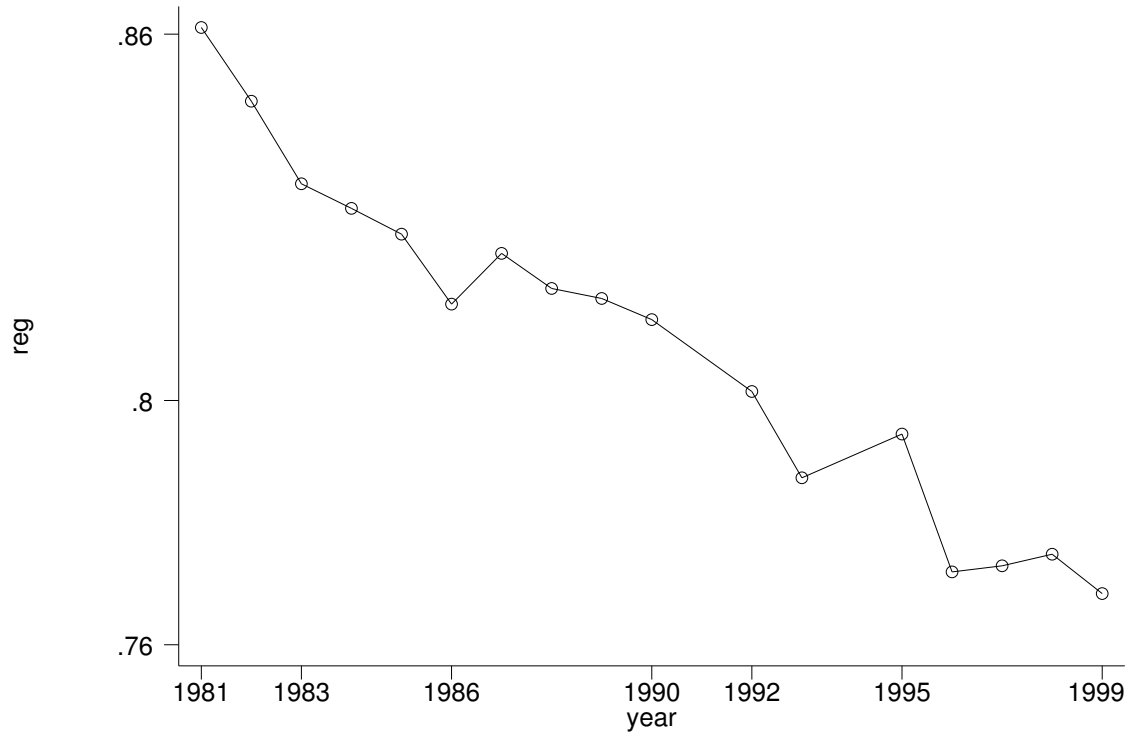

Figure 1: Proportion of Registered Workers in the Manufacturing Sector - 1981 - 1999

facturing sector[8], Figure 2 shows that it followed very closely the wage differential between registered and non-registered workers in the entire economy. There were minor differences in the intensity of the movements, but their directions were basically the same. The wage differential between registered and non-registered in the manufacturing sector that had peaked at 86% in 1992 was down to 44% in 1999.

These figures reveal sharp movements in the time series of both the wage differential between registered and non-registered workers and the proportion of registered workers in the entire economy and in the manufacturing sector, in particular. Our aim is to establish whether the coincidence between the reduction in the wage differential between registered and non-registered workers and the fall in the proportion of registered workers and the end of the trade reforms was a mere coincidence or was really linked to the trade liberalisation measures. In the next section, we discuss the impact of trade liberalisation in developing countries labour market, and how it might have affected the wage differential between registered and non-registered workers in Brazil and the proportion of informal sector workers.

[8]The wage differential is calculated as $100 * [exp(b) - 1]$, where b is the coefficient of a dummy coefficient for registered workers in a standard semi-log wage equation, controlling for education (6 categories), experience, experience squared, gender, region, and metropolitan area.

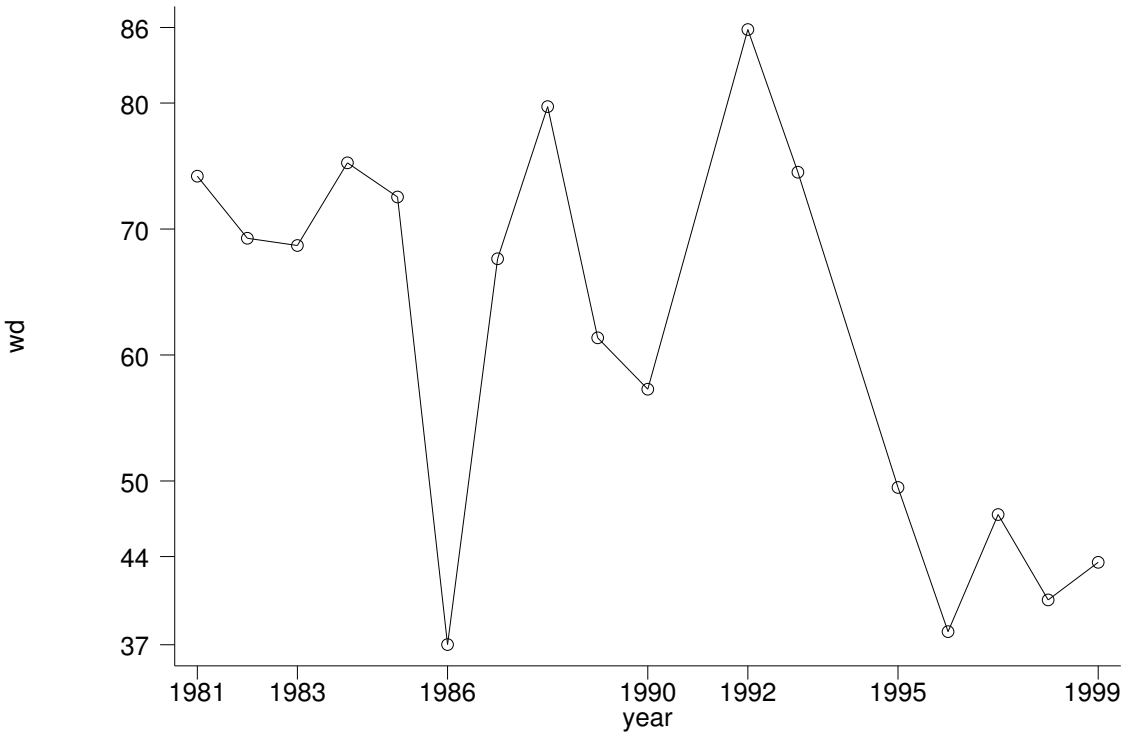

Figure 2: Wage Differential between Registered and Non-registered Workers in the Manufacturing Sector (in %) - 1981 - 1999

3 Trade Liberalisation and Labour market

3.1 A Brief Overview of the Literature on the Impact of Trade Liberalisation on Developing Country Labour Markets.

Researchers have looked for evidence of any of the Hecksher-Ohlin/Stolper-Samuelson (HOS) framework's implications. More specifically, they have looked for evidences that trade liberalisation has triggered the following sequence of events: 1) increases in the relative price of less-skill intensive products, firms or industries; 2) a positive effect of these price increases on the demand for unskilled workers; 3) a reduction in the wage premium of skilled workers, leading to a lower wage inequality in these countries, and 4) an increase in the share of skilled workers in all industries. Such chain of causation relies on the hypothesis that developing countries have a higher endowment of unskilled workers, leading to comparative advantages in the production of goods intensive in this factor. The Hecksher-Ohlin theorem states that a country will tend to export goods that are relatively intensive in the abundant factor. The Stolper-Samuelson theorem shows that changes in the output price have a more than proportional effect on the return of the relatively abundant factor in the industry where the shock occurred. The combination of these two theorems yields the above prediction that trade policy changes that lead to a higher relative price of unskilled-intensive goods should bring about an increase in the

relative wage of unskilled workers[9].

Assuming the special case where the functional form of the production functions for all sectors and for the aggregate utility function is Cobb-Douglas, the proportional change in the relative wage rate between skilled workers (s) and unskilled workers (u) in an open economy can be expressed as:

$$\left(\frac{\hat{W_s}}{W_u}\right) = \frac{1}{\beta_1 - \beta_2}\left(\frac{\hat{P_1}\hat{A_1}}{P_2 A_2}\right) \tag{1}$$

where β_1 and β_2 are the proportion of skilled workers in the skilled-intensive sector and in the unskilled-intensive sector, respectively; A_1 and A_2 are technology parameters in these same sectors, and P_1 and P_2 the respective product prices. Since $\beta_1 > \beta_2$ changes in prices and/or technology have a more than proportional effect on changes in the relative wage, an increase in P_2, the price of the product in the unskilled-intensive sector, should lead to a more than proportional fall in the relative wage of the skilled workers.

However the above result only holds if we assume that: 1) the economy is small so that it cannot affect the international price of the product, which is assumed to be exogenous, 2) the economy is inside the cone of diversification, meaning that tradable goods intensive in both factors, skilled and unskilled labour, are produced in that economy; 3) there is no product differentiation, i.e., foreign and domestic goods are perfect substitutes; and 4) there are no mobility barriers for workers to respond to wage changes. A corollary of this theory is that changes in the supply of different factors do not alter their relative prices (as changes in the relative price do). Changes in the factor endowment of a country would increase the production in the industries intensive in the factor, without altering its relative price (Johnson and Stafford, 1999).

So far the empirical literature on the developing countries has found at best mixed results regarding HOS predictions. For the Mexican experience in the mid-1980s, Hanson and Harrison (1999) show that the reduction in tariff protection disproportionately affected low-skilled industries, contrary to what one would expect for a developing country. However, they argue that such a result does not come as a surprise, since the Mexican import substitution strategy had extended trade protection preferentially to industries that made relatively intensive use of unskilled labour. The relative higher protection of industries in which the countries would, in principle, have comparative advantage was also noticed by Currie and Harrison (1997) for the Moroccan manufacturing sector. Goldberg and Pavcnik (2003) also found that the structure of tariff protection benefited more the industries with a higher share of unskilled workers in Colombia and in Brazil[10]. These studies highlight the necessity to understand the previous structure of protection before assuming that any trade liberalisation reform would trigger a reduction in wage inequality, as measured by the relative wage between skilled and unskilled workers. If the protected sectors were the ones in which the country already had comparative advantage, then the openness measures could lead to a fall in their product prices and then trigger an increase

[9]Due to this sort of reasoning trade liberalisation has been prescribed as a policy that not only would increase economic efficiency, but also would deliver less inequality in developing and unskilled labour abundant countries.

[10]Gonzaga et al. (2003) found exactly the opposite result for Brazil. The reason for this difference, however, is not very clear.

in the relative demand for the scarce factor (skilled workers).

Behrman et al. (2001) do not find evidence that trade liberalization has any overall widening effect on wage differentials for a panel of 18 Latin American countries - including Brazil - for the period 1977 to 1998. Robbins (1996) also fails to find any relationship between trade liberalisation and wage inequality for Colombia. Gindling and Robbins (2001) find evidences consistent with a positive correlation between trade liberalisation and higher returns to education in Chile. Galiani and Sanguinetti (2001) find that manufacturing sectors where the import penetration increased the most, wage inequality also widened relatively more in favour of the most skilled workers in Argentina. However, they point out that the effect is quantitatively too small to explain the increase in the inequality in that country in the nineties. Pavcnik et al. (2002) show that the increase in the return of the college-educated workers coincide with the trade liberalisation in Brazil. They do not find any relationship between trade related measures and the increase in wage premium in sectors more affected by the reform, but they do find that the sector specific skill premium did rise for skilled workers. Green et al. (2001) also stress the coincidence between trade liberalisation in Brazil and the increase in the relative wage of college-educated workers, but fail to find any casual relationship. Unlike Pavcnik et al. (2002), however, they do find that the wage premium increased in sectors more affected by the trade reform[11]. Dickerson et al. (2001) using a pseudo panel approach find that the returns to education for college-educated workers fell after the trade liberalisation in Brazil, but do not find any correlation between trade measures and the return to education for college workers[12]. Gonzaga et al (2003) argue that the wage differential between skilled and non-skilled workers fell after trade liberalisation in Brazil and that the mechanism of transmission of this fall through tariff to prices and prices to wages is in line with HOS predictions[13].

The lack of strong evidence for HOS implications in developing countries has been rationalised via three hypotheses. The first is related to the perception that developing countries with higher proportion of semi-skilled workers may have been suffering strong competition from countries with a higher proportion of unskilled workers (Wood, 1997 and Hanson and Harrison, 1999). This halfway position of some industrialised developing countries, mainly in Latin America, would prevent HOS framework from working[14].

The second hypothesis assumes that trade may have caused a higher contact with leading-edge technology. In order to install this newly available technology, firms might

[11]In another paper Arbache and Corseuil (2003) find the opposite result using a fixed-effect model with time dummies. The result in Green et al. (2001) is based on the spearman correlation of long changes of the two variables.

[12]Note that this result is at odds with Green et al. (2001). This is so due to the fact that the pseudo-cohort approach adopted by Dickerson et al. (2001) points to an overestimation of the returns to education yielded by the OLS method employed in Green et al. (2001).

[13]Notice that unlike Pavcnik et al. (2002) they argue that tariffs fell more in the most skill-intensive sectors, so that their analysis could follow the HOS mechanism.

