CENTRE for ECONOMIC PERFORMANCE

CEP Discussion Paper No 763

December 2006

The Effect of Trade Liberalization on Informality and Wages: Evidence from Mexico

Benjamin Aleman-Castilla

Abstract
This paper studies the impact of NAFTA on informality and real wages in Mexico. Using a dynamic industry model with firm heterogeneity, it is predicted that import tariff elimination could reduce the incidence of informality by making more profitable to some firms to enter the formal sector, forcing the less productive informal firms to exit the industry, and inducing the most productive formal firms to engage in trade. The model also predicts market share reallocations towards the most productive firms, and an increase in real wages due to the increased labour demand by these firms. Using data on Mexican and U.S. import tariffs together with the Mexican National Survey of Urban Labour (ENEU), I find that reductions in the Mexican import tariffs are significantly related to reductions in the likelihood of informality in the tradable industries. I also find that informality decreases less in industries with higher levels of import penetration, while it decreases more in industries that are relatively more export oriented. Finally, I confirm that the elimination of the Mexican import tariffs is related to an increase in real wages, and that the elimination of the U.S. import tariff has contributed to the expansion of the formal-informal wage differentials.

Keywords: trade liberalization, informality, wage differentials
JEL Classifications: F00, F02, F14, F15, F16, J00, J21, J23, J31
Data: Mexican National Survey of Urban Labour (ENEU) 1989-2002; Law of General Import and Export Tariffs (TIGIE) 1989-2002 (Publicly available at Diario Oficial de la Federacion, Mexico), NBER U.S. Tariff Database.

This paper was produced as part of the Centre's Labour Markets Programme. The Centre for Economic Performance is financed by the Economic and Social Research Council.

Acknowledgements
I am very grateful to Alan Manning for his advice. I also thank Barbara Petrongolo, Steve Pischke, Steve Redding, Ricardo Sousa, Mariano Bosch, Regis Barnichon, Ghazala Azmat, and participants at the LSE Labour Economics Work in Progress Seminar for their comments. Gonzalo Hernandez must be thanked for sharing the labour survey database, and Arturo Ramirez for sharing the industry-level data from the industrial survey. Financial support from CONACYT (Consejo Nacional de Ciencia y Tecnología) is acknowledged.

Benjamin Aleman-Castilla is an Occasional Research Assistant at the Centre for Economic Performance, London School of Economics. Email: B.Aleman-Castilla@lse.ac.uk

Published by
Centre for Economic Performance
London School of Economics and Political Science
Houghton Street
London WC2A 2AE

ISBN 0 7530 2069 6

1. Introduction

Over the last 25 years many Latin American countries have abandoned their import-substitution strategies in order to embrace free trade. While it has been found that this change in policy helped the region to recover from the 1980s period of stagnation and crises by increasing exports, investment, productivity and growth, there has not been any sign of beneficial effects from trade liberalization on the allocation of labour between the formal and the informal sector, the latter defined as the set of economic activities often, but not exclusively, carried out in small firms or by the self-employed, which elude government requirements such as registration, tax and social security obligations, as well as health and safety rules (Roberts, B. R. (1989)). Under the absence of unemployment benefits and a well developed social insurance system, one could think of working in the informal sector as the best alternative for a worker who loses his formal job and is not able to return to the formal sector, either temporarily or permanently, because going into unemployment would leave him receiving no income at all. In fact, one can think of the informal sector as a competitive sector with relatively free worker entry. It is not difficult to find examples of free entry to the informal sector: just think for example of a worker that loses his or her job and becomes a street vendor or opens an informal food stand in his own house. The investment required in both cases is minimal and in general there are no "bureaucratic" or similar kinds of barriers to do so[1].

This paper focuses precisely on analyzing whether trade liberalization leads to an increase or a decrease in the rate of informality. It adds to the existing literature by analyzing the 1990s Mexican experience. The North American Free Trade Agreement came into effect on the 1st of January, 1994 and, according to the legal text, its general objective was to create a free-trade zone, through the establishment of clear and permanent rules for commerce, so as to help increasing trade volume and investment, as well as generating new employment opportunities and better living standards[2]. The impact that NAFTA and other trade liberalization processes have had on the Mexican

[1] Cases in which there could be "bureaucratic" barriers to entry are those activities that are controlled by an informal, clandestine union. An example is perhaps car washing in Mexico City. The only investment a person needs to make in order to enter the business is a bucket and a cloth, but it is well known that this activity is usually controlled by a person or a group that decides if the new car washer will be allowed to work or not, and it normally depends on paying a regular "fee". However, even though this is common practice, the power of these groups is often limited to a small zone or a particular neighbourhood, and the new entrant can always choose to move to another one or to join a more convenient group.

[2] NAFTA Secretariat, http://www.nafta-sec-alena.org/DefaultSite/index_e.aspx

labour market outcomes and living standards has been previously studied by a number of researchers. Among others, Revenga, A. (1995) analyzes how Mexico's 1985-87 trade liberalization affected average employment and earnings; Hanson, G. H. (1994) studies the effect of economic integration with the United States on state-industry employment growth in Mexico. In another paper (Hanson, G. H. (2003)) he examines the impacts of trade and investment liberalization on the wage structure of Mexico. Finally, Nicita, A. (2004) performs an ex-post analysis of the effects of the trade liberalization process in Mexico between 1989 and 2000 on labour income and welfare. However, none of these previous studies has dealt with the effect of trade liberalization on the size of the informal sector.

Recent estimates by the World Bank (Maloney, W. F. (1999)) suggest that between 30 and 40% of the Mexican labour force works in the informal sector. From here, the importance of this phenomenon is evident: First, it implies that a significant fraction of Mexican workers are unprotected, which puts them in a vulnerable bargaining position with their employers. Second, it also means that the corresponding proportion of labour income in the country does not generate fiscal revenue, and this is directly reflected in the quantity and the quality of the public goods and services provided by the state. And third, as the results in this paper will show, informality disproportionately affects the less favoured groups, such as the low-skilled workers. This intensifies the problems of inequality and poverty for the country as a whole. Furthermore, the informal sector does not seem to shrink with economic growth. In the case of Mexico, while real GDP grew at an average quarterly rate of 3.17% between 1990 and 2002, the rate of informality also increased and, as estimated in this paper, it passed from about 47% to approximately 49% of total employment.

Informality is also an important characteristic of the labour markets in other developing countries. Goldberg, P. K. and N. Pavcnik (2003) analyze the cases of Brazil and Colombia, two countries that joined the General Agreement on Tariffs and Trade (GATT) and where the rates of informality are approximately 35% and 50% of the labour force, respectively. They conclude that trade liberalization did not have any significant effect on the size of the informal sector in these countries. Currie, J. and A. Harrison (1997) study the effect of trade reforms on capital and labour in Morocco during the 1980s, and they find that state-owned firms increased employment by hiring low-paid temporary workers. Even though these previous studies suggest a null or positive effect of the elimination of barriers to trade, the study of the 1990s

Mexican experience could provide more conclusive evidence, given that it involves a free trade agreement with the largest economy in the world, which means the bilateral elimination of import tariffs and at the same time a privileged access for the Mexican firms to a much wider market.

The present study uses a dynamic industry model with heterogeneous firms to analyse the possible implications of trade liberalization on the rate of informality. By making more profitable to some firms to enter the formal sector rather than the informal sector, forcing the less productive informal firms to exit the industry, and inducing the most productive formal firms to engage in trade, the model predicts that it is possible for trade liberalization to reduce the incidence of informality. Both the exit of the least productive firms and the additional export sales gained by the more productive firms reallocate market shares towards the more productive firms and contribute to an aggregate productivity increase. The increased labour demand by the more productive firms (due to their larger market shares) will tend to increase more the real wages in industries that experience larger tariff cuts.