[14]Davis (1996) argues that a possible explanation for this phenomenon is the fact that what is relevant to an economy is its relative skilled/unskilled labour supply within its cone of diversification. A country regarded as abundant in unskilled labour globally, may be in fact relatively skill abundant inside its relevant cone of diversification. In this case, trade liberalisation may have the effect of increasing inequality if the country starts suffering a stronger competition from relatively unskilled abundant countries within its cone of diversification.

have demanded more skilled workers to operate them and to adapt the production process to this more efficient technology. Such reasoning is advocated by the *skill-enhancing trade hypothesis* due to capital-skill complementarity (Robbins, 1996b)[15] and by the *learning-by-trade hypothesis* (Pissarides, 1997). According to the latter, even if the technology is not skilled biased, in the short run the acquisition and incorporation of the technology would imply in a higher demand for skilled workers[16] The diffusion of more efficient technologies in developing countries would lead to an increase in A_1 in equation (1) and then to an increase in the relative wage of skilled workers[17].

The third hypothesis argues that empirical studies fail to find any HOS trade related impact on income distribution because of global/pervasive skill biased technological change (Berman and Machin, 2000). In this case, no correlation between trade measures and the increase in the premium of skilled workers would be observed, since this would be an economy-wide phenomenon.

A second point that has been emphasized in the literature is the role of trade liberalisation in changing institutional features of industrial relations and then indirectly affecting the wage and employment structure (mainly in the manufacturing sector) of countries that have undertaken trade reforms. The main hypothesis has to do with the loss of union power triggered by trade reforms. Both the fall of trade barriers and tariff reductions increase the price elasticity of product demand, hence reducing rents that sustained the union wage premium.

Nickell (1999) points out that the relationship between wages and factors that reflect market power, such as market share, the number of a firm's competitors, reductions in tariff barriers, deregulation or the price of competing imports, have been used to assess the hypothesis that product market power affects wages.

We will briefly report some results of empirical studies on the impact of trade reforms on relative wages. Driffil et al. (1998) show that when non-tariff barriers were reduced in Britain, the wages in the relevant establishments fell significantly. Revenga (1992) observes a similar effect associated with falls in import prices in the US. Lang (1998) argues that the small effect of trade liberalization in New Zealand on the composition of employment suggests that the effect of tariffs on wages and firms' monopoly power, reducing both of them, eliminated any effect on the distribution of employment. Borjas and Ramey (1995) show that the impact of international trade on relative wages (skilled/unskilled wages) depends on the market structure of the industry affected. They argue that many

[15]According to this view, sectors under pressure to increase their productivity due to an increase in foreign competition would invest in technology that would lead to a higher demand for skilled labor. Evidence that sectors most affected by the trade liberalisation were the ones that experienced an increase in their wage premium or where the wage premium of skilled workers increased most would be in line with this argument.

[16]This argument is also found in the theory of technological cycles, where the development and introduction of new technologies would generate a rise in the demand for skilled workers, but as the technology becomes standard and all workers learn how to work with it, the shock fades away. See Goldin and Katz (1998).

[17]Such explanation is in line with the simultaneous rise in inequality in both developed and developing countries. However, in order to observe all these effects it is necessary that the industry where the transference of technology occurred is still operating in the developed countries, so that the fall in prices (P_1) does not compensate for the increase in A_1. See Johnson and Stafford (1999) section 4.8 for a brief discussion of these models.

of durable good industries in the US in the 1980's that employed a disproportionate share of less educated workers were highly concentrated, earned significant rents, and shared those rents with their workers by paying them higher-than-average wages. Their empirical evidence shows that employment changes in a small group of trade-impacted concentrated industries can explain not only part of the aggregate rise in wage inequality in the US, but also some of the differences in trends in wage inequality across metropolitan areas. Somewhat against those findings, Johnson and Stafford (1999) in their review of the impact of trade on labour market institutions argued that despite the theoretical negative relationship between increased international competition and "monopoly rents" enjoyed by the firms protected in the past, there is no strong evidence of a negative effect of increased trade on unionism either in the US or in the UK.

The findings on the impact of trade-related variables on wages and on employment for developing countries also tend to place this sort of rent-sharing argument as a possible explanation for decreases in the average wage, at least, in the manufacturing sector. Arbache (1999) argues that the marked-oriented reforms in Brazil, and particularly trade liberalisation, led to a higher demand for skilled workers that ended up increasing union power. This happened because unlike developed countries, the unionized workers are relatively more educated in Brazil than non-unionized workers. Revenga (1997) finds evidences that the (negative) impact of trade liberalisation on wages in Mexico was higher than the (negative) effect on employment. She argues that this fact may be explained by the prevalence of rent-sharing schemes in the period previous to trade liberalisation. Such schemes would have allowed unions and firms to agree in cutting "excessive wages" rather than adjusting the employment margin after the reforms. Similarly, Currie and Harrison (1997) analysing the Moroccan trade liberalisation argue that in an imperfect competitive framework where some rents were captured by workers in the form of higher wages, firms could also respond to their rent loss by cutting wages and substituting temporary workers for permanent ones. Menezes-Filho and Arbache (2002) show evidences of rent-sharing for unionized workers in the manufacturing sector in Brazil. However, they also find that the increase in quasi-rents brought about by trade liberalization was not shared with unionized workers[18]

3.2 Trade Liberalisation and Segmented Labour Market.

The impact of trade liberalisation on the informal sector is less understood and less documented. Behrman (1999) points out that most studies have focused on the impact of trade liberalisation on the formal manufacturing sector, but less is known about its effect on the informal sector, both in the manufacturing sector[19] and in the entire labour market. In this section, we will highlight possible effects of trade liberalisation on segmentation – in terms of the registered *versus* non-registered classification - in Brazil.

The first thing to notice about the relationship between trade liberalisation and the relative wage of registered and non-registered workers is that such a classification is an institutional feature and not a skill-based classification. Unlike the classifications by edu-

[18]Note that the effect of trade liberalisation on rents or quasi-rents is not consensual. It can decrease rents because it increases competition, or it can increase them because it forces an increase in productivity. Thus, the overall effect depends on which of these two effects will be dominant.

[19]To the best of our knowledge the only paper to address this issue is Goldberg and Pavcnik (2003).

cational attainment; occupational categories; production and non-production workers as traditionally used in the literature and that are based on productivity related features; the classification between registered and non-registered workers parallels the classifications between union/non-union workers and/or temporary/permanent workers, which are much more related to institutional features of the labour market. Nevertheless, given the lower level of schooling of non-registered workers[20], it does not seem implausible to assume that the production function of the industries may be approximately depicted as having registered and non-registered workers as two inputs instead of the traditional division between skilled and unskilled workers. This argument can be made stronger if we assume that it is the employer's decision that determines the *institutional* status of the worker and employers will choose workers that, given their productivity, minimise their production costs. Thus assuming that the employers know better than the researcher the productivity of the workers, the employees *institutional status* may well be determined by their productivity[21].

In this context, equation (1) might give us the prediction of the impact of price changes (ΔP_i) or technological changes (ΔA_i) on the relative wage of registered/non-registered workers. Assuming that both factors are used in the tradable industries, and that there is at least one industry where the registered status is prevalent, and another where the non-registered status is prevalent, an increase in the price of non-registered prevalent industry good would lower the wage differential between registered and non-registered workers. The problem with this reasoning, as already mentioned above, is that in contrast with the other common classifications, the non-registered status is not necessarily production-related. Factors such as lower school attainment do not necessarily mean that non-registered status may be directly linked to lower observed or non-observed skills. However, it is possible that on average what happens with the wage of unskilled workers is reflected on non-registered workers[22].

The presence of a non-tradable sector where non-registered status is prevalent would not affect such analysis, i.e., the world prices of good 1 and 2 would still determine the relative wage as in equation (1). However, the presence of a non-tradable sector with such characteristic would make the cone of diversification of that country thinner, and more likely that a fall in the relative price of the "non-registered" prevalent good would lead that industry to close down so that non-registered workers would be employed only in the non-tradable sector (Johnson and Stafford, 1999). In this case, equation (1) would no longer represent the skilled/unskilled (or registered/non-registered) wage rate. The relative wage would be determined as in the case of a closed economy:

[20]This difference is persistent in the data and the difference in means is statistically significant at conventional levels.

[21]In Soares (2004) we tested the hypothesis of a job queue for formal jobs. The employers decision of hiring a worker as registered was modelled as well as the employee's decision of joining the queue. The hypothesis of the non-existence of a job queue for registered jobs was strongly rejected.

[22]In fact, the literature using Brazilian data has failed to find strong evidence of lowering wage inequality or a fall in the wage premium of skilled workers after trade liberalisation. See for instance Green et al (2001) and Dickerson et al. (2001). The only empirical paper that claims such effect is Gongaza et al. (2002). See last subsection.

$$\left(\frac{\hat{W_s}}{W_u}\right) = \frac{\beta_4}{1-\beta_4}\left(\frac{U_4}{S_4}\right) \tag{2}$$

where the subscript 4 stands for the non-tradable sector 4, which is "non-registered" prevalent and unskilled intensive.

It is clear from (2) that regardless of the changes in prices in the tradable sector, the relative wage would be unaffected. In this context, one should not expect to find any effect of trade-related variables on the relative wage of skilled/unskilled workers or registered/non-registered workers. Midway situations between the result of the closed model represented by equation (2) and the open model in equation (1) arise if one assumes that a) domestic and foreign goods are not perfectly substitutes and b) labour types cannot move in response to wage changes (Johnson and Stafford, 1999).

In fact, some commentators have used the tradable *versus* non-tradable approach to explain the dichotomy between formal *versus* informal sector in Brazil[23]. The idea behind this correspondence is that the earnings of workers in the informal (non-tradable sector) is determined by supply and demand in that sector, whereas the earnings of workers in the formal sector is determined by the external demand for the export goods. The demand for the national manufactured product would be lower after the trade reform due to the access to cheaper products, whereas the non-tradable sector would be protected from that competition. The difficulty in such argument is how to justify the lack of mobility between workers from the formal to the informal sector. It could be argued that the informal sector would act as a cushion for workers displaced from the tradable sector, leading to a downward pressure on wages in that sector. Therefore, it is not clear how trade liberalisation would affect the wage of the employees in the tradable sector, but would not affect the wage of the employees in the non-tradable sector[24].

This sort of argument would be more justifiable in a context of imperfect competition where one would focus on the effect of trade reforms on institutional features of developing country labour markets. In this framework, trade reform would squeeze rents that would have been captured by protected firms and shared with their employees. As seen above, if the protected firms were the ones abundant in the scarce factor (skilled labour) then one should expect under HOS assumptions that the reduction or elimination of trade barriers would reallocate resources to the now more competitive firms based on the abundant factor and hence increase the demand for unskilled labour. However, as many papers have shown this is not necessarily the case, and the protected sector may have been in fact the one that had a higher proportion of the abundant factor. Alternatively, if the protected sector cannot be characterised as perfectly competitive, then there is space for some sort of rent sharing. Therefore, workers in most affected industries would experience a reduction in their bargaining power –and so in their wages - since the ground for rent sharing would be reduced. Assuming that the most protected sectors are the ones with a higher proportion of registered workers, or where registered workers profit more from

[23]See Barros et al. (1998) for an informal explanation of the argument.

[24]Generally, it is argued that the participation of non-registered workers in the manufacturing sector is so small that it can be considered as a specific factor of the non-tradable sector. However, as seen in the last section, despite the higher proportion of registered workers in the manufacturing (tradable) sector, its proportion has fallen over time.

rents thanks to the market power of their firms, one should observe a reduction in the wage premium for registered workers after the reforms.

In Brazil registered workers are more likely to be unionized and to work in large firms, which are more likely to have market power and therefore to have some loss due to trade liberalisation. Therefore, it would be reasonable to assume that the degree of segmentation, as measured by the wage premium for registered workers, is positively correlated with trade protection measures[25]. The process of trade liberalisation should hence curb the wage differential between registered and non-registered workers. Besides this direct effect, skilled workers displaced from registered jobs may have joined the pool of non-registered workers, increasing their average skill level and contributing to the reduction in the wage differential due to changes in the composition of the two groups[26] However, it is also important to consider that the effect of trade liberalisation on productivity[27] may, on the other hand, lead to higher wages for the workers who managed to keep their jobs and also to an expansion of registered jobs. This process could lead both to a higher proportion of registered workers and a larger wage gap between the two groups. Therefore, the impact of the trade liberalisation on the wage gap is mainly an empirical question.

So far we have focused on wage differential, but as mentioned above, trade liberalisation can also affect the allocation of different type of workers between and within industries. In particular, Brazilian firms may have reacted to the trade liberalisation shock not only by substituting non-registered workers for registered workers, but also sub-contracting part of the tasks that they could have performed earlier in an attempt to reduce costs[28]. The reallocation of part of the production to smaller firms may have led to a higher participation of the non-registered workers in the pool of manufacturing employee. Similarly, the reduction in absolute terms of the number of jobs in the manufacturing sector due to adjustments in the size and composition of its workforce may have led to an increase in the proportion of non-registered workers in the entire economy.

Most of these channels are hard to assess since there is no available and compatible data on "informal firms" in Brazil that would allow one to compare its performance over the recent period with the performance of medium to large firms[29]. Nevertheless, data

[25]See the discussion about the correlation of wage premium and trade-related measures in the next section.

[26]Barros et al. (1998) using the Oaxaca-Blinder decomposition show that composition effect (change in the attributes) was responsible for 25% of the reduction in the wage differential and conclude that the increase in the return of non-registered workers productive characteristics, possibly due to a positive demand shock, was the main factor responsible for the reduction in the wage gap.

[27]Muendler (2001) using an unbalanced panel of medium and large manufacturing firms in Brazil estimates the impact of nominal tariff and market penetration on total factor productivity at firm-level. He instruments nominal tariff and market penetration with inflation rate and real exchange rate and finds that lowering tariff by 10% leads to an increase of almost 0.3% in productivity, while a 10% point increase in market penetration leads to another 1.3% increase in productivity. It is also worth noting that the changes in the probability of transition between categories of activity was, according to Muendler's decomposition exercise, responsible for 50% of the increase in productivity observed in the period. Hay (1999) and Rossi Junior and Ferreira (1999) also find a positive relationship between manufacturing productivity and trade liberalisation in Brazil.

[28]Maloney (1997) shows a sharp increase in the number of workers who earn by piece, the so-called contract workers, after the trade liberalisation in Mexico.

[29]Most of the available data on firms such as value-added, payroll payment, working hours are data collect from medium and large firms.

from the Brazilian annual household survey (PNAD) shows that the proportion of non-registered workers increased in the manufacturing sector from 15% to 24% from 1981 to 1999, which is a clear indication of a possible lower degree of compliance within the manufacturing sector. Furthermore the proportion of workers in small firms (up to ten employees) increased from 40% to 50% in the entire economy and from 15% to 23% in the manufacturing sector during the same period. These changes may have two causes: a) more firms decided to contract workers illegally; b) the balance on the birth and death of firms favoured smaller firms that are more likely to employ non-registered workers. Somewhat supporting this latter hypothesis, Muendler (2001), based on an unbalanced panel of medium to large size manufacturing firms, finds that in the period 1992-1998, the probability of transition from active status to extinct (shut down), and from suspended to extinct had increased considerably in comparison to the period 1986-1990. This evidence lends some support to the argument that there was a clean up effect among medium to large firms after trade liberalisation that may have led to a reduction in the proportion of registered workers. In the next section we will describe the main characteristics of the trade liberalisation process.

4 Some Features of the Trade Liberalisation Process in Brazil

The process of trade liberalisation in Brazil started in 1988, but only gained pace after 1990. The structure of protection of the national production was very complex. Besides high tariffs, it included several non-tariff barriers along with special regimes that exempted some sectors of paying standard import tax. One of the most important restrictions was the "law of national similar" which forbade the import of any product that had an equivalent/similar produced in Brazil (Moreira and Correia, 1998). There were also import quotas for firms and the need to get permission one-year in advance to import.

According to Kume et al. (2000) the trade liberalisation process in Brazil can be divided in three phases. The first period between 1988-1989 consisted in scrapping redundancies in tariffs, i.e., in cutting the excessive and unnecessary level of tariffs that is more than sufficient to compensate for the difference between the world price and the domestic price, and in the partial reduction of special regimes[30]. The second period 1990-1993 witnessed the elimination of all special regimes for imports except for *Zona Franca de Manaus* (Manaus Duty Free Zone) and for the computer industry; the elimination of all non-tariff barriers and a schedule for a gradual reduction of tariffs during four years from 1990 onwards. The programme intended to reduce by a lower amount the tariffs of sectors more intensive in technology such as computer and chemical industries and those with a high demand for national input products such as the automobile industry. It also intended to reduce more sharply, in the beginning of the reform, the tariffs on capital and intermediate goods, and later on the tariffs on consumption goods. However, in order to tighten up the price control of oligopoly groups and curb the inflationary process, the

[30]According to Kume et al. (2000) these partial reforms did not have a strong impact on the foreign competition due to their small scope. Despite the apparent strong reduction in nominal tariffs, most of them were redundant. In addition, the most important non-tariff barriers were not lifted during this period.

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Average tariff	54.9	37.7	29.4	27.2	20.9	14.1	12.5	10.2	10.8	10.8	13.4	13.4
Standard deviation	21.3	14.6	15.8	14.9	12.7	8.2	6.7	5.9	7.4	8.7	7.6	6.6
Maximum tariff	102.7	76	75	78.7	58.7	39	34	23.5	41	52.4	47.1	38.1
Minimum tariff	15.6	5.6	1.9	3.3	1.7	0.6	0.0	0.0	0.0	0.0	0.0	0.0
Import Penetration			4.4	4.2	6.0	6.1	6.9	7.7	10.0	10.7	12.5	13

Sources: Kume et al. (2000) for the average Nominal Tariff and Fonseca et al. (2000) for the import penetration coefficient in the manufacturing sector.

Table 1: Nominal Tariff and Import Penetration Coefficient (in %)

government decided to anticipate the lowering of tariffs for consumption goods. For this reason, in October 1992, the tariffs were reduced to the levels that were scheduled for January 1993 and in July 1993 to the levels that were scheduled for January 1994. Such anticipations announced in February 1992 reinforce the natural experiment environment in which the process of trade liberalisation took place in Brazil. The third and last period consisted of the anticipation of the Mercosur Common Tariff from January 1995 to September 1994 and of the reduction of tariffs to 0% for intermediate goods and 2% for consumption goods which figured prominently in the bundle of goods that compounded the price indices in order to control inflation just after the *Plano Real*[31].

The partial reversion in the tariff reduction observed from 1995 onwards was followed by other measures that intended to reduce the trade deficit. Among these measures were the reintroduction of some non-tariff barriers such as previous authorisation for some imports and increases in *red tape* in general. However, in spite of a short-term reduction in the growth rate of the import penetration ratio, these measures were not able to prevent the increase in the foreign market penetration.

Table 1 reports the evolution of the nominal tariff between 1987 and 1998 and of the import penetration coefficient between 1989 and 1998. As one can see, not only did the process of trade liberalisation lead to a decrease in the average value of nominal tariffs, but also to a reduction in the dispersion of their level among industries. In 1987, the average nominal tariff was 55% with a standard deviation of 21.3. These figures were down to 13.4% and 6.6, respectively in 1998.

Despite this sharp fall in tariffs, imports did not increase immediately. This occurred because the process of trade liberalisation took place during the recession period 1990-92 and in a period when the currency was depreciated. Furthermore, as mentioned above, a considerable part of the reduction in the late 1980's was due to cuts in redundant tariffs. The import participation in the total supply increased from 3.78% in 1985 to 4.05% in 1992, and by 1997, this figure was up to 5.67% (Oliveira-Junior, 2000). Similarly, the import penetration ratio was 6.1% in 1992 (the same level as in 1985) and increased to 13% by 1998 (Fonseca et al., 2000).

An important point to note is the possible lack of a direct relationship between either the nominal tariff or effective tariff[32] and import penetration ratio across sectors. As

[31]The appreciation of the *Real* witnessed after the *Plano Real* together with reductions in tariffs and an increase in the aggregate demand led to successive trade deficits. This fact led the government to slightly increase tariffs in 1995. It is worth noting that whereas the tariffs were used to control inflation rather than to enhance productivity in the first phases of the process, after the *Plano Real* it was used as a mean to smooth the increasing trade deficits faced by the country. However, due to the agreements established by the Mercosur, the ability of the government to change tariffs was constrained.

[32]Effective tariff is a measure that not only includes the nominal tariff for the output of the industry,

	Nominal Tariff	Import Penetration	Export Orientation	Wage Premium	Proportion Registered
Effetive tariff	0.929* *(0.000)*	-0.042 *(0.874)*	0.324 *(0.205)*	-0.005 *(0.985)*	-0.049 *(0.852)*
Nominal tariff		-0.164 *(0.529)*	0.172 *(0.510)*	-0.206 *(0.428)*	-0.213 *(0.411)*
Import penetration			0.328 *(0.198)*	0.238 *(0.358)*	0.444*** *(0.075)*
Export Orientation				0.267 *(0.299)*	0.086 *(0.743)*
Wage premium					0.064 *(0.808)*

*Significant at 1%; **Significant at 5%; ***Significant at 10%
P-value in parenthesis

Table 2: Spearman Rank Cross-correlation in 1987

discussed above, there were many non-tariff barriers preventing imports as well as special regimes that allowed protected sector to import inputs without paying the due amount of import tax. Moreover import penetration ratio captures other features that are not captured by tariff measures such as the level of the real exchange rate and tastes and preferences of consumers. Tables 2 and 3 show the Spearman rank correlation between all pairs of variables that we are going to investigate for 1987 and 1998, respectively. The variables are a) trade-related variables: nominal tariff, effective tariff, import penetration ratio[33], export orientation; and b) the wage premium for registered workers and the proportion of registered workers for 17 manufacturing industries[34]. It is striking the lack of rank correlation between import penetration ratio and effective tariff. In 1987 the rank correlation was slightly negative (-0.04), but not statistically significant; in 1998, the correlation was positive (0.22), and again not significant.

It is worth noting that the only statistically significant rank correlation for both years, besides the obvious correlation between effective and nominal tariff, was the positive correlation between the import penetration ratio and the proportion of registered workers. This surprising result indicates that manufacturing sectors that tend to have a higher import penetration ratio also have a higher proportion of registered workers.

Another interesting feature is the rank correlation among these variables between 1987 and 1998. Table 4 shows that both effective and nominal tariffs have a low positive own-rank correlation between 1987 and 1998[35], the correlation for the effective tariff is not statistically significant and for the nominal tariff is only significant at 10% level. Similarly, the own-rank correlation for the wage premium is also low, despite being positive (0.45)

but also takes into account input tariffs as a way to measure the overall degree of protection enjoyed by the industry. See Kume et al. (2000) for more details.

[33]Import penetration ratio is measured as the ratio between imports over the sum of the value of the production plus imports minus exports (M/(Y+M-X)), which gives us a measure of the real external competitive environment faced by each industry in the internal market. This variable is important because it is determined not only by tariffs, but also by other policy instruments and macroeconomic variables such as non-tariff barriers, exchange rate and GDP growth that determine the actual degree of openness of the economy. Data for import penetration ratio and export orientation (exports/value of the production) come from Haguenauer et al. (1998).

[34]The manufacturing industry groups at 2-digit level are non-metallic, metallurgic, mechanic, electronics, transport, wood and furniture, paper printing and publishing, rubber, chemical, oil refining, pharmaceutical and perfume, plastics, textiles, clothes, shoes and leather, food, and other industries.

[35]The own-rank correlations correspond to the numbers in the diagonal of Table 4.

	Nominal Tariff	Import Penetration	Export Orientation	Wage Premium	Prop. Registered
Effective tariff	0.919 *(0.000)**	0.221 *(0.395)*	0.326 *(0.202)*	0.397 *(0.115)*	0.091 *(0.729)*
Nominal tariff		0.382 *(0.130)*	0.353 *(0.165)*	0.279 *(0.277)*	0.103 *(0.694)*
Import penetration			0.390 *(0.122)*	0.142 *(0.586)*	0.637*** *(0.006)*
Export. Orientation				0.257 *(0.319)*	0.088 *(0.736)*
Wage premium					-0.140 *(0.593)*

*Significant at 1%; **Significant at 5%; ***Significant at 10%
P-value in parenthesis

Table 3: Spearman Rank Cross-correlation in 1998

	Effective Tariff(98)	Nominal Tariff(98)	Import Penetration (98)	Export Orientation (98)	Wage Premium (98)	Prop. Registered (98)
Effective tariff (87)	0.353 *(0.165)*	0.373 *(0.141)*	0.047 *(0.859)*	0.270 *(0.295)*	-0.017 *(0.948)*	-0.164 *(0.529)*
Nominal tariff (87)	0.363 *(0.152)*	0.434*** *(0.082)*	-0.042 *(0.874)*	0.154 *(0.554)*	-0.243 *(0.348)*	-0.194 *(0.457)*
Import penetration (87)	-0.064 *(0.808)*	0.066 *(0.801)*	0.858* *(0.000)*	0.441*** *(0.076)*	0.588** *(0.013)*	0.052 *(0.845)*
Export. Orientation (87)	0.360 *(0.155)*	0.343 *(0.178)*	0.282 *(0.273)*	0.897* *(0.000)*	-0.007 *(0.978)*	0.409 *(0.103)*
Wage premium (87)	0.206 *(0.428)*	-0.010 *(0.970)*	0.140 *(0.593)*	0.309 *(0.228)*	0.446*** *(0.073)*	0.326 *(0.202)*
Prop. Registered (87)	0.199 *(0.445)*	0.262 *(0.3092)*	0.662** *(0.004)*	0.186 *(0.474)*	-0.064 *(0.808)*	0.814* *(0.0001)*

*Significant at 1%; **Significant at 5%; ***Significant at 10%
P-value in parenthesis

Table 4: Spearman Rank Correlations between 1987 and 1998

and significant at 10%. In contrast, import penetration ratio, export orientation and the proportion of registered workers have a much higher own-rank correlation, 0.86, 0.90, 0.81, respectively, which are all significant at 1% level. Thus it seems that the changes in tariffs were strong enough to change the relative position of the 17 manufacturing industries in relation to effective and nominal tariffs and in relation to the wage premium. However, the same is not true for the export orientation, for the import penetration ratio and for the proportion of registered workers. Nevertheless, it is important to bear in mind that the rank-correlation does not take into account the intensity with which the different industries were affected, just their relative position within a specific year rank.