These implications seem to be confirmed by the econometric analysis, which mainly relates data on both Mexican and U.S. import tariffs to the Mexican National Survey of Urban Labour (ENEU) for the period 1989 through 2002. To preview the results, reductions in the Mexican import tariffs are found to reduce significantly the likelihood of informality in the tradable sectors: a 1-percentage point decline in the Mexican import tariff reduces the probability of informality in a given industry by 0.392 percentage points. Combining the trade data with information from the Mexican input-output matrices available to date, an import tariff is also mapped to the non-tradable sectors. The corresponding estimates indicate that the reduction in this weighted tariff, even though positively correlated with, has not have a significant impact on the rate of informality, meaning perhaps that the beneficial effect of trade liberalization has not spread outside the tradable industries. Also, when the import tariffs are interacted with different measures of exposure to trade for the manufacturing sectors –which are constructed using data from the Mexican Annual Industrial Survey (EIA), it is found that for a given reduction in the Mexican import tariff, informality decreases less in industries with higher levels of import penetration; while for a given reduction in the U.S. import tariff, the rate of informality decreases more in those industries that are relatively more export oriented. Finally, analyzing the effect of trade liberalization on the industry employment shares and the

composition of informality within industries, it is found that reductions in the U.S. import tariffs are related to an increase in the proportion of workers in a given industry, that reductions in the Mexican import tariff generate a decrease in the fraction of informal self-employed, and that the elimination of the U.S. import tariff seems to have a reallocation effect within the informal labour force, from informal salaried to either self-employment or unpaid work.

Regarding the predictions for the wage distribution, this study confirms the conclusions by many other previous studies, in the sense that the elimination of the Mexican import tariff has contributed to increase wages. Industries with larger tariff cuts experienced larger increases in real wages. Finally, the effect of trade liberalization on the wage gap between formal and informal workers is also analyzed here, and it is found that the elimination of the U.S. import tariffs on Mexican products has contributed to the widening of this wage differential in the tradable industries.

The rest of this paper is organized as follows: Section 2 presents the theoretical framework. Section 3 provides some background on the Mexican trade liberalization process. Section 4 gives a description of the main datasets used. Section 5 presents a preliminary analysis of the relationship between trade liberalization and the rate of informality. Section 6 develops the corresponding econometric analysis. Section 7 studies the parallel implications for wages. Section 8 concludes.

2. How Could Trade Liberalization Affect Informality?

In order to give an answer to this question, three things must be considered: first, it is necessary to model the decision process of firms facing the option of producing either in the formal or the informal sector. Second, it is also necessary to incorporate a framework that is able to explain how trade liberalization affects the performance of firms. And third, these two points have to be put together. Under these considerations, a dynamic industry model with firm heterogeneity like the one in Melitz, M. J. (2003) can be used to describe the way in which trade liberalization could affect the rate of informality. The original model shows how the exposure to trade induces only the more productive firms to export while simultaneously forcing the least productive firms to exit. Both the exit of the least productive firms and the additional export sales

gained by the more productive firms reallocate market shares towards the more productive firms and contribute to an aggregate productivity increase. Profits are also reallocated towards more productive firms. This model does not consider different sectors within an industry in which firms could produce, but as shown below, it is relatively easy to include this possibility.

2.1. The decision of becoming formal.

To begin, as in the original model, assume that the preferences U of the representative consumer are given by a C.E.S. utility function over a continuum of goods indexed by ω. As shown by Dixit, A. and J. Stiglitz (1977), in such a case consumer behaviour can be modelled by considering the set of varieties consumed as an aggregate good $Q \equiv U$ with an aggregate price P. Optimal consumption and expenditure decisions for individual varieties can then be defined as:

$$\begin{aligned} q(\omega) &= Q\left[\frac{p(\omega)}{P}\right]^{-\sigma} \\ r(\omega) &= R\left[\frac{p(\omega)}{P}\right]^{1-\sigma} \end{aligned} \tag{1}$$

where $p(\omega)$ is the price for variety ω, P is the aggregate price, R is the aggregate expenditure, and σ refers to the constant elasticity of substitution between any two goods. There is a continuum of firms in the industry, each one producing a different variety. The only factor of production is labour, inelastically supplied at level L, an index of the economy's size. The cost function exhibits constant marginal cost with a fixed overhead cost. Labour used is thus a linear function of output q:

$$l = f + q/\varphi \ , \qquad \begin{array}{l} f > 0 \text{ and common to all firms in a sector} \\ \varphi > 0 \text{ different accross firms} \end{array} \tag{2}$$

where f represents the fixed overhead cost, and φ is a productivity parameter. Each firm in the domestic market faces a residual demand curve with constant elasticity σ and thus chooses the same profit maximizing mark-up equal to $\sigma/(\sigma-1) = 1/\rho$. Under these assumptions, the profits of a particular firm can be expressed as the difference between its revenue and the cost of labour:

$$\pi(\varphi) = pq - w\left(f + \frac{q}{\varphi}\right) \tag{3}$$

where w is the real wage, common to all firms in a particular industry. Substituting p from (1), maximizing (3) with respect to q, and using the resulting expression for the profit-maximizing level of output back in this same equation leads to:

$$\pi(\varphi) = k\left(\frac{\varphi}{w}\right)^{\frac{\rho}{1-\rho}} - wf \tag{4}$$

where $k = (\rho P_0)^{\frac{1}{1-\rho}}\left(\frac{1-\rho}{\rho}\right)$ and $P_0 = Q^{\frac{1}{\sigma}}P$. Equation (4) is a general expression for the maximum level of profits as a function of the productivity parameter, φ. In the Melitz, M. J. (2003) model, there are two types of firms: exporters and non exporters. Non-exporters derive profits only from their sales in the domestic market, and these could be represented by a function like the one in (4). Exporters instead get their profits both form their sales in the domestic and the foreign markets. Selling in foreign markets implies incurring an extra marginal cost τ of shipping product units abroad, as well as a fixed cost f_X of entering the foreign markets. Therefore, the total profits of an exporting firm can be expressed as the sum of the typical profit function for a non-exporting firm and another function that represents the profits obtained from exports: $\pi_X(\varphi) = k(\varphi/\tau w)^{\rho/(1-\rho)} - wf_X$. In the present context, apart from these differences between traders and non traders, there might be differences in the profit functions of firms in the formal sector with respect to firms in the informal sector. Consider first the characteristics of the informal firms. Because of their informal status, firms in the informal sector cannot take advantage of any of the trade promoting programs conducted by governmental institutions such as the Secretariat of Finance, the Secretariat of Economy, or the National Bank for Foreign Trade (BANCOMEXT)[3], and it is more difficult for them to import machinery and equipment than for formal firms, since importing would imply exposure to the

[3] For a review of the main governmental programs and instruments for promoting Mexico's exports, see MATTAR, J. (1998): "Export Promotion in Mexico," *Integration and Trade 4/5. Institute for the Integration of Latin America and the Caribbean, Inter-American Development Bank.*

customs authority and, therefore, to the government. Thus, assume that informal firms cannot import nor export. Also, given that firms in the informal sector evade taxes, every period they face a positive probability γ of being caught by the government. If this happens, the government may force them to pay a fine equal to a fraction $\varepsilon > 0$ of its profits. On the other hand, firms in the formal sector pay taxes and worker benefits over wages, so they do not need to hide from the authorities. They can also get involved in trade and thus have access to more intermediates and are in general more productive than firms in the informal sector. In the present framework, for a partition of firms between formal and informal sectors to exist in equilibrium, and in order to get the bigger and more productive firms being formal, the marginal costs of production in the formal sector are modelled as being lower than those in the informal sector, but the fixed overhead costs in the former are assumed to be higher, so that the combination of both ends being higher than the fixed overhead cost in the informal sector. Regarding the marginal costs, the above can be interpreted as saying that the fact that formal firms do not need to hide away from the authorities, that they have access to better intermediates, and that they are generally more productive, more than compensates for having to pay taxes and worker benefits. As for the higher fixed overhead costs, it represents the fact that opening a business in the formal sector implies complying with a number of regulations that the informal sector avoids (e.g. registration, bureaucracy, and corruption). Furthermore, as described above, whenever a formal firm gets involved in trade, it has to pay taxes on imported inputs and exports (per-unit costs), and there is also a fixed cost of entering a foreign market, that does not vary with the volume of exports (i.e. they have to find and inform prospective clients about their products, learn about the practices and rules in the new market, comply with foreign regulations and standards, and set up new distribution channels). As before, for a partition of the formal sector between traders and non-traders to exist in equilibrium, trade costs have to be relatively higher than formality costs.