Figures 3 and 4 plot all the data points of our ten-year (1987, 1988, 1989, 1990, 1992, 1993, 1995, 1996, 1997 and 1998) and 17 industries panel for the relationship between wage premium and trade-related measures and for the relationship between proportion of registered workers and trade-related measures, respectively. Both export orientation and effective tariff are positively correlated with the wage premium, whereas there seems to be a negative correlation between import penetration ratio and wage premium[36] for registered workers as one would expect. As for the proportion of registered workers, surprisingly

[36]However, none of these correlations are statistically significant at 5% of significance, but the coefficient on effective tariff is significant at 10% level.

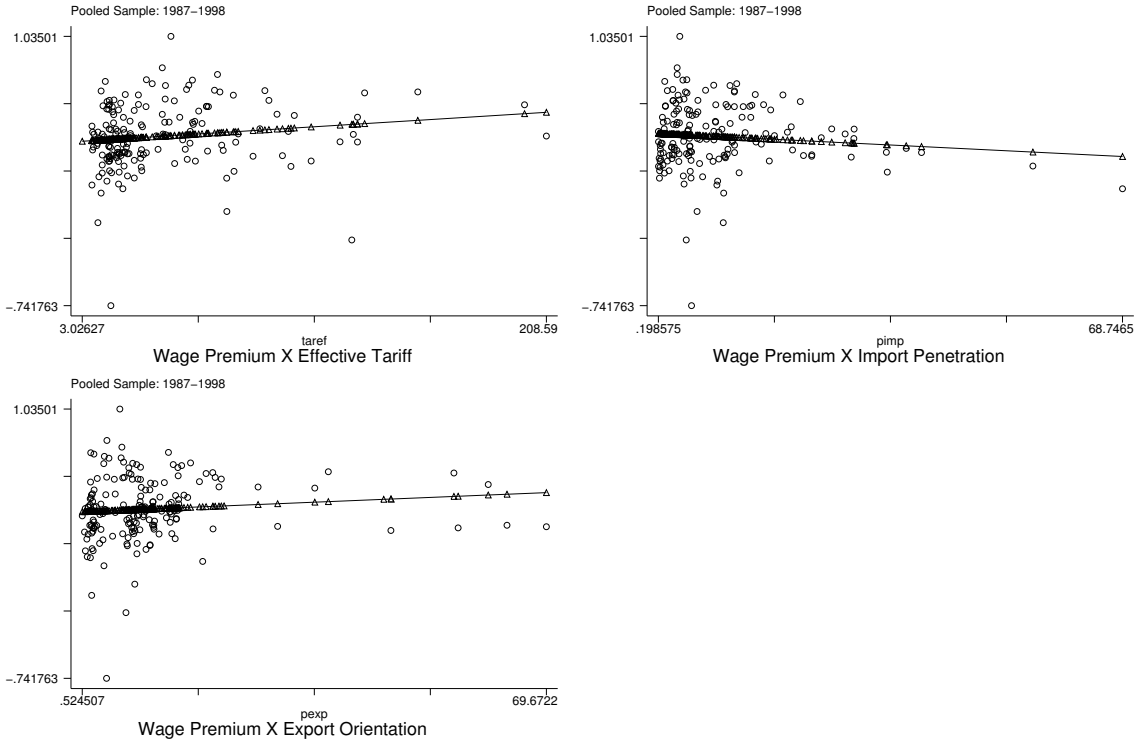

Figure 3: Wage Premium and Trade Measures (Pooled Sample) - 1981 - 1999

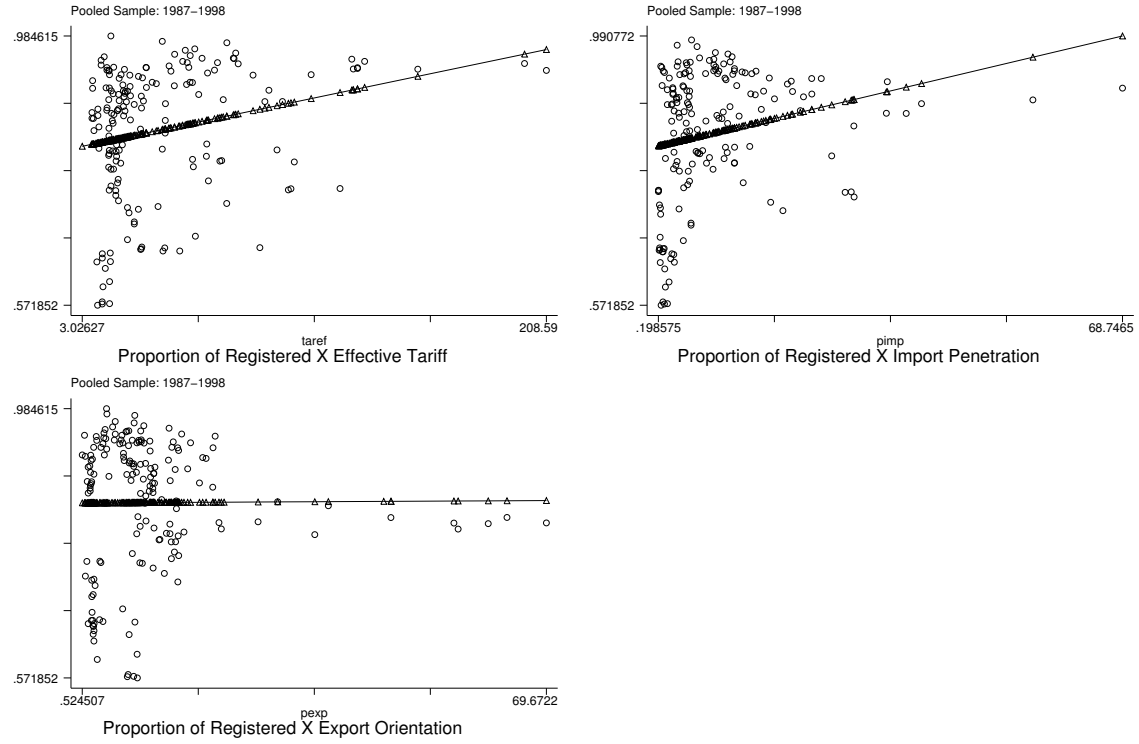

Figure 4: Proportion of Registered Workers and Trade Measures (Pooled Sample) - 1981 - 1999

both effective tariff and import penetration ratio show a strong positive correlation with it[37], whereas the export orientation ratio seems to be only slightly positively correlated with it, displaying an almost flat regression line. However, these results are just raw correlations and do not control for several other variables that are meant to affect both the wage premium and the proportion of registered workers. Moreover they do not control for industry fixed-effects and common macroeconomic shocks nor use weights in order to get more accurate correlations. Nevertheless, it anticipates the results we would get from the regression analysis based on the pooled cross-section and time-series sample. In the next section, we will discuss the empirical strategies to investigate the relationship between trade-related variables and both the wage premium between registered and non-registered workers and the proportion of registered workers controlling for the drawbacks highlighted above.

5 Empirical Strategies

In order to test whether or not trade liberalisation did have an effect on the *degree of segmentation* and on the expansion of the informal sector in either the manufacturing sector or in the entire labour market, we apply three distinct reduced-form strategies. Since tariffs are uniform within the country in a given period of time, the first strategy relies on the variation of the degree of protection enjoyed by different industries, and on the different speed of the reform for different industries as described in the last section. This strategy allows us to check whether the industries most affected by the trade reform were also those that experienced the strongest reduction in both the *degree of segmentation* as measured by the wage differential and in the proportion of registered workers. Thus, in order to avoid bias due to the correlation between unobserved industry specific characteristics and trade related variables, we estimate this relationship using industry fixed-effect models and time dummies[38]. Controlling for time invariant unobserved industry characteristics is important because industry features that affect the relative wage of registered workers (and its proportion) may also affect their ability to lobby the government and/or the government priority in tariff reduction[39]. Likewise, time dummies would control for common macroeconomic shocks that would affect both the relative wage and the proportion of registered workers and the behaviour of trade related variables. For instance, during a recession it is likely that the import penetration ratio would fall as well as the relative wage of informal sector workers, whereas the proportion of workers in that sector increases. If the recessive period coincides with the trade liberalisation measures and we do not control for this common macroeconomic shock we would find a spurious relationship between the wage gap and the size of the informal sector and the trade measures.

[37] Both correlations are also statistically significant at 1% level.

[38] Unfortunately, due to the lack of the data for 1991 and 1994 for the variables related to wage differential and proportion of registered workers we cannot estimate first-difference models in order to test the robustness of the fixed-effect models.

[39] As mentioned in the last section, not only did the government establish different priorities in the tariff reduction schedule according to "observable" industry characteristics, such as the more aggressive reduction for intermediate and capital goods, but it also tried to curb inflationary pressures through reduction in tariffs due to the ability of certain industries to link prices to past inflation and wage hikes.

The second strategy is based on the fact that the industries are not evenly distributed within the country. Thus if we assume that regions are differently affected by the trade reform according to their "industry composition" and that there is some sort of regional segmentation that prevents workers from migrating in the short term, we can test the existence of spillover effect of the trade liberalisation into the entire economy due to the different intensities with which each region was affected by the reform.

The third strategy adds two other sources of variation to estimate the impact of trade liberalisation on the proportion of registered workers and on their wage premium in the wide economy. We build industry-cohort cells that account for 30 sectors in the economy[40] - including both tradable and non-tradable sectors - and seven 10-year length cohorts. Thus we are able to exploit both cohort[41] and industry variation in order to identify the impact of trade liberalisation measures on employment structure and on the wage differential in the manufacturing sector. This is possible, because besides the different impact of the trade liberalisation on the manufacturing industries, we will be also using the non-tradable industries as a comparison group. These three identification strategies are detailed below.

5.1 The Impact of Trade Liberalisation on the Manufacturing Sector.

To test whether or not trade liberalisation had any impact on the fall in the wage differential between the registered and non-registered workers and on the increase in the proportion of the non-registered workers in the pool of manufacturing employees between 1987 and 1998, we run a fixed-effect model for both the coefficient of the "registered worker" dummy variable obtained from a standard semi-log Mincerian wage equation and the proportion of registered workers on a set of variables related to trade: effective tariff, nominal tariff[42], import penetration ratio and export orientation[43] for a panel of 17 industries[44]. The industry classification was developed in order to make the data from the household survey compatible with the trade-related data used in this paper. The sample is restricted to employed individuals between 14 and 65 years old with positive earnings and who worked more than 20 hours per week.

In the case of the effect of trade openness measures on the wage differential, we first estimate the following log wage equation for each pair of industry j and year t separately between 1987 and 1998.

$$w_{ijt} = \alpha_{jt} + \Gamma_{jt} X_{ijt} + \beta_{jt} Reg_{ijt} + \epsilon_{ijt} \tag{3}$$

where w_{ijt} is the log of the real hourly-wage for the individual i in industry j and year t and Γ is a vector of coefficients of the following independent variables X: region, gender,

[40]This classification is not exhaustive of all sectors in the economy, because we excluded the public administration. We did that because public administration industry classification was used to filter out public servants that are classified as non-registered workers in the household survey.

[41]The use of cohorts enables us to control for industry-cohort fixed-effect, something that we could not do using only the repeated cross sections without building the cohorts.

[42]Data for effective and nominal tariffs come from Kume et al. (2000).

[43]Data for import penetration ratio and export orientation come from Haguenauer et al. (1998).

[44]The data for all these industries is available in the Appendix.

education (6 groups), experience, experience squared and metropolitan area, and β_{jt} is the coefficient for the dummy variable *Reg* that indicates whether the individual is a registered worker.

In a second step, we regress the estimate coefficient β_{jt} on the trade-related variables[45]:

$$\beta_{jt} = \alpha + \delta TM_{jt} + \phi_j + \theta_t + \varepsilon_{jt} \tag{4}$$

where TM_{jt} stands for trade measure variables in period j and time t and ϕ_t are industry dummies and θ_t are time period dummies and ε_{jt} is assumed to be a white noise.

The second reduced-form estimates refers to the impact of trade-related measures on the proportion of registered workers in the industries[46]:

$$Preg_{jt} = \alpha_2 + \lambda TM_{jt} + \phi_j + \theta_t + \varepsilon_{jt} \tag{5}$$

where $Preg_{jt}$ is the proportion of registered worker in industry j and year t and the remaining variables are as stated in equation (4).

Before discussing the results for this procedure, we will have a look at the long change (between 1987 – 1998) relationship between wage premium and proportion of registered workers and our trade-related measures. Figure 5 shows the long-change relationship in percentage between nominal tariff and the other three trade related measures used in this paper. Nominal and effective tariff decreased in almost equal proportion for all industries. Export-orientation increased more in the industries whose nominal tariff decreased less, but the relationship is not statistically significant and in fact the regression line is almost flat. It is also worth noting that whereas the import penetration ratio increased for all industries, particularly for textiles and clothes, and the effective tariff fell for all sectors, the export orientation showed a less balanced figure, some sectors increased their export orientation and other experienced a reduction between 1987 and 1998. Figure 5 reveals a negative, but not statistically significant, relationship between changes in tariff and changes in import penetration ratio[47]. As mentioned in the last section, the strong reduction in nominal tariffs observed in 1988-89 was concentrated on redundant tariffs, this fact can explain the weak correlation between changes in nominal tariffs and changes in the import penetration ratio. Unfortunately, we do not have good data for several years on the non-tariff barriers by industry which were lifted in 1990. Therefore, we assume that changes in import penetration ratio, despite its possible endogeneity[48] in relation to wage differential and to the proportion of registered workers, can act as a summary variable

[45]This two-step procedure has been used in the literature on the impact of trade on the US labour market by Borjas and Ramey (1994) and Slaughter (2001), see subsection 3.1 for a discussion of Borjas and Ramey (1994) results.