Thus, to put the above discussion more formally, let $0 < \alpha < 1$ represent the taxes and worker benefits paid by the formal firms over wages, let β represent the fraction by which productivity is higher in the formal sector relative to the informal sector, and let f_I and f_F represent the fixed overhead costs in the informal sector and the formal sector, respectively. It is assumed that $\alpha < \beta$ and that $f_F > f_I$. Also, as in the Melitz, M. J. (2003) model, let τ be the increased marginal cost of serving the foreign market

(i.e. tariffs), and let f_X represent the fixed costs of entering the trading sub-sector. Given that access to trade increases the variety and quality of intermediate goods available for the formal firms, one could think of β as being affected by the degree of exposure to trade. In particular, $\beta_\tau < 0$. For a partition between traders and non-traders within the formal sector to exist, it is assumed that the trade costs relative to the overhead production cost in the formal sector are above a threshold level, or that $\tau^{\sigma-1} f_X > f_F$. The per-unit trade costs are modelled in the standard iceberg formulation, whereby $\tau > 1$ units of a good must be shipped in order for 1 unit to arrive at destination.

At the margin, the decision of a firm of whether to become informal or formal will be based on the comparison of the profits that it could make in the informal sector and the profits that it could make in the non-trading formal sector only. Using equation (4) together with the above assumptions leads to the following profit functions for these two types of firms:

$$\pi(\varphi) = \begin{cases} \pi_I(\varphi) = k\left[\dfrac{\varphi}{w}\right]^{\frac{\rho}{1-\rho}} - wf_I & \text{if informal} \\ \pi_F(\varphi) = k\left[\dfrac{(1+\beta)\varphi}{(1+\alpha)w}\right]^{\frac{\rho}{1-\rho}} - (1+\alpha)wf_F & \text{if non - trading formal} \end{cases} \tag{5}$$

A firm will choose to become formal whenever its expected profits in this sector are higher than the expected profits in the informal sector; this is $\pi_F^e(\varphi) \geq \pi_I^e(\varphi)$. Recalling that firms in the informal sector face a positive probability of being caught by the government and of paying a fraction of their profits as a fine, this condition defines a cut-off productivity level for firms entering into the formal sector, φ_F^*:

$$\varphi_F^* = \left\{ \frac{w^{1/(1-\rho)}\left[(1+\alpha)f_F - (1-\gamma\varepsilon)f_I\right]}{kB} \right\}^{\frac{1-\rho}{\rho}} \tag{6}$$

where $B = \left(\dfrac{1+\beta}{1+\alpha}\right)^{\frac{\rho}{1-\rho}} - (1-\gamma\varepsilon)$. Any firm with a productivity parameter above φ_F^* will prefer to produce for the formal sector. In equilibrium, φ_F^* determines the share

of firms in the formal and the informal sectors. Similarly, a firm drawing productivity φ produces in the industry if at least the expected revenue from operating in the informal sector covers the expected fixed overhead costs of production, i.e. $\pi_I^e(\varphi) \geq 0$. This defines an overall zero-profit productivity cut-off for the industry, φ^*. Finally, a firm operating in the formal sector will choose to engage in trade whenever its productivity parameter is such that the extra profits from trade are nonnegative, $\pi_X(\varphi) \geq 0$. This also defines a cut-off productivity level for the trading sub-sector, φ_X^*.

2.2. The effects of trade liberalization.

In the Melitz, M. J. (2003) model, trade liberalization comes through a reduction in the per-unit trade costs. A decrease in τ would increase the cut-off productivity level for the industry φ^*, and at the same time it would decrease the cut-off productivity level for the trading sub-sector, φ_X^*. This forces the least productive firms to exit and at the same time it generates entry of new firms into the trading sub-sector. There is also a reallocation of market shares and profits from the least productive to the most productive firms, which contributes to an aggregate productivity gain. Finally, the expanded exposure to trade offers new profit opportunities only to the more productive firms who can cover the entry cost f_X, and it also induces more entry of new firms to the industry, as prospective firms respond to the higher potential returns associated with a good productivity draw. These two effects together increase the labour demand and therefore tend to bid up the real wages in the industry.

To see the implications of this mechanism for the formal/informal decision, note that the cut-off productivity level for formality depends on P_0 through k, and P_0 in turn depends on the aggregate productivity level in the industry. φ_F^* is also a function of real wages, w, and the productivity differential between the formal and informal firms (through *B*), β. In the present framework, these are the three channels through which trade liberalization could affect the decision of a firm of whether to become formal or to stay in the informal sector.

First, if there is no effect on β, then the only channel in which trade liberalization affects informality is through wages. As in the Melitz (2003) model, a decrease in τ

increases the cut-off productivity φ^* and the aggregate productivity level in the industry. As shown in appendix A, P_0 would not change, and given that trade liberalization increases the labour demand of the new trading firms and the new prospective entrants to the industry, then the real wages in the industry will also tend to increase. As can be seen in equation (6), φ_F^* is an increasing function of wages, hence:

Proposition 1. *If trade liberalization reduces τ , then: 1) real wages in the industry will increase; 2) φ_F^* will increase, inducing less firms to enter the formal sector; 3) φ^* will increase, forcing the least productive informal firms to exit the industry; 4) φ_X^* will decrease, inducing more formal firms to enter the trading sub-sector and increasing their employment share; and 5) there will be an ambiguous effect in the employment share of the informal sector. (proof: see appendix B)*

The effect of trade liberalization on wages has been extensively studied by different researchers. For example, Hanson, G. H. (2003) examines the impact of trade liberalization on the wage structure of Mexico during the 1990s. He finds that the policy reforms resulted in an increase of wage dispersion due to an increase in the demand of skill, a reduction of the rents in industries that prior to the reform paid their workers higher wages, and a larger premium for workers in states sharing a border with the United States. Hanson, G. H. and A. Harrison (1999) study the effect of trade liberalization on Mexican wages for the pre-NAFTA period. Using data on Mexican manufacturing plants from 1984 to 1990 and from the Mexican industrial census for 1965-1988, they find that the reduction in tariff protection in 1985 disproportionately affected low-skilled workers. Cragg, M. and M. Epelbaum (1996) also analyze the Mexican case for the 1987-1993 period, and find that the wages of urban workers with completed primary education fell relative to the wages of those with higher levels of schooling. Finally, Attanasio, O., P. K. Goldberg and N. Pavcnik (2003) investigate the effects of the 1980s and 1990s tariff reductions on the wage distribution of Colombia. They identify the increasing returns to college education, the changes in industry wages that hurt sectors with initially lower wages and a higher fraction of unskilled workers, and shifts of the labour force towards the informal sector as the main channels through which trade liberalization affected the wage

distribution in that country. Thus, although the effect of trade liberalization on wages has been widely studied before, section 7 of this paper will present new evidence on this subject that confirms the important relationship between trade policy and labour income, and it will also contribute to the existing literature by analyzing the effect of trade liberalization on the wage gap between the formal and the informal sectors, which has not been studied before.

On the other hand, there might be an effect on the productivity differential, β. This could be so because firms in the formal sector may benefit more from trade liberalization than firms in the informal sector, given that they can get involved in trade and therefore have access to better and more intermediates coming from abroad. Thus,

Proposition 2. *If trade liberalization increases productivity in the formal sector, then: 1) points 1, 3, and 4 in proposition 1 will still hold; 2) there will be an ambiguous effect on* φ_F^**; and 3) there will be an ambiguous effect in the employment share of the informal sector. (proof: see appendix C)*

Intuitively, if the productivity differential between formal and informal firms increases, then the profits of the formal firms relative to those of the informal firms will also be larger than before. Formal firms will tend to get bigger and at the same time informal firms will tend to get smaller, which will bid up the real wages and could increase the employment share of the formal sector. To date, there is plenty of evidence on the fact that trade liberalization helps in increasing productivity. To mention some examples: Fernandes, A. M. (2003) explores Colombian trade policy from 1977 to 1991. Using a panel of manufacturing plants, she finds a strong positive impact of trade liberalization on productivity. Ferreira, P. C. and J. L. Rossi (2003) analyze the Brazilian trade liberalization process of 1988 to 1990. Using industry level data, they find large and widespread productivity improvements across industries after trade barriers were reduced. Pavcnik, N. (2002) investigates the effects of liberalized trade on plant productivity in Chile. Using plant-level data on Chilean manufacturers, she finds evidence of within plant productivity improvements that can be attributed to trade liberalization for the plants in the import-competing sector. Harrison, A. (1994) measures the relationship between productivity and trade reform using a panel of firms from Ivory Coast. She finds a positive association between

more open trade policies and higher productivity growth. The pre-NAFTA Mexican case has also been analyzed before. Tibout, J. and M. Westbrook (1995) examine the effects of trade liberalization on productivity for the period 1984 through 1990. Using plant-level data provided to them by the Mexican Secretariat of Commerce and Industrial Development (nowadays the Secretariat of Economy), they find that average costs in most industries fell with trade liberalization. For importables, the authors find that the cost reductions were due partly to improvements in relative productivity, whereas for exportables they seem to be due to favourable changes in relative prices (imported intermediate goods becoming cheaper).

Overall, the model presented in this section opens the possibility for the effect of trade liberalization on informality to be negative; that is, more trade liberalization leading to a lower rate of informality. In the context of the Mexican experience under NAFTA, the previous propositions could translate in the following hypotheses regarding the bilateral elimination of the import tariffs:

a. A lower Mexican import tariff allows firms in the formal sector to obtain cheaper inputs, machinery and equipment from the United States, which leads to an increase in their productivity. This effect would contribute to the reallocation of profits and labour from the less efficient informal firms to more efficient formal ones, increasing the employment share of the formal sector.
b. A reduction in the Mexican import tariff cuts down the costs for U.S. firms of operating in Mexico, in the sense that it now becomes cheaper to open a plant in Mexico and import intermediate inputs and materials from the U.S. These new, more productive entrants will increase labour demand in the formal sector and this could as well reduce informality.
c. A lower U.S. import tariff benefits the Mexican producers by allowing them to access the U.S. market in a cheaper and easier way. This would generate new profit opportunities, particularly for the more productive firms in the formal sector that are able to export, leading to an increase in their labour demand and raising real wages.

At the end, after liberalization, one could then observe lower informality rates and higher wages in more productive industries, and perhaps higher informality rates in less productive ones.

3. Trade Policy Background

The beginning of the Mexican trade liberalization process can be traced back to 1986, when the country became a member of the General Agreement on Tariffs and Trade (GATT) and stopped its import-substitution industrialization strategy. According to Kate, A. t., C. Macario and G. Niels (2000), and Revenga, A. (1995), the main consequences of these changes in trade policy were: (a) a reduction in the coverage of import license requirements from 100% of the domestic production in 1982 to 25.4% by December 1987, and to 16.5% in 1993; (b) a reduction in the maximum import tariff from 100% in 1985 to 20% in 1988; (c) a reduction of the average import tariff in the manufacturing sector from 23.5% in 1985 to 11% in 1988; and (d) a reduction in the coverage of reference prices in the manufacturing sector from 18.7% in 1985 to 0% in 1988.

In 1993 the country expanded its trade liberalization process by signing the North American Free Trade Agreement (NAFTA) with the United States and Canada, which took effect on the 1st of January 1994, and that aims at the total elimination of import tariffs by 2008. The agreement sets up a trade liberalization calendar that classifies products and by-products in 5 different groups, according to the date and way in which the corresponding import tariffs were going to be eliminated[4]:

- Group A: products and/or by-products for which tariffs were completely eliminated on the 1st of January 1994.
- Group B: products and/or by-products for which tariffs were gradually eliminated in 5 equal annual stages, starting on the 1st of January, 1994, and finishing by the 1st of January, 1998.
- Group C: products and/or by-products for which tariffs were gradually eliminated in 10 equal annual stages, starting on the 1st of January, 1994, and finishing by the 1st of January, 2003.
- Group C+: products and/or by-products for which tariffs were gradually eliminated in 15 equal annual stages, starting on the 1st of January, 1994, and finishing by the 1st of January, 2008.

[4] The text of the North American Free Trade Agreement and the calendar for Mexico's tariff elimination process can be found at the Mexican Secretariat of Economy's website: http://www.economia-snci.gob.mx/sic_php/ls23al.php?s=502&p=1&l=1

- Group D: products and/or by-products for which there were no tariffs before and after NAFTA.

Apart from tariff elimination, NAFTA also contemplates the partial elimination of many barriers to trade in services and to cross-border investment.

After 1994, Mexico signed other trade agreements with several countries, such as Colombia and Venezuela (1995); Costa Rica (1995); Bolivia (1995); Nicaragua (1998); Chile (1999); the European Union (2000); Israel (2000); El Salvador, Guatemala and Honduras (2001); Iceland, Norway, Liechtenstein and Switzerland (2001); Uruguay (2004); and Japan (2005). Nevertheless, NAFTA remains the most important event for the Mexican trade policy in the last 20 years, as the United States is by far the largest trading partner of the country[5].

4. Trade and Labour Data

The present study focuses on trade liberalization under NAFTA, and specifically on the import tariff elimination part of the agreement. It uses data on both Mexican and U.S. tariffs. The Mexican data covers the 1988-2002 period and was collected directly from the Law of General Import and Export Tariffs (TIGIE), published by the Mexican government in the Official Journal of the Federation (Diario Oficial de la Federación). During this period the TIGIE was totally modified in February 1988, December 1995 and January 2002. It was also subject to several partial modifications between these years: 84 between 1988 and 1995, and 46 between 1995 and 2002. Among these changes are those regarding NAFTA and its liberalization calendar, starting on January 1994. The data includes ad-valorem tariffs only. Regarding the U.S. tariffs, the data comes from the NBER U.S. Tariff Database, constructed by Robert C. Feenstra, John Romalis and Peter K. Schott[6], and which is based on the Harmonized Tariff Schedule of the United States (HTS). It includes ad-valorem,

[5] According to data published by the Mexican National Institute of Statistics, Geography and Computing (INEGI), FOB imports from the U.S. represented on average 69% of total Mexican FOB imports between 1990 and 2005. See http://dgcnesyp.inegi.gob.mx/cgi-win/bdieintsi.exe/Consultar.