[46]One alternative to this approach would be to follow Goldberg and Pavcnik (2003) and regress the probability of being a registered worker against other trade measures. This implies a first stage where one would estimate the registered status against several controls such as schooling, experience and, most importantly, industry affiliation. In the second stage, the estimated coefficient of the industry affiliation would be the dependent variable in a regression equation like the one below, and the inverse of its sampling variance would be used as weight in the estimation. We checked the robustness of our results and found very similar results when applying this methodology.

[47]It is worth noting that this negative relationship is somewhat driven by two outliers: clothes and textiles industry (numbers 17 and 18, respectively, in the graphs).

[48]As a way to control for this problem in our regression analysis, we also try specifications using lags of the trade measures rather than their contemporaneous values.

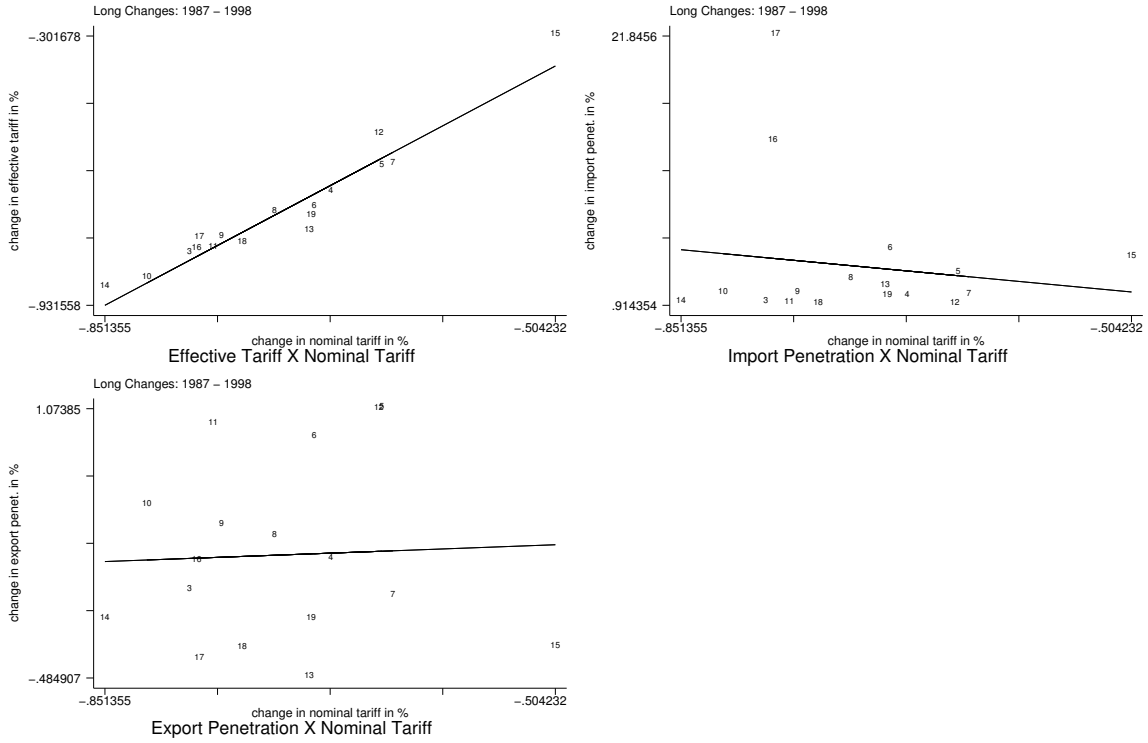

Figure 5: Nominal Tariff and Trade Measures (Long Changes: 1987-1998)

that captures both the effect of non-redundant tariff reductions and the elimination of non-tariff barriers.

Figure 6 shows the long changes between wage premium for registered workers and trade related measures in percentages. Changes in effective tariff as well as changes in the import penetration seem to be positively correlated with changes in wage premium ratio[49]. However, only the correlation between changes in effective tariff is statically significant at 10%. Thus sectors that experienced the highest (long) fall in effective tariff were also the ones that witnessed the highest (long) fall in the wage premium. Export orientation is negatively correlated with changes in the wage premium, but it is not statistically significant. Changes in import penetration ratio are positively correlated with changes in the wage premium, which is again an unexpected result.

Figure 7 shows a negative relationship between changes in effective tariff and import penetration ratio and changes in the proportion of registered workers. The export orientation seems to display a positive correlation, but the regression line is almost flat. Not surprisingly, none of these estimated correlations are statistically significant. Therefore, the only statistically significant relationship found using the long-change approach was the negative impact that lowering tariffs had on the wage differential between registered and non-registered workers. However, despite controlling for individual fixed-effects, the long-change approach loses lots of variation in the estimation procedure, and for this

[49]Notice that one should expected that the relationship between changes in import penetration ratio and changes in the wage premium would have the opposite sign of the relationship between changes in effective tariff and changes in wage premium.

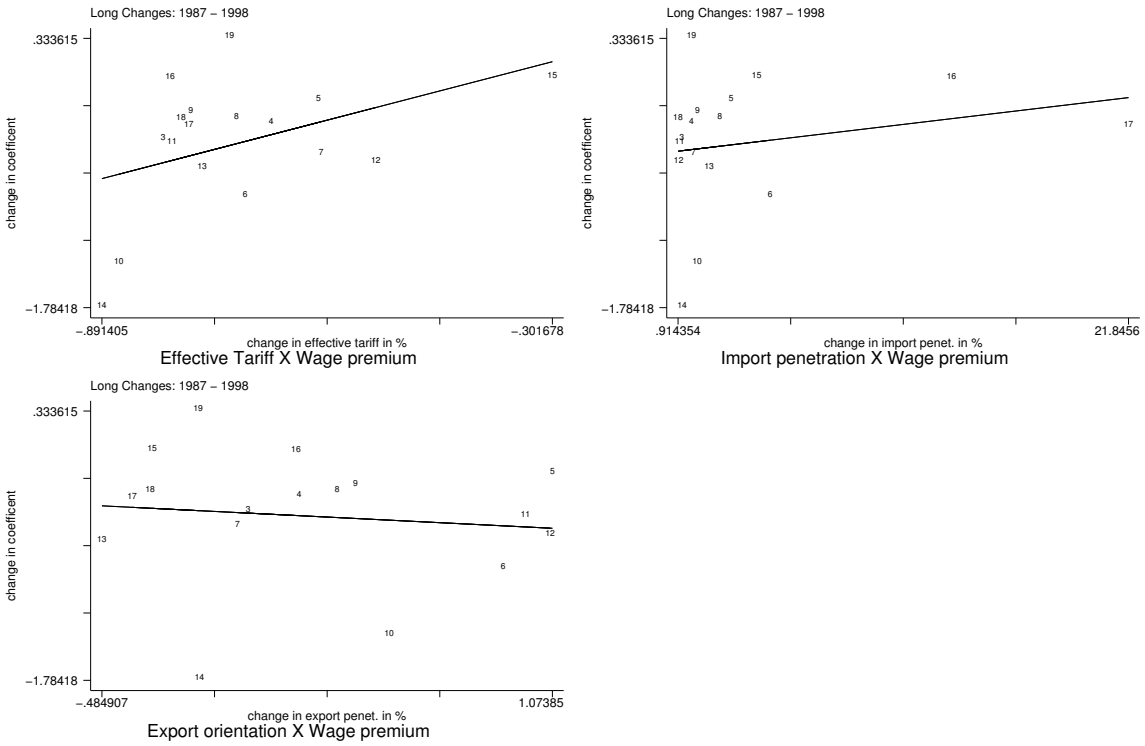

Figure 6: Wage Premium and Trade Measures (Long Changes: 1987-1998)

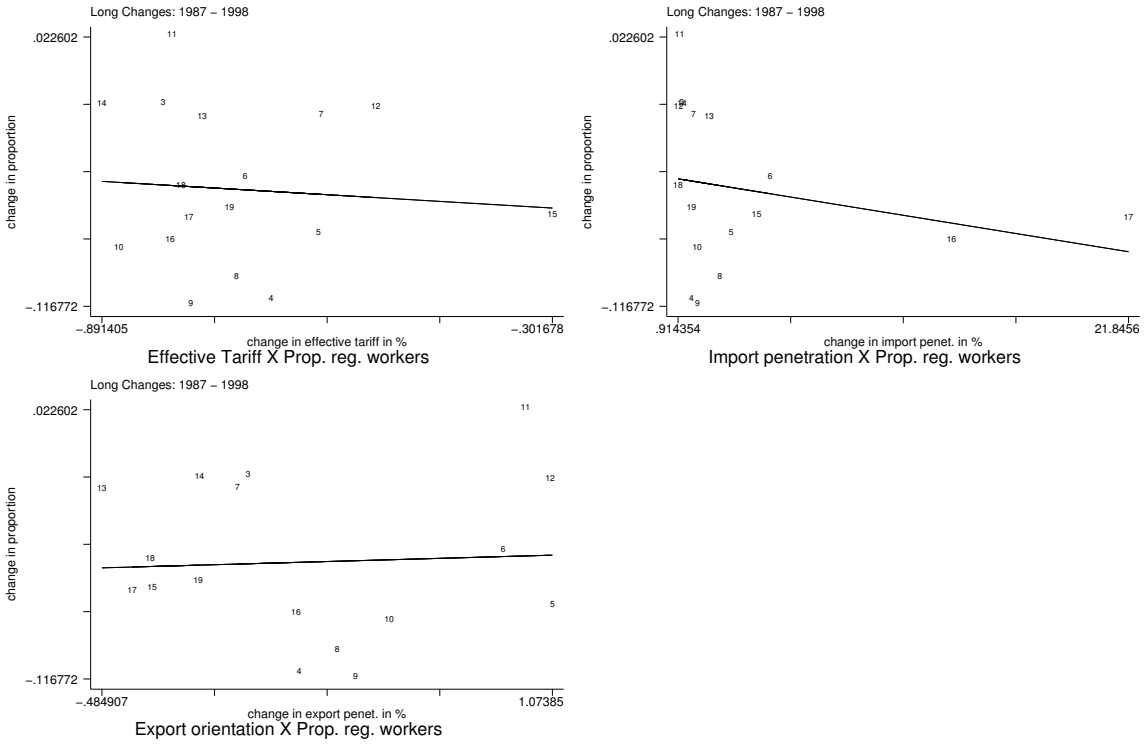

Figure 7: Proportion of Registered Workers and Trade Measures (Long Changes: 1987-1998)

reason we will emphasize the results of the fixed-effect estimations described bellow.

The fixed-effect regression versions of equation (4) are weighted by the inverse of the sampling variance of the dependent variable. Saxonhouse (1976) shows that estimations where the dependent variable is estimated in a first step and then regressed against a set of variables intended to explain it, suffer from heteroscedasticity because the stochastic term in the first stage is individual specific (in our case, industry specific). Similarly, equation (5) is estimated using the share of the industry in the total manufacturing employment as weight. Besides this weighting scheme, the standard errors in both equations are Huber-White corrected for any other source of general heteroscedasticity.

We run separate regressions for each trade measure and a joint one with effective tariff, import penetration and export orientation, we also include other variables related to the structure of the industry in order to test the robustness of the results. These variables are value-added[50], and the proportion of workers who earn less than the minimum wage. Additionally, we run one specification adding the industry-specific nominal exchange rate[51] to the joint specification. The set of regressions also contains year dummies aimed at capturing aggregate shocks that may have had some impact on all manufacturing industries.

Table 5 summarises the results of the fixed-effect with time dummies of the estimations for the wage premium as measured by the registered worker's dummy coefficient. Both effective and nominal tariffs have a (small) positive, but statistically insignificant coefficient. In contrast, the specification with import penetration as the only regressor shows a negative and significant coefficient (-0.0042). This results is robust to the inclusion of the other trade-related variables in column [5] and to industry characteristics (column[7]), as well as to the inclusion of the log of the industry-specific nominal exchange rate in column [6]. The inclusion of latter variable aims at preventing the trade-related variables, particularly the import penetration ratio, from spuriously capturing the effect of different trends in the industry-specific exchange rates. The inclusion of industry-specific exchange rate does not affect either the sign or the statistical significance of the coefficients of the other trade-related variables. However, it slightly diminishes the negative effect of the import penetration ratio. The estimates range from -0.0033 to -0.0064[52]. The export orientation variable has a negative and statistically insignificant coefficient in all specifications. All additional controls have a positive effect on the wage premium, as expected, but they are never statistically significant.

These results suggest that trade liberalisation as measured by the import penetration ratio had a diminishing effect on the wage differential between registered and non-registered in the manufacturing sector. As for the other trade measures directly affected by the reform, the coefficients for nominal and effective tariff is correctly signed as we would expect based on our discussion in the last section, i.e., they would have a posi-

[50]The value-added was calculated based as the difference between total sales and total costs of the industries based on the data of the Industry Annual Survey (PIA) from IBGE, http www.ibge.gov.br .