[6] See: FEENSTRA, R. C., J. ROMALIS, and P. K. SCHOTT (2002): "U.S. Imports, Exports and Tariff Data, 1989-2001," *NBER Working Paper Series.* The database is freely available at http://gsbwww.uchicago.edu/fac/john.romalis/research/

Table 1: Production-Weighted Average Import Tariffs 1989-2002

	Mexican Tariff on U.S. Imports (% ad valorem)[1]		U.S. Tariff on Mexican Imports (% ad valorem)[2]	
	Mean	**S.D.**	**Mean**	**S.D.**
1989	14.03	0.24	2.87	0.27
1990	13.81	0.27	2.92	0.26
1991	13.96	0.26	2.47	0.26
1992	13.88	0.25	2.53	0.27
1993	13.99	0.26	2.41	0.26
1994	7.43	0.30	1.07	0.15
1995	6.40	0.25	1.63	0.19
1996	5.30	0.22	1.01	0.12
1997	4.24	0.20	0.77	0.09
1998	3.13	0.18	0.58	0.07
1999	2.42	0.14	0.41	0.06
2000	1.93	0.12	0.40	0.06
2001	1.42	0.10	0.40	0.07
2002	0.95	0.09	0.11	0.03

Calculations by the author. Weights equal to the share of Mexican sector production on national GDP. [1] Source: Diario Oficial de la Federacion (Mexico). [2] Source: NBER U.S. Tariff Database.

specific and estimated ad-valorem equivalent (AVE) tariffs based on the MFN rate of the HTS. The file also indicates products that are eligible for tariff preferences under free trade agreements such as with Canada and Mexico, and indicates products eligible for any preferential programs such as the Generalized System of Preferences (GSP). This database covers the period 1989-2001, and was complemented with the year 2002 for the present study, using the original documents of the U.S. tariff schedule published by the United States International Trade Commission[7]. Both the Mexican and the U.S. tariff schedules are based on the International Harmonized System, the global system of nomenclature that is used to describe most world trade in goods. The annual production-weighted average tariffs and their standard deviations are reported in table 1. The trade data is linked to individual level data from the Mexican National Survey of Urban Employment (ENEU), carried out by the National Institute of Statistics, Geography and Computing (INEGI) since 1983. It provides information about the state of the Mexican labour market, the main socio-demographic characteristics of the household members aged 12 and above, and housing in the principal urban areas of the country. Among other things, the ENEU provides information about employment status, duration of unemployment, job

[7] These documents can be found in PDF format at http://www.usitc.gov/tata/hts/archive/index.htm.

characteristics (position, size of workplace, social security coverage, industry affiliation, etc), hours worked, quality of job, and job search. The social security coverage data is used to generate an indicator for the informal workers. A person is classified as working in the informal sector if he or she runs a firm of 6 or less employees and does not have any kind of social or health insurance (*informal self-employed*), if he or she works for a firm of any size and does not have any kind of social or health insurance (*informal salaried*), and if he or she works without receiving any kind of payment (*unpaid workers*). This definition is similar to the one suggested by Maloney, W. F. (1999). The main socio-demographic characteristics covered by the survey are age, gender, kinship, marital status, schooling, place of birth, number of children, and migratory status. Regarding housing, the ENEU obtains information about type of dwelling, ownership, size, services, and construction materials.

The survey is carried out on a quarterly basis. The sample is divided in five independent panels (waves), and each one of them stays in the sample for five consecutive quarters. From 1983 to 1984 it covered only the three main cities in Mexico (Mexico City, Guadalajara and Monterrey). From 1985 to 1991 its coverage was expanded to 16 cities, including also the main cities at the US-Mexico border (Ciudad Juarez, Matamoros, Nuevo Laredo and Tijuana). In 1992 other 18 cities were included in the survey, and in the subsequent years another 14 cities were added. By the fourth quarter of 2000 there were 48 cities covered by the ENEU (and approximately 51.2% of the total population of the country was living in these cities by that time). This study uses mainly the April-June interviews for each year between 1989 and 2002. Only employed people are included in the sample. Matching the ENEU industry codes with the tariff codes yields an average of 243 tradable industries and 96 non-tradable industries per year. Table 2 reports some of the main characteristics of the sample for each one of the years covered here, and table 3 summarizes worker characteristics in the formal and the informal sectors for the 1994 April-June interview. From the latter it can be seen that hourly wages, years of schooling and the fraction of married workers tend to be higher in the formal sector. The likelihood of being informal also appears to be lower for the heads of the household. Regarding the geographic characteristics, the table suggests that informality rates are higher in places closer to Mexico City than to the Mexico-U.S.

Table 2: Labour Data. Sample Characteristics by Year

Year	Observations	Tradable Industries	Non-tradable Industries	Cities Covered	Informality/Total Employment[1]
1989	60,334	238	96	16	47%
1990	62,441	237	94	16	46%
1991	63,082	237	92	16	46%
1992	114,637	243	94	32	47%
1993	123,460	245	96	35	49%
1994	126,976	244	95	37	50%
1995	130,054	246	95	39	52%
1996	138,384	242	99	41	53%
1997	147,271	247	101	43	52%
1998	153,622	245	95	44	50%
1999	173,095	250	96	45	50%
2000	183,999	248	95	45	49%
2001	190,405	246	99	48	49%
2002	184,229	238	93	48	50%
Maximum	190,405	250	101	48	53%
Minimum	60,334	237	92	16	45%
Average	127,520	243	96	35	49%

Source: Mexican National Survey of Urban Employment (ENEU), INEGI. Calculations based on samples restricted to employed people. [1] Estimated as the fraction of employed people that are (a) patrons in a firm with less than 6 employees and that do not have social or health insurance, (b) employees in a firm of any size and that do not have social or health insurance, and (c) employees that do not receive payment.

border[8], and lower in places with high exposure to globalization, as measured by Hanson, G. H. (2004)[9]. At first glance this might appear to be redundant, as one may think that cities closer to the Mexico-U.S. border are those located in states with high exposure to globalization. However, figure 1 shows that the mapping between these two characteristics is not perfect. Finally, regarding the job characteristics, the table indicates that the rate of self-employment is much higher in the informal sector than in the formal one. The fraction of people working in establishments of less than 6 persons is also higher, as well as the fraction of people working at home. By the definition of informality used here, no one in the informal sector receives any kind of social or health insurance.

[8] The fraction of people living closer to Mexico City than to the U.S.-Mexico border is estimated with a variable that takes the value 0 if the road distance (in kilometres) from a particular city to the closest major U.S.-Mexico border crossing is shorter than the road distance between that city and Mexico City. It takes the value 1 otherwise. The distance data comes from the Secretariat of Transport and Communications. The four major border crossings are Tijuana-San Diego, Nogales, Ciudad Juarez-El Paso, and Nuevo Laredo-Laredo.

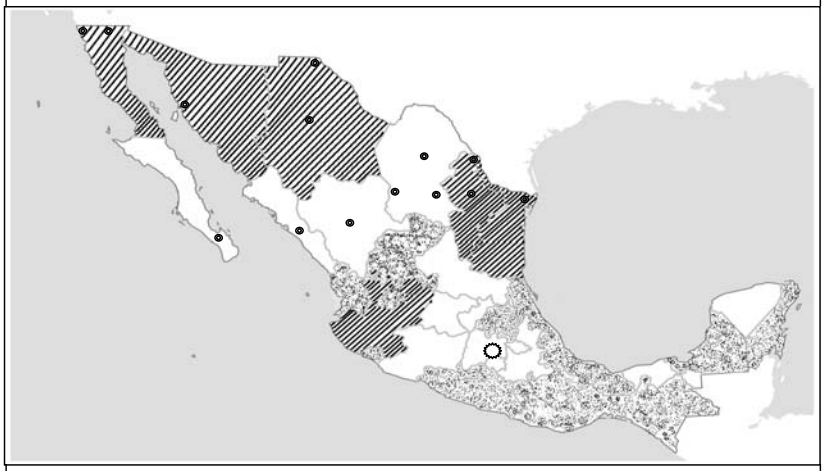
[9] He measures regional exposure to globalization through the share of *maquiladora* value added, foreign direct investment, and imports in state GDP, each one averaged over the period 1993-1999. Hanson sorts states according to their average rank across the three measures and selects as high-exposure states those whose average rank is in the top third, while low-exposure states are those whose average rank is in the bottom third. The high-exposure states are Baja California, Chihuahua, Nuevo Leon, Sonora, Jalisco, Tamaulipas and Aguascalientes. The low-exposure states are Zacatecas, Quintana Roo, Nayarit, Colima, Guerrero, Veracruz, Chiapas, Campeche, Hidalgo and Oaxaca.