[51]The industry-specific exchange rate was calculated as the weighted average of the nominal exchange rates of countries accounting for more than 2% of industry exports in each year as in Revenga (1992). Due to the lack of good data on producer price indexes and the high inflation witnessed by the country until 1994, we decided not to calculate real exchange rates and to enter the industry-specific nominal exchange rate only in the specifications with time dummies.

[52]The estimates seem to be small because the explanatory variables entered the regressions as percentages.

	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Effective Tariff	0.0008				0.0007	0.0008	-0.0003
	[0.0007]				[0.0007]	[0.0007]	[0.0009]
Nominal Tariff		0.0009					
		[0.0013]					
Import Penet.			-0.0042		-0.0039	-0.0033	-0.0064
			[0.0013]**		[0.0013]**	[0.0015]*	[0.0015]**
Export Orient.				-0.0011	-0.0009	-0.0004	-0.0004
				[0.0016]	[0.0016]	[0.0017]	[0.0021]
Exchange Rate						-0.0096	
						[0.0089]	
% less than mw							0.6548
							[0.3437]
Value Added							0.0131
							[0.0503]
Constant	0.4076	0.4152	0.4669	0.4711	0.4132	0.2252	0.064
	[0.0604]**	[0.0844]**	[0.0327]**	[0.0323]**	[0.0600]**	[0.1876]	[1.1551]
N	170	17 0	170	170	170	170	153
Adj. R2	0.71	0.71	0.72	0.71	0.72	0.72	0.73
F test: industry	19.18	18.48	21.24	16.2	19.62	19.86	15.33
Prob >F	0	0	0	0	0	0	0

Robust standard errors in brackets. * Significant at 5%; ** significant at 1%.
Industry and time dummy variables not shown.
Note: As we do not have data on value-added for 1998, column [7] specification has only 153 observations.

Table 5: Wage Premium: Fixed Effect with Time Dummies (Contemporaneous Regressors)

tive impact on the registered workers wage premium, but they are very small and not statistically significant.

The regressions for the proportion of registered workers in the pool of employees were weighted by the share of workers in the industry for each industry/year pair. The standard errors are Huber-White corrected. Table 6 shows the results for the fixed effect specifications with time dummies. Both effective and nominal tariffs have a negative effect on the proportion of registered workers for all specifications, and their coefficients are significant for most of them[53]. The coefficients for the import penetration ratio and for the export orientation are not significant, but while the import penetration ratio shows a negative impact in most specifications, the export orientation has a positive impact in all specifications[54]. The proportion of workers earning below the minimum wage is, as expected, negatively correlated with the proportion of registered workers. Including the industry-specific exchange rate does not change the coefficient (column [6]) of the the other variables.

The results in Tables 5 and 6 are somewhat puzzling. Whereas the import penetration ratio seems to have had a negative impact on the wage differential, it has not affected (significantly) the proportion of registered workers, despite its negative sign in most specifications. The effective tariff has had no effect on the wage differential (despite its positive sign), but it has had a negative impact on the proportion of registered workers. Thus, industries most affected by the reduction in effective tariff were the same that witnessed an increase in the proportion of registered workers. Therefore, at least for the manufacturing sector, trade liberalisation may have had an impact on cutting the wage premia

[53]The coefficient on effective tariff is not significant at 5% level for the specification with additional controls, column [7].

[54]In fact, the export orientation ratio is significant in the joint specification.

	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Effective Tariff	-0.0003				-0.0004	-0.0004	-0.0002
	[0.0001]**				[0.0001]**	[0.0001]**	[0.0001]
Nominal Tariff		-0.0003					
		[0.0002]					
Import Penet.			-0.0002		-0.0003	-0.0003	0.0001
			[0.0003]		[0.0002]	[0.0003]	[0.0003]
Export Orient.				0.0006	0.0008	0.0008	0.0006
				[0.0004]	[0.0004]*	[0.0004]	[0.0004]
Exchange Rate						-0.0001	
						[0.0021]	
% less than mw							-0.2733
							[0.0709]**
Value Added							-0.0021
							[0.0105]
Constant	0.6976	0.6916	0.6713	0.6705	0.698	0.6962	0.8009
	[0.0116]**	[0.0166]**	[0.0087]**	[0.0090]**	[0.0118]**	[0.0421]**	[0.2346]**
N	170	170	170	170	170	170	153
Adj. R2	0.97	0.97	0.97	0.97	0.97	0.97	0.97
F test: industry	289.89	280.66	227.76	302.16	203.25	203.19	46.03
Prob >F	0	0	0	0	0	0	0

Robust standard errors in brackets. * Significant at 5%; ** significant at 1%.
Industry and time dummy variables not shown.
Note: As we do not have data on value-added for 1998, column [7] specification has only 153 observations.

Table 6: Proportion of Registered Workers: Fixed Effect with Time Dummies (Contemporaneous Regressors)

of registered workers, but if anything, it had the effect of increasing the proportion of registered workers in the most affected industries.

In order to check the robustness of these results, allowing for some delay in the adjustments to the new tariffs and to the more competitive environment, and also to avoid problems of simultaneity between import penetration ratio and export-orientation and the wage differential, we re-run equations (4) and (5) using lagged regressors rather than contemporaneous.

As for the results for the wage premium, Table 7 reveals that the main difference is that the coefficient of effective tariff is negative in most specifications, but again it is never statistically significant. The coefficients of export orientation turn out to be positive for most the fixed-effect specifications with time dummies, but they are not significant either. The coefficients for import penetration are negative and show a point estimate somewhat higher than the one with contemporaneous effect, ranging from -0.0048 to -0.0064. The inclusion of the lagged industry-specific exchange rate does not change this result (see column [6]).

As for the results for the proportion of registered workers, Table 8 shows that the use of a lagged specification instead of contemporaneous does not change the former results. The only remarkable difference is that when the additional controls are introduced, the negative effect of tariffs on the proportion of registered becomes insignificant[55] (see column [7]).

Altogether, the results for both set of equations suggest that trade reforms as measured by the import penetration ratio had a diminishing effect in the wage differential between

[55]Using the probability of registered job as the dependent variables as suggested in Goldberg and Pavcnik (2003) none of the trade variables in any of the specifications are statistically significant. The results are available upon request.

	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Effective Tariff	0.0002				-0.0001	-0.0000	-0.0003
	[0.0008]				[0.0008]	[0.0008]	[0.0009]
Nominal Tariff		-0.0005					
		[0.0014]					
Import Penet.			-0.0048		-0.0061	-0.0055	-0.0064
			[0.0016]**		[0.0016]**	[0.0019]**	[0.0022]**
Export Orient.				-0.0001	0.0013	0.0018	0.0018
				[0.0019]	[0.0022]	[0.0023]	[0.0026]
Exchange Rate						-0.0078	
						[0.0079]	
%less than mw							-0.1119
							[0.6606]
Value Added							-0.0418
							[0.0458]
Constant	0.3861	0.5788	0.4703	0.4693	0.3928	0.3931	1.2582
	[0.0349]**	[0.0979]**	[0.0328]**	[0.0321]**	[0.0367]**	[0.1704]*	[1.0235]
N	153	153	170	170	153	153	119
Adj. R2	0.71	0.71	0.72	0.71	0.72	0.72	0.7
F test: industry	16.32	15.26	20.32	15	17.75	18.05	9.05
Prob >F	0	0	0	0	0	0	0

Robust standard errors in brackets. * Significant at 5%; ** significant at 1%.
Industry and time dummy variables not shown.
Note: As we do not have data on value-added for 1998, column [7] specification has only 153 observations.

Table 7: Wage Premium: Fixed Effect with Time Dummies (Lagged Regressors)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Effective Tariff	-0.0003				-0.0003	-0.0003	-0.0001
	[0.0001]*				[0.0001]*	[0.0001]*	[0.0002]
Nominal Tariff		-0.0004					
		[0.0003]					
Import Penet.			-0.0001		-0.0001	0.0000	0.0003
			[0.0003]		[0.0003]	[0.0005]	[0.0004]
Export Orient.				0.0004	0.0001	0.0002	0.0006
				[0.0005]	[0.0004]	[0.0005]	[0.0005]
Exchange Rate						-0.0018	
						[0.0022]	
%less than mw							-0.349
							[0.0653]**
Value Added							0.0183
							[0.0114]
Constant	0.6419	0.6435	0.6716	0.6714	0.6419	0.656	0.3663
	[0.0087]**	[0.0089]**	[0.0088]**	[0.0088]**	[0.0088]**	[0.0451]**	[0.2617]
N	153	153	170	170	153	153	119
Adj. R2	0.97	0.97	0.97	0.97	0.97	0.97	0.97
F test: industry	266.07	244.75	226.28	310.58	193.33	194.34	42.1
Prob >F	0	0	0	0	0	0	0

Robust standard errors in brackets. * Significant at 5%; ** significant at 1%.
Industry and time dummy variables not shown.
Note: As we do not have data on value-added for 1998, column [7] specification has only 153 observations.

Table 8: Proportion of Registered Workers: Fixed Effect with Time Dummies (Lagged Regressors)

registered and non-registered workers. However, they also suggest that trade liberalisation did not play any role in the increase of the proportion of non-registered workers in the manufacturing sector. If anything, the effective tariff seems to have a negative impact on the proportion of registered workers and no role in the diminishing wage differential between the two groups. Nevertheless, the narrowing effect of the increase in the import penetration ratio on the wage gap seems to be more robust than the effect of effective tariff on the proportion of registered workers. Using lagged regressors does not change the results for the wage differential, but it does change for the proportion of registered workers when more controls are added. Moreover, it is important to keep in mind that the effective tariff does not take into account the lifting of important trade barriers that may have affected the actual degree of competitiveness in the industry. This effect is captured, at least partially, by the import penetration ratio.

5.2 Spillover Effects of Trade Liberalisation

In order to check whether the process of trade liberalisation had any impact beyond the supposedly direct effect on the manufacturing labour market, we run some fixed-effect models exploiting the different composition of the manufacturing sector in different regions of the country. The idea is to assess whether or not the economy-wide narrowing of the wage gap between formal and informal workers can be attributed to the trade liberalisation process[56]. To implement that, we use the wage gap in different regions as the dependent variables and the trade measures as the regressors. As there is no regional variation in the trade measures since these data are only available at national level, we use the following strategy: we take the share of workers in each of the 17 industries in 1987 within the following eight regions: metropolitan Southeast, non-metropolitan Southeast, metropolitan South, non-metropolitan South, metropolitan Northeast, non-metropolitan Northeast, North and Midwest, and multiply this share by the effective and nominal tariffs, by the import penetration ratio and by export orientation ratio for each industry, and calculated the regional weighted average for each of these variables. These modified trade-related variables would indicate the intensity with which each regional labour market must have been affected by trade liberalisation. The source of variation now comes from the different degrees of protection between industries and from their regional dispersion within the country.

One caveat of this procedure is that trade liberalisation is likely to have led to a reallocation of the industries within the country. In order to face a more competitive environment firms are likely to move to places where their costs can be lowered. This is one of the reasons why we choose to use a fixed weight - the industry structure in 1987.

It is important to bear in mind that the results for this set of equations are not comparable to the previous one, since now we are looking at the effect of trade liberalisation on the economy-wide wage differential between registered and non-registered workers and on the economy-wide proportion of registered workers in the economy, and not only in the manufacturing sector. Equations (3), (4), and (5) may be rewritten as:

[56]Notice that the impact of the trade liberalisation on wages as discussed in section 3.1 applies to the whole economy and not only to the manufacturing sector.

$$w_{irt} = \alpha_3 + \Lambda_{rt} Z_{irt} + \beta_{rt} Reg_{irt} + \varepsilon_{irt} \tag{6}$$

where w_{irt} is the log of the real hourly-wage for the individual i in region r and year t and Λ is a vector of coefficients correspondent to the following independent variables Z: gender, education (6 groups), experience, experience squared, and β_{rt} is the coefficient for the dummy variable *Reg* that indicates whether the individual is a registered worker or not.

$$\beta_{rt} = \alpha_4 + \pi TM_{rt} + \mu_r + \theta_t + \varepsilon_{rt} \tag{7}$$

where TM stands for trade measures variables as defined above, μ_r are region dummies and θ_t, time period dummies and ε_{rt} is assumed to be a white noise.

$$Preg_{rt} = \alpha_5 + \kappa TM_{jt} + \mu_r + \theta_t + \varepsilon_{rt} \tag{8}$$

where *Preg* is the proportion of registered workers in region r and year t and the remaining variables are as stated in equation (5).

The fixed-effect with time dummies versions of equation (7) are weighted by the inverse of the sampling variance of the dependent variable, whereas the fixed-effects with time dummies versions of equation (8) are weighted by the share of workers in each region. We also include additional controls in one of the specifications in order to check the robustness of the results. The controls are: proportion of workers employed in the manufacturing sector in each region, and the proportion of worker who earn less than the minimum wage.

Table 9 shows the results for the estimation of equation (7) with year and industry dummies using regional variation to identify the impact of trade related variables on the entire labour market. The effective and nominal tariffs have a negative and insignificant effect on wage differential between registered and non-registered workers. The sign of the import penetration ratio and of the export orientation are very sensitive according to the specification, but they are never significant. The only variable that is statistically significant in the specifications showed in Table 9 is the proportion of workers earning less than the minimum wage that has a positive impact on the wage premium of registered workers. Therefore, it seems that the trade-related variables did not have any impact on the behaviour of the wage differential in terms of its regional variation.