Table 3: Formal and Informal Workers 1994

	Formal	Informal
Personal Characteristics		
Hourly wages	8.718	6.172
Male	0.639	0.650
Age	33.229	34.888
Experience	17.366	21.329
Schooling	9.865	7.563
Married	0.556	0.498
Cohabitating	0.044	0.064
Head of household	0.487	0.453
No. of children	1.325	2.427
Geographic Characteristics		
Living closer to Mexico City	0.647	0.727
High exposure to globalization	0.296	0.245
Low exporsure to globalization	0.239	0.293
Job Characteristics		
Self-employed	0.030	0.430
Work in less than 6 person establishment	0.115	0.801
Work at home	0.235	0.314
Receive annual bonus	0.867	0.053
Paid vacations	0.811	0.035
Receive credit for housing	0.269	0.006
Health insurance	0.961	0.000
Weekly hours worked	42.261	39.033
Has a second job	0.038	0.026

Source: author's calculations based on the Mexican National Survey of Urban Labour (ENEU) INEGI.

Figure 1. Exposure to Globalization and Proximity to the U.S. - Mexico Border



■ States with high exposure to globalization[1]

■ States with low exposure to globalization[1]

◎ Cities closer to the U.S.- Mexico border than to Mexico City [2]

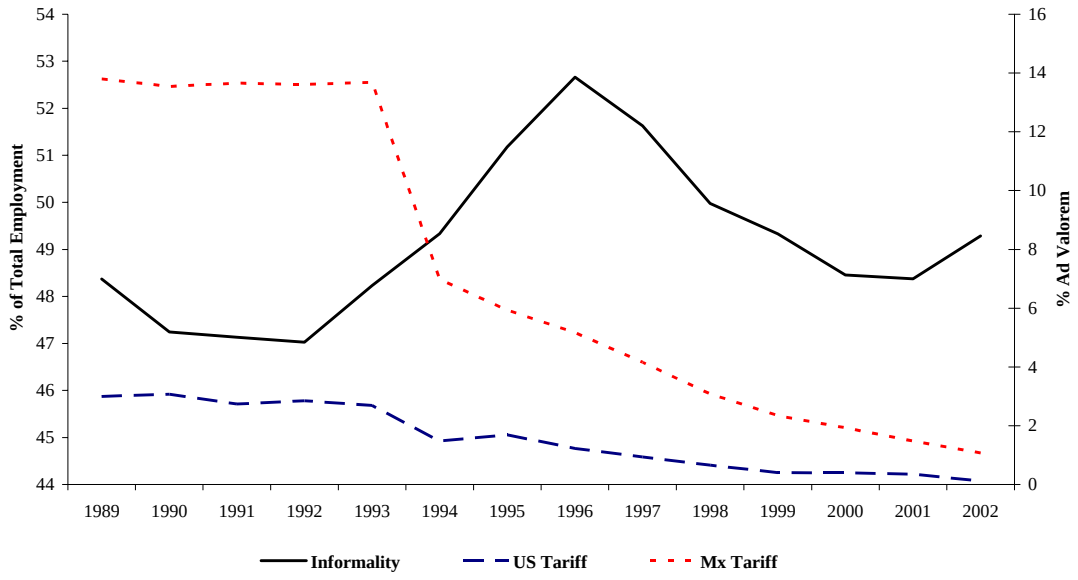
○ Mexico City

[1] Exposure to globalization as measured by Hanson, G.H. (2004)
[2] Proximity is measured by road distance (kilometers)

5. Trade Liberalization and Informality: Preliminary Analysis

The analysis of the relationship between trade liberalization and informality in this paper begins by looking at the behaviour of the average import tariffs and informality rate across time. As shown in table 2, the city coverage of the ENEU survey doubled in 1992. The 16 original cities passed from representing 100% of the observations before 1992 to approximately 40% afterwards[10]. This is a drastic modification that could affect the estimation of the yearly average rate of informality. In order to control for this possible bias, the rate of informality is obtained from a regression of the indicator for informality defined above on a set of city and time dummies, using all the years available in the sample. The estimated year coefficients are then the estimates of the annual average informality rate after controlling for the cities included in the survey. These coefficients are finally rescaled so that their mean is equal to the mean of the informality rate obtained when using the raw data. The informality rate and import tariffs series are plotted in Figure 2. The average Mexican import tariff on U.S. products remained basically constant at around 14% ad valorem between 1989 and 1993. It then dropped to 7% in the first year of NAFTA (1994), and continued to decrease gradually to approximately 1% in 2002. The U.S. import tariff

Figure 2: Average Import Tariffs and Informality



[10] The 16 original cities are Mexico City, Guadalajara, Monterrey, Puebla, León, San Luis Potosí, Tampico, Torreón, Chihuahua, Orizaba, Veracruz, Mérida, Ciudad Juárez, Tijuana, Nuevo Laredo, and Matamoros. These cities represent approximately 35% of the total population of the country.

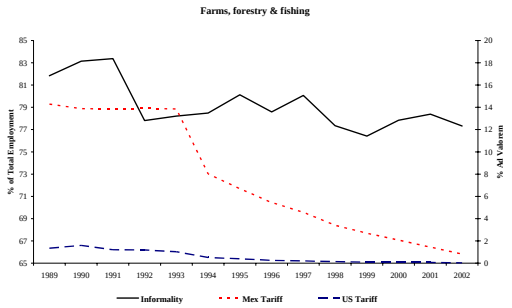
on Mexican products also remained relatively constant between 1989 and 1993, at around 3%. This low level of pre-NAFTA tariffs reflects the fact that, according to the United States International Trade Commission, Mexico was already being benefited with the Generalized System of Preferences by qualifying as a Beneficiary Developing Country[11]. This average tariff then decreased to 1% during the first year of NAFTA, increased temporarily to 2% in 1995 as a response to the Mexican peso crisis, and continued to decrease gradually to approximately 0.1% in 2002. Regarding the share of informality, the figure shows a positive trend starting in 1992 and reaching its peak just after the crisis in 1996, making the average rate to increase from 48% to 53% of total employment. It then decreased gradually to 49% in 2002. From figure 2 is difficult to see a clear relationship between trade liberalization and informality. On one hand, comparing the level of the latter in the first and the last years of the period suggests that this rate moved to a higher permanent level, and this would imply a negative relationship between tariff reduction and the rate of informality[12]. But according to the 1992-1996 positive trend, the transition to this new permanent level of informality began 3 years before the implementation of NAFTA, indicating that the change may be due to factors other than the reduction in the import tariffs. On the other hand, there is a negative trend in informality between 1996 and 2001, which coincides with the gradual reduction in both the Mexican and U.S. import tariffs, and this would suggest a positive relationship between the level of the tariffs and the rate of informality. But it is very likely that most of this negative trend is simply reflecting the recovery of the Mexican economy from the 1995 financial crisis.

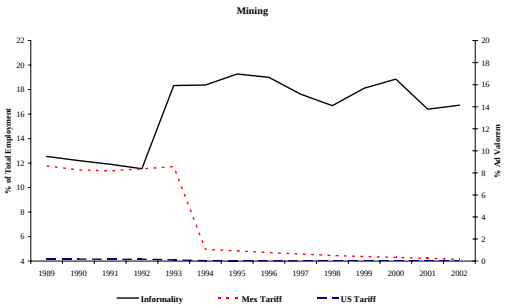
To analyze these series at a more disaggregated level, figure 3 decomposes figure 2 by economic sectors. Once again, an unambiguous relationship between the average tariffs and the rate of informality does not seem to be present. Perhaps the strongest evidence of a positive relationship comes from the *Primary metals* and the *Farms, forestry & fishing* sectors. The change to a new steady state level of informality is clearer for the *Mining* and the *Food, beverages & tobacco* sectors. As in figure 2, the

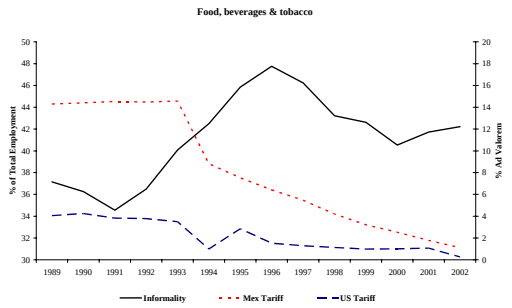
[11] For more detail, see the general notes on the Official Harmonized Tariff Schedule of the United States Annotated, from the HTSA Basic Publication in any year between 1989 and 1994. These documents can be found in the website mentioned in footnote 7.

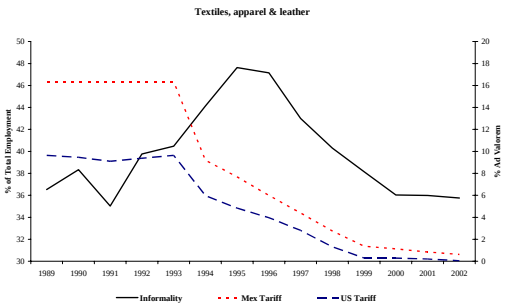
[12] The correlation coefficients for the series depicted in figure 2 are -0.546 between the Mexican import tariff and the rate of informality, and -0.484 between the latter and the U.S. import tariff.

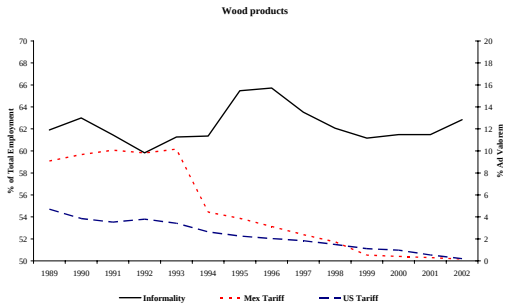
Figure 3: Average Import Tariffs and Informality Rates by Sector

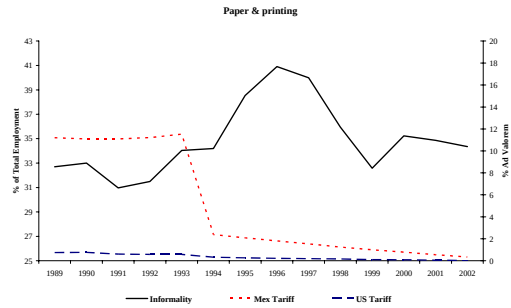


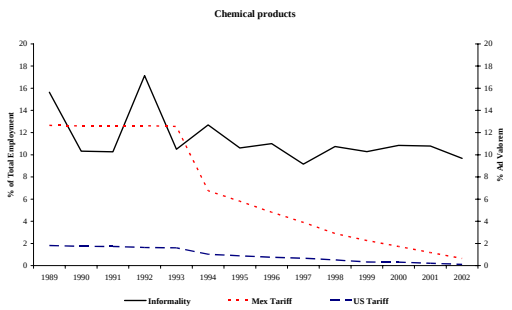












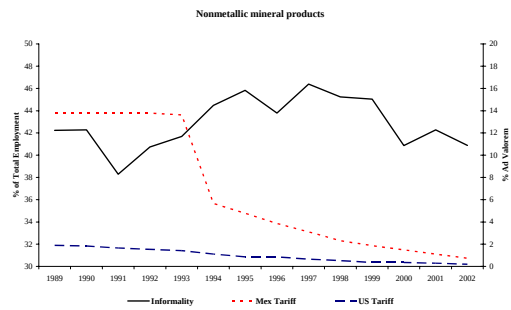
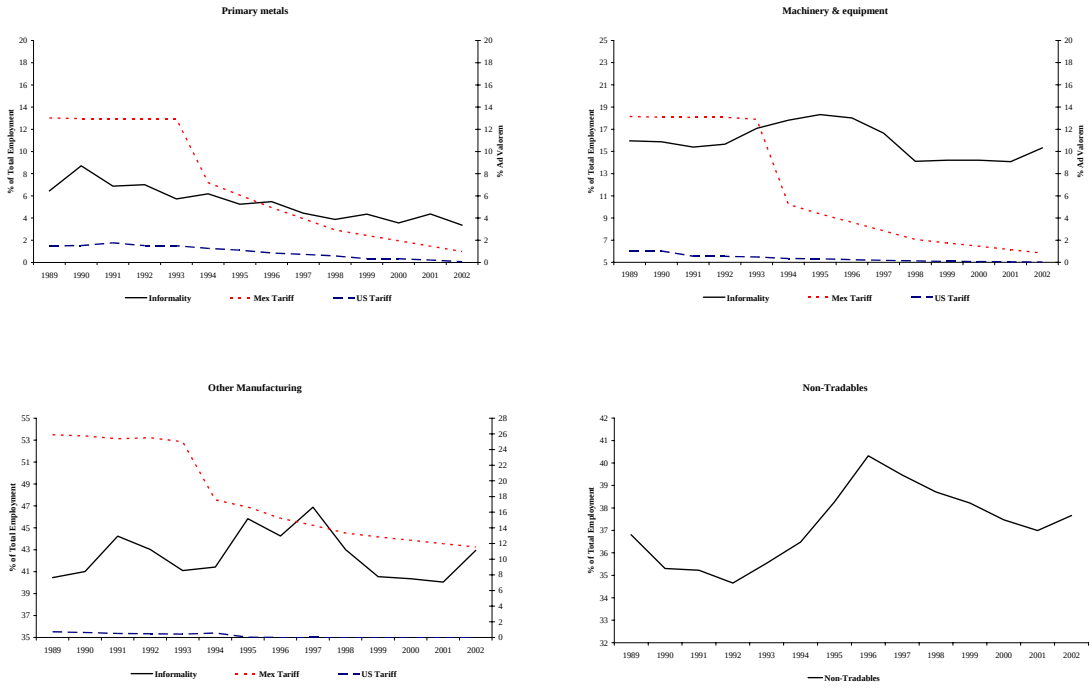


Figure 3 (continued)



transition appears to begin before the implementation of NAFTA and to peak during the financial crisis. For the rest of the sectors, the behaviour of the rate of informality is either erratic or does not seem to be affected by the import tariff elimination process. The last panel in figure 3 summarizes the trends of informality in the non tradable sectors. The rate of informality increases with the Mexican crisis in 1995 and it does not decrease to its pre-1995 levels afterwards, indicating perhaps that any beneficial effect steaming from trade liberalization has not permeated significantly to these sectors.