	[1]	[2]	[3]	[4]	[5]	[6]
Reg. Effective Tariff	-0.005616				-0.006354	-0.003711
	[0.003032]				[0.003841]	[0.003809]
Reg. Nominal Tariff		-0.00547				
		[0.005242]				
Reg. Imp. Penet.			0.005169		0.008033	-0.00047
			[0.010112]		[0.008984]	[0.008203]
Reg. Exp. Orient.				-0.005762	0.001539	-0.000944
				[0.012008]	[0.015678]	[0.017714]
Prop. in Manufac.						-0.217793
						[0.345291]
%less than mw						0.639823
						[0.291847]*
Constant	0.659821	0.650932	0.622713	0.626998	0.662332	0.648209
	[0.033614]**	[0.039330]**	[0.028562]**	[0.029977]**	[0.034016]**	[0.373064]
N	73	73	73	73	73	73
Adj. R2	0.91	0.91	0.9	0.9	0.91	0.91
F test: region	63.34	63.41	61.34	60.31	58.98	14.06
Prob >F	0	0	0	0	0	0

Robust standard errors in brackets. * Significant at 5%; ** significant at 1%.
Region and time dummy variables not shown.

Table 9: Regional Wage Premium: Fixed Effect with Time Dummies (Contemporaneous Regressors)

	[1]	[2]	[3]	[4]	[5]	[6]
Reg. Effective Tariff	0.003072				0.001908	0.000015
	[0.002121]				[0.001979]	[0.001120]
Reg. Nominal Tariff		0.003283				
		[0.002945]				
Reg. Imp. Penet.			-0.013051		-0.017194	-0.001762
			[0.005686]*		[0.005023]**	[0.002364]
Reg. Exp. Orient.				0.01275	0.013671	0.006479
				[0.004933]*	[0.004381]**	[0.003039]*
Prop. in Manufacturing						0.839754
						[0.125824]**
% Workers earning less than mw						-0.375648
						[0.073687]**
Constant	0.633378	0.637003	0.656274	0.645894	0.635496	-0.023001
	[0.012382]**	[0.019419]**	[0.012439]**	[0.012284]**	[0.011026]**	[0.126030]
N	73	73	73	73	73	73
Adj. R2	0.97	0.97	0.97	0.97	0.98	0.99
F test: region	395.2	409.92	426.82	527.53	576.04	141.3
Prob >F	0	0	0	0	0	0

Robust standard errors in brackets. * Significant at 5%; ** significant at 1%.
Region and time dummy variables not shown.

Table 10: Regional Proportion of Registered Workers: Fixed Effect with Time Dummies (Contemporaneous Regressors)

As for the proportion of registered workers in the pool of employees, Table 10 shows that the import penetration ratio coefficients are negative for three specifications, but it is not significant in the specification with additional controls. The export orientation coefficients, on the other hand, have a positive and significant effect on the proportion of registered workers. Both nominal and effective tariff have a positive, but insignificant effect. As for the other controls, it is quite remarkable the positive impact of the proportion of workers employed on the manufacturing sector and the negative effect of the proportion of workers earning below the minimum wage on the proportion of registered workers. If anything, we could only say from these results that there is some weak evidence that import penetration ratio is negatively correlated with the proportion of registered workers and some strong evidence that the export orientation ratio is positively correlated with the proportion of registered workers.

The results above suggest that import penetration ratio affects negatively the proportion of registered workers in the entire economy when we use regional variation to identify the impact of trade liberalisation. Regions with industries more affected by the higher import penetration were the regions that witnessed a higher decrease in the proportion of registered workers. Similarly, regions with industries with a high export orientation ratio witness an increase in the proportion of registered workers. However, unlike the specifications for the manufacturing sector, there has been no evidence that trade-related measures have affected the wage differential between registered and non-registered workers under this identification strategy.

The re-estimation of (7) and (8) using lagged regressors instead of contemporaneous yields very similar results for the impact of the trade-related measures on the wage differential. Table 11 shows that there is no indication of any impact of trade liberalisation on the wage differential. However, for the impact of trade-related measures on the propor-

	[1]	[2]	[3]	[4]	[5]	[6]
Reg. Effective Tariff	-0.006393				-0.006038	0.00144
	[0.005678]				[0.006716]	[0.007599]
Reg. Nominal Tariff		-0.004922				
		[0.008077]				
Reg. Imp. Penet.			-0.034032		-0.02887	-0.01803
			[0.025302]		[0.026758]	[0.027799]
Reg. Exp. Orient.				-0.007305	0.004199	-0.010641
				[0.011589]	[0.017899]	[0.022503]
Prop. in Manufac.						-0.163564
						[0.371722]
% Workers earning less than mw						0.820167
						[0.426472]
Constant	0.69069	0.687941	0.645335	0.639479	0.694627	0.489913
	[0.042675]**	[0.042119]**	[0.027623]**	[0.027924]**	[0.044029]**	[0.458521]
N	59	59	65	65	59	59
Adj. R2	0.9	0.9	0.9	0.9	0.9	0.91
F test: region	47.77	48.91	45.46	51.56	32.97	10.13
Prob >F	0	0	0	0	0	0

Robust standard errors in brackets. * Significant at 5%; ** significant at 1%.
Region and time dummy variables not shown.

Table 11: Regional Wage Premium: Fixed Effect with Time Dummies (Lagged Regressors)

tion of registered workers the story is somewhat different. Table 12 shows that the import penetration ratio has now a positive, but not significant effect on the proportion of registered workers. Furthermore, the positive effect of the export orientation ratio becomes insignificant.

All in all we find evidence that the increase in the import penetration ratio seems to have lowered the wage differential within the manufacturing sector. As for the proportion of registered workers in the manufacturing sector, we find some evidence that contemporaneous effective tariffs are negatively correlated with the proportion of registered workers. However, this result does not hold when we use lagged regressors to assess its robustness. We do not find any evidence of spillover effect of trade liberalisation on the economy-wide wage gap. But there is some weak evidence that the proportion of registered workers in the entire (regional) economy was negatively affected by the increase in import penetration ratio. But again this result does not hold when we enter lagged regressors.

5.3 Pseudo-cohort Approach

This last approach aims at putting together the variation exhibited by both tradable and non-tradable sectors in order to assess the impact of trade liberalisation. Therefore, besides the information (variation) due to the heterogeneous impact on the manufacturing sector (traded sector) of the trade-related variables, we would be also using the information (variation) on the non-traded sector as a comparison group, which was not directly affected by the trade reform to identify the overall effect of trade liberalisation on the wage premium for registered workers and for its proportion in the pool of employees.

In the absence of a panel data set that covers most of the country, we decided to build a pseudo-panel from the repeated cross section that we have been using so far. In order

	[1]	[2]	[3]	[4]	[5]	[6]
Reg. Effective Tariff	0.003685				0.002525	0.000779
	[0.002967]				[0.003738]	[0.001426]
Reg. Nominal Tariff		0.002596				
		[0.003509]				
Reg. Imp. Penet.			0.004658		0.005012	0.006171
			[0.011899]		[0.012131]	[0.005171]
Reg. Exp. Orient.				0.002155	0.003661	-0.004568
				[0.005033]	[0.007387]	[0.005023]
Prop.in Manufac.						0.900756
						[0.123634]**
% Workers earning less than mw						-0.337007
						[0.079362]**
Constant	0.621272	0.623155	0.641534	0.641249	0.620169	-0.099816
	[0.009507]**	[0.009352]**	[0.009311]**	[0.009682]**	[0.010300]**	[0.147417]
N	59	59	65	65	59	59
Adj. R2	0.98	0.98	0.98	0.98	0.98	1
F test: region	331.86	333.74	363.71	357.25	234.34	237.13
Prob >F	0	0	0	0	0	0

Robust standard errors in brackets. * Significant at 5%; ** significant at 1%.
Region and time dummy variables not shown.

Table 12: Regional Proportion of Registered Workers: Fixed Effect with Time Dummies (Lagged Regressors)

to get a better view of what is going on, the unit of analysis is no longer the industry, but industry-cohort cells. We divided the sample in 7 cohorts of 10-year length and 30 industry-cells. From those 30 industry-cells, 19 are classified as tradable sectors[57] and 11 as non-tradable sectors. The latter comprises mainly activities such as construction sector, lodging, restaurants, personal services, and productive services.

The panel is unbalanced due to the fact that persons from the fist cohort (born between 1916 and 1925) do not show up after 1990 (we drop people older than 65 from the sample) and persons from the last cohort (born between 1976 and 1985) only show up in the panel from 1990 onwards. Moreover, when some cohorts are still too small (either full of young people or older people), they have missing observations for some industries. We use data from 1981 to 1998[58], thus for complete industry-cohort cell observations we should observe 16 observations for each cell. Table 13 shows the number of years observed for each industry-cohort cell. The maximum number of observations in our estimations is 2867[59]. However, more worrying than the missing cells is whether or not the number of observations that have generated the mean value cells for each industry-cohort and for each year is large enough, so that we can ignore the correction put forward by Deaton (1985). As Deaton points out, if one intends to get an unbiased estimate, then one must take into account the variability of the calculated cell mean in the estimation of the parameters. Nevertheless, several studies have shown that when the number of observations that have generated the mean cell is higher than 100, the correction advocated by Deaton does not make much difference. From the 2867 mean cell observations, 56% (1602) were generated

[57]Besides the 17 industries used previously, we also add agriculture and the mineral extracting industry to the group of tradable sector. As there is no data on import penetration for the agriculture sector, we also run some specifications without it.

[58]There is no data for 1991 and 1994.

[59]This corresponds to the specifications that use data for all years and all sectors (including agriculture).

	Cohort							Total
Industry	1	2	3	4	5	6	7	
Tradable								
1. Agriculture	10	16	16	16	16	16	7	97
2. Ext.mineral	10	16	16	16	16	16	7	97
3. Non-metalic	10	16	16	16	16	16	7	97
4. Metallic	9	16	16	16	16	16	7	96
5. Mechanic	10	15	16	16	16	16	7	96
6. Electric and electronics	10	15	16	16	16	16	7	96
7. Vehicles	10	16	16	16	16	16	7	97
8. Wood	10	16	16	16	16	16	7	97
9. Paper	10	16	16	16	16	16	7	97
10. Rubber	8	14	16	16	16	16	7	93
11. Shoes	10	16	16	16	16	16	7	97
12. Chemicals	9	16	16	16	16	16	7	96
13. Oil refining	6	13	16	16	16	16	6	89
14. Pharmaceutical	9	15	16	16	16	16	7	95
15. Plastics	8	16	16	16	16	16	7	95
16. Textiles	9	16	16	16	16	16	7	96
17. Clothes	10	16	16	16	16	16	7	97
18. Food	10	16	16	16	16	16	7	97
19. Other manufacturing	9	15	16	16	16	16	7	95
Non-Tradable								
20. Construction	10	16	16	16	16	16	7	97
21. Industrial services	10	16	16	16	16	16	7	97
22. Commerce	10	16	16	16	16	16	7	97
23. Financial institution	9	16	16	16	16	16	7	96
24. Transport	10	16	16	16	16	16	7	97
25. Communications	9	16	16	16	16	16	7	96
26. Family services	10	16	16	16	16	16	7	97
27. Company services	10	16	16	16	16	16	7	97
28. Other non-traded services	10	16	16	16	16	16	7	97
29. Rentals	10	16	16	16	16	16	7	97
30. Petrol and gas	6	11	16	16	16	12	2	79
Total	281	466	480	480	480	476	204	2867

Table 13: Number of Years Observed for Each Industry-cohort Cell

from 100 or more individual observations. For now, we decide to run the regressions without using the correction, but we weight each cell mean observation by the number of observations that have generated it.

In order to investigate the impact of trade liberalization on wage differential and on the proportion of registered workers we adopt several different strategies, always using fixed-effect model with time dummies, where the unit of analysis is the industry-cohort cell.

First, we will approximate the impact of trade liberalisation by a binary dummy (*lib92*) that assumes value 1 from 1992 onwards and 0 otherwise. We use this definition because the bulk of the trade liberalisation process occurred between 1990 and 1992. This strategy will allow us to use the whole sample period from 1981 to 1998. The sample period in this case is different from the one in the previous section because the trade-related variables that we have used there are only available from 1987 onwards. The use of interactions between the binary *lib92* and another binary variable named *trade* (trade=1 if industry is tradable, and 0 otherwise) will allow us to infer whether the wage of workers in the tradable sector had a different behaviour when compared to the wages of workers in the non-tradable sector after the trade liberalisation. Similar interactions will be used to assess the impact on the wage premium for registered workers. In this case, we interact *lib92* with the proportion of registered workers in the specific industry-cohort cell (*preg*).

Second, we will add to the regression the trade-related variables: effective tariff and import penetration ratio as we did in the previous sections. In this case, the sample period will be reduced to the period 1987-1998; however we will be using additional variation within the manufacturing sector in order to estimate the effect of the changes in trade-related measures. In order to standardize the trade-related measures so that we can put together the data in meaningful way for both tradable and non-tradable sectors, we follow Dickerson et al. (2001) and use the following transformations[60]:

Openness=exp(-effective tariff) if the industry is in the tradable sector and *Openness*=0 otherwise.;

Closedness=exp(-import penetration ratio) if the industry is in the tradable sector and *closedness*=1 otherwise.

These transformations enable us to restrict the *openness* and *closedness* measures inside the range [0,1]. For the *openness* measure, the higher the effective tariff the closer the index will be to 0; whereas for the *closedness* measure, the lower the import penetration ratio, the closer the index will be to 1.

Besides the trade-related variables, i.e., *lib92* dummy, *openness* and *closedness* indices, we also control for human capital variables - 6 groups of educations (illiterate as the base category), experience and experience squared – gender and registered status. The registered status variable will give us a measure of the wage differential between registered and non-registered workers[61].

5.3.1 The Impact on Wages

Table 14 shows the results of the fixed-effect specifications with time dummies. The coefficients on column [1] suggest a wage premium of 43%[62] for registered workers. As for the impact of trade liberalisation, the coefficient of *lib92* and of its interactions with *trade* show that after 1992 workers experienced a fall of 13% in their wage relative to their counterparts in the non-tradable sector[63]. Column [2] shows that registered workers in the tradable sector earn less than registered workers in the non-tradable sector *reg*trade*. Column [3] shows that after 1992 the wage differential in favour of registered workers fell by 17%. Columns [4] to [6] bring the results for these same specifications, but excluding the agricultural sector[64]. The previous results do not change much. The estimated wage premium for registered workers is higher, 95%. After 1992, the wage for workers in the tradable sector fell by 11%. Registered workers in the tradable sector earned less than registered workers in the non-tradable sector. But the most striking result is the fall in the wage of registered workers by 55% after 1992. It is clear from these results that after the trade liberalisation, the wage of workers in the tradable sector fell relatively to the

[60]Behrman et al. (2001) use the maximum of their *index of openness* (average nominal tariff*standard deviation of nominal tariff) as the normalisation factor for their sample of countries. They argue that this would be a more credible measure in order to get a [0,1] scale. However, we cannot use such scale since by definition our index measures assume extreme values (either 0 or 1) for the non-tradable industries.

[61]Notice that this variable for each industry-cohort cell is not a binary dummy (1/0), but the proportion of registered workers on that cell.

[62]Calculated as [100*(exp(0.38)–1)].

[63]Calculated as 100*[exp(-0.1537+0.0128) –1].

[64]Note that the sample size was reduced to 2.770 observations.

wage of workers in the non-tradable sector and that the wage differential in favour of registered workers fell sharply.

So far we discussed the different response of the tradable and non-tradable sector wages to changes before and after the trade liberalisation in order to identify its impact on wage differential between registered and non-registered workers. To add more variability in the way that the trade liberalisation may have affected the wage of workers in different industries, we introduce the variables *openness* and *closedness* and their interactions with the proportion of registered workers in order to capture the different intensity that the reform affected different tradable industries. Hence, besides variation between tradable and non-tradable sectors, we add the variation within the tradable sector to identify the impact of trade liberalisation on the wage differential between registered and non-registered workers. Columns [7] to [10] in Table 14 show the results for the restricted sample that covers the period 1987-1998 and excludes the agricultural sector. This smaller sample period changes a bit the magnitude, but not the sign of the previous result: there is a positive wage premium for registered workers, but this wage premium is lower in the tradable sector. The *openness index* added in column [8] is negative and statistically significant. When we add the interaction between the openness measure and the proportion of registered workers (*openness*reg*), both variables (*openness* and *openness*reg*) turn out to be insignificant, but with opposite signs. The coefficient on the interaction (*openness*reg*) is relatively high and negative, whereas the coefficient on *openness* is small and positive. The fall in effective tariffs seems to have affected negatively the wages and this effect is mainly borne by registered workers. The *closedness* index display a positive and significant coefficient when entered without interaction as in Column [9]. Thus, increases in the import penetration ratio leads to a fall in wages. Column [10] shows that this effect is stronger the higher the proportion of registered workers in the sector.

	1981 -1998						1987 - 1998			
	Including agricultural sector			Excluding agricultural sector			Excluding agricultural sector			
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Reg	0.382	0.578	0.566	0.671	0.715	0.662	0.928	0.932	0.879	0.881
	[0.035]**	[0.039]**	[0.041]**	[0.039]**	[0.041]**	[0.037]**	[0.058]**	[0.058]**	[0.058]**	[0.058]**
lib92	0.013	0.059	0.164	-0.038	-0.029	0.263				
	[0.057]	[0.056]	[0.059]**	[0.061]	[0.061]	[0.058]**				
(lib92) * trade	-0.154	-0.126		-0.105	-0.101					
	[0.007]**	[0.008]**		[0.008]**	[0.008]**					
(lib92) * reg			-0.198			-0.444				
			[0.018]**			[0.018]**				
Reg * trade		-0.513	-0.868		-0.179	-0.120	-0.483	-0.470	-0.457	-0.544
		[0.051]**	[0.049]**		[0.055]**	[0.050]*	[0.082]**	[0.083]**	[0.081]**	[0.088]**
Openness							-0.085	0.069		
							[0.036]*	[0.118]		
Openness * reg								-0.284		
								[0.209]		
Closedness									0.168	-0.212
									[0.031]**	[0.156]
Closedness * reg										0.5248
										[0.2109]*
Constant	-1.426	-1.258	-1.093	-1.291	-1.248	-1.297	-1.424	-1.433	-1.406	-1.437
	[0.096]**	[0.095]**	[0.097]**	[0.095]**	[0.096]**	[0.089]**	[0.160]**	[0.160]**	[0.159]**	[0.159]**
N	2867	2867	2867	2770	2770	2770	1731	1731	1731	1731
R2	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
F test: id dummy	25.62	26.12	25.1	30.67	30.13	30.35	21.68	21.7	22.06	22.04

Standard errors in brackets. * Significant at 5%; ** significant at 1%
Human capital variables, gender, and industry-cohort and time dummies not shown.

Table 14: Pseudo-Cohort: Fixed Effects with Time Dummies for log Hourly Wage

All in all, it seems that all trade-related measures in the fixed-effect specifications (*lib92* dummy, *openness* index and *closedness* index) point to lower wages in the sectors most affected by the trade liberalisation, and among the most affected it seems that the registered workers were the ones who suffered most. Altogether, these results suggest that, in fact, trade liberalisation had a role in narrowing the wage gap between registered and non-registered workers. It is noteworthy that the impact of the import penetration ratio in this framework is similar to the one we found within the manufacturing sector in our first strategy.

5.3.2 The impact on the Proportion of Registered Workers

The results for the fixed-effect model with time dummies for the proportion of registered workers in Table 15 show that the proportion of men and of more educated people is positively correlated with the proportion of registered workers regardless of the specification in use. Columns [2] to [4] reveal that both tradable and non-tradable sectors had an increase in the proportion of registered workers after 1992, and the tradable sector grew by a lower amount in the sample without the agricultural sector[65]. However, when the sample is restricted to the period 1987 to 1998 and without the agricultural sector, as in Column [5], we see no change in the non-tradable sector after 1992 and a decrease in the proportion of registered workers in the tradable sector. Columns [6] and [7] show the results including *openness* and *closedness* indices. The coefficient of the openness index is positive and statistically significant (0.0414), implying that the higher the *openness* index the higher the proportion of registered workers. As for the coefficient of the *closedness* index, it is also positive and statistically significant[66].

[65]It is worth noting that unlike the "urban sectors", the agricultural sector has experienced an increase in the proportion of registered workers from 1981 to 1999.

[66]This latter result is in line with the one we found using the Spearman rank correlation.

	1981 1998				1987 1998		
	Including agricultural sector		Excluding agricultural sector		Excluding agricultural sector		
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Some elementary	-0.058	-0.060	0.180	0.198	-0.223	-0.253	-0.247
	[0.0505]	[0.0504]	[0.0474]**	[0.0465]**	[0.0601]**	[0.0606]**	[0.0603]**
Comp. elementary	0.477	0.475	0.515	0.495	0.108	0.100	0.095
	[0.0405]**	[0.0405]**	[0.0374]**	[0.0367]**	[0.0540]*	[0.0546]	[0.0543]
Comp. primary	0.835	0.836	0.881	0.880	0.510	0.493	0.497
	[0.0527]**	[0.0527]**	[0.0482]**	[0.0472]**	[0.0627]**	[0.0633]**	[0.0629]**
Comp. secondary	0.74	0.74	0.73	0.72	0.37	0.36	0.35
	[0.0552]**	[0.0552]**	[0.0510]**	[0.0500]**	[0.0690]**	[0.0698]**	[0.0694]**
Comp. college	0.399	0.409	0.405	0.381	0.122	0.128	0.109
	[0.0683]**	[0.0683]**	[0.0629]**	[0.0617]**	[0.0846]	[0.0854]	[0.0851]
exp	0.002	0.003	-0.002	-0.003	0.009	0.009	0.009
	[0.0019]	[0.0019]	[0.0019]	[0.0019]	[0.0029]**	[0.0029]**	[0.0029]**
exp^2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	[0.0000]**	[0.0000]**	[0.0000]**	[0.0000]**	[0.0000]**	[0.0000]**	[0.0000]**
sex	0.128	0.121	0.095	0.118	0.177	0.148	0.155
	[0.0263]**	[0.0264]**	[0.0231]**	[0.0228]**	[0.0301]**	[0.0301]**	[0.0299]**
lib92	0.165	0.039	0.268	0.130	0.000		
	[0.0315]**	[0.0088]**	[0.0315]**	[0.0156]**	[0.0000]		
lib92 * trade		0.010		-0.041	-0.026		
		[0.0040]**		[0.0040]**	[0.0043]**		
Openness						0.041	
						[0.0172]*	
Closedness							0.068
							[0.0148]**
Constant	0.126	0.129	0.177	0.175	0.340	0.365	0.363
	[0.0533]*	[0.0532]*	[0.0499]**	[0.0489]**	[0.0761]**	[0.0768]**	[0.0764]**
N	2867	2867	2770	2770	1731	1731	1731
R2	0.98	0.98	0.97	0.97	0.98	0.98	0.98
F test: id dummy	52.2	40.64	62.15	34.68	24.92	44.6	41.79

Standard errors in brackets. * Significant at 5%; ** significant at 1%
Industry-cohort and time dummies not shown.

Table 15: Pseudo-Cohort: Fixed-Effect with Time Dummies for the Proportion of Registered Workers

Again, there is no strong evidence that trade liberalisation has triggered an increase in the proportion of non-registered workers. The fixed effect models with time dummies revealed a positive effect of the fall in tariffs on the proportion of registered workers and at the same time a negative effect of the increase import penetration ratio. Thus, the fall in tariff would have led to an increase in the proportion of registered workers whereas the increase in the import penetration ratio would have led to a decrease in the proportion of registered workers.

6 Conclusion

The fall in the wage differential between registered and non-registered workers as well as the fall in the proportion of registered workers are two stylised facts of the Brazilian labour market in the 1990's. In this paper, we investigated whether or not trade liberalisation had a role in this process using three strategies: 1) variation in the manufacturing sector; 2) (artificial) regional variation and 3) industry-cohort variation.

Overall, we found evidence that the trade liberalisation process is behind the fall in the wage gap in the manufacturing sector. It seems that rents that went to registered workers were cut due to the more competitive environment in the economy. This result was found in both the first strategy and the third strategy used in this paper. The first strategy used only within-manufacturing industry variation and revealed a negative effect of import penetration on the wage gap. The third strategy used the non-tradable sector as a comparison group in addition to the variation within the manufacturing sector. In this latter case, both the fall in tariffs as measured by the *openness* index and the increase in import penetration ratio as measured by the *closedness* index led to a fall in the wage gap between formal and informal workers. The use of the non-tradable sector as a comparison group in the third strategy can be justified by the fact that we failed to find convincing evidence that trade liberalisation had any impact on the economy-wide fall in the wage gap according to the second strategy, that used regional variation in the industry dispersion to identify the effects of trade liberalisation in the entire economy.

The fall in the proportion of registered workers, however, does not seem to be correlated with trade liberalisation[67]. None of the strategies yielded robust evidence that the trade measures were correlated with the fall in the proportion of registered workers. The evidence found in the first strategy that effective tariff led to an increase in the proportion of registered workers in the manufacturing sector was not robust to the use of lagged regressors in the specification with additional controls. Similarly, the evidence yielded by the second strategy that the increase in the import penetration ratio led to a fall in the proportion of registered workers in the entire labour market is not robust to the use of lagged regressors. According to the third strategy, the fall in tariffs led to a higher proportion of registered workers[68], whereas the increase in the import penetration ratio led to a fall in the proportion of registered workers.

Therefore, the weak evidence for the effect of trade liberalisation on the proportion of registered workers suggests that the fall in the proportion of registered workers was due

[67]This result is in line with the results of Goldberg and Pavnick (2003) for Brazil using a different data source, the Monthly Employment Survey (PME).

[68]Similar results was found in the first strategy.

to macroeconomic factors or institutional changes that had affected in a homogenous way regions and industries within the country.

A possible caveat of the approach adopted in this paper is the fact that we do not look at the effects of trade liberalisation on the mobility pattern of the working population. Focusing on the effect on the proportion of registered workers and on the wage differential gives us only a partial account of the possible effects of those changes in the labour market. An interesting topic of research would be to analyse what happened to the size of the queue for formal jobs after the trade liberalisation. Unfortunately, we do not have surveys that contain a question similar to the one used in Soares(2004) to identify informal workers in the queue for formal jobs for periods after the trade liberalisation. However, as the wage differential is one of the main determinants of the queue for formal jobs, it is reasonable to infer that the size of the queue may have diminished after trade liberalisation due to the narrowing of the gap between formal and informal workers.

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