Table 4 summarizes the changes of the import tariffs and the informality rate for the tradable sectors over the 1989-2002 period. It shows the percentage point changes from the 1989-91 to the 2000-02 averages. Six of the sectors experienced a reduction in their informality rates. The largest increase in the informality rate is of 5.6 percentage points in the *Mining* and *Food, beverages & tobacco* sectors, while the largest decrease is of 5.2 percentage points in the *Farms, forestry & fishing* sector. It can also be seen that the *Textiles, apparel & leather* and the *Mining* sector are the ones with the largest and smallest tariff cuts respectively, both under the Mexican and

Table 4: Change in Import Tariffs and Informality by Sector (Percentage Points)

	1989-91 to 2000-02[a]		
Sector	**Informality**	**Mex**	**US**
Farms, forestry & fishing	-5.2	-12.6	-1.3
Mining	5.6	-8.1	-0.2
Food, beverage & tobacco	5.6	-12.6	-3.3
Textiles, apparel & leather	0.1	-15.5	-9.2
Wood products	-0.7	-9.3	-3.4
Paper & printing	2.0	-10.6	-0.7
Chemical products	-1.4	-11.4	-1.5
Nonmetallic mineral products	1.8	-12.7	-1.5
Primary metals	-3.3	-11.5	-1.4
Machinery & equipment	-1.6	-12.0	-0.8
Other manufacturing	-1.6	-13.7	-0.6
Maximum	5.6	-8.1	-0.2
Minimum	-5.2	-15.5	-9.2
Average	0.1	-11.8	-2.2

Source: author's calculations based on the Mexican National Survey of Urban Labour (ENEU) INEGI, Diario Oficial de la Federacion (Mexico), and the NBER U.S. Tariff Database. [a] Changes calculated as the difference between the 2000-02 and the 1989-91 averages.

the U.S. schedules[13]. The reduction in the Mexican import tariff is on average 9.6 percentage points larger than the change in the U.S. import tariff.

At an even higher level of disaggregation, tables 5 and 6 list the 50 most and the 50 less liberalized industries respectively, in terms of reduction in import tariff percentage points. For each of these industries, the tables show the 4-digit code used by INEGI in the ENEU, a brief description of the industry, the economic sector to which they belong, and the percentage point change between the 1989-91 and the 2000-02 average informality rate and import tariffs. The industries included in table 5 (table 6) are those that, when sorting all the industries in the sample according to the

[13] The *Mining* sector was nonetheless the one with the lowest levels of pre-NAFTA tariffs. See figure 3.

change of the Mexican and the U.S. import tariffs separately, appear in the top 100 (bottom 100) in both cases.

The main things to notice from the ranking in table 5 are the following: first, it is dominated by the *textiles, apparel & leather* economic sector, with 25 industries in the list; second, 25 industries experienced a decrease in their rates of informality during this period; third, the largest reductions in import tariffs are of approximately 20 percentage points; and fourth, the change in the Mexican import tariff is on average 9.2 percentage points larger than the change in the U.S. import tariff. The missing data in the "Informality" column corresponds to industries that did not appear in the sample for some of the years considered here. The tariff and informality changes are plotted against each other in figures 4 and 5. The simple regression lines fitted in these figures suggest a slightly positive relationship between the reductions in imports tariff and the changes in informality.

Regarding table 6, it can be seen that the *Machinery & equipment* and the *Mining* sectors dominate the "least liberalized" ranking, with 12 and 10 industries respectively. 28 industries had their informality rates reduced, and the largest reductions in import tariffs are of approximately 11 percentage points. Notice that for many of these industries, the change in the U.S. import tariff is equal to zero because they were already fully liberalized in 1989-91, due to the Generalized System of Preferences. The decrease in the Mexican import tariff is on average 8.6 percentage points larger than the change in the U.S. import tariff. Figures 6 and 7 plot these import tariffs changes against the informality changes. The fitted regression lines indicate that, unlike the most liberalized industries, changes in the import tariffs are now negatively correlated with changes in informality.

Finally, table 7 offers a look at the evolution of informality in the non-tradable sectors[14]. It shows the percentage point changes from the 1989-91 to the 2000-02 average rates. The *Hotels, restaurants & trade* sector is the only one that experienced a reduction in informality, of about 0.5 percentage points. The largest increase is of 8 percentage points for the *Financial services & real estate* sector. The average change in informality in the non-tradable sectors (bottom row in the table) is an increase of approximately 3 percentage points.

[14] *Petroleum & coal extraction* is classified as non-tradable because of two reasons: first, it mainly refers to petroleum extraction activities and not to the marketing of its outputs (such as oil or gas) which are mostly included in the *Chemical products* sectors; and second, petroleum extraction in Mexico is an exclusive activity of the state-own company, PEMEX.

Table 5: 50 Most Liberalized Industries

INEGI Code	Description	Sector	Informality	Change Mex	Change US
105	Fruits	Food, beverages & tobacco	-0.10	-18.66	-4.08
205	Horses, mules and donkeys	Farms, forestry & fishing	0.25	-15.50	-2.08
206	Poultry	Farms, forestry & fishing	-0.08	-15.28	-5.03
208	Lambs	Farms, forestry & fishing	.	-14.60	-1.96
1112	Cream, butter, cheese	Food, beverages & tobacco	-0.08	-13.86	-6.72
1201	Dehydrated fruits and vegetables	Food, beverages & tobacco	-0.09	-18.11	-4.21
1202	Prepared and packed fruits and vegetables	Food, beverages & tobacco	-0.05	-15.65	-5.62
1602	Piloncillo, Panela or Mascabado	Food, beverages & tobacco	0.00	-14.72	-2.15
1611	Ethyl alcohol	Food, beverages & tobacco	.	-18.15	-3.07
1901	Regional candies and jelly	Food, beverages & tobacco	0.08	-18.66	-7.64
1903	Candies and chocolates	Food, beverages & tobacco	-0.06	-18.66	-7.64
1942	Ice cream	Food, beverages & tobacco	0.04	-13.52	-14.67
2001	Agave liquors	Food, beverages & tobacco	-0.41	-20.00	-4.51
2011	Non-fermented alcoholic beverages	Food, beverages & tobacco	0.10	-18.15	-3.07
2012	Wines	Food, beverages & tobacco	0.16	-19.38	-4.53
2201	Softdrinks and purified water	Food, beverages & tobacco	0.03	-17.00	-3.32
2421	Threads	Textiles, apparel & leather	-0.06	-14.69	-9.00
2432	Cashmeres, cloths and similar products	Textiles, apparel & leather	0.04	-14.00	-20.40
2601	Impregnated textiles	Textiles, apparel & leather	0.29	-18.07	-4.55
2611	Padding and similar articles	Textiles, apparel & leather	-0.07	-17.57	-5.41
2612	Carpets and similar articles	Textiles, apparel & leather	-0.06	-15.60	-3.93
2613	Felts	Textiles, apparel & leather	0.50	-20.00	-10.94
2614	Quilted textiles	Textiles, apparel & leather	-0.21	-16.25	-13.22
2621	Lace and similar articles	Textiles, apparel & leather	0.07	-18.15	-10.27
2631	Cotton and bandages	Textiles, apparel & leather	-0.02	-15.00	-13.48
2641	Tapestry	Textiles, apparel & leather	-0.10	-18.36	-5.00
2642	Buttons, sequins, and similar articles	Textiles, apparel & leather	0.09	-18.86	-15.54
2643	Sheets and tablecloths	Textiles, apparel & leather	-0.06	-18.99	-7.36
2644	Other textiles	Textiles, apparel & leather	0.15	-18.39	-7.82
2701	Socks and tights	Textiles, apparel & leather	-0.05	-20.00	-16.43
2702	Sweaters and vests	Textiles, apparel & leather	-0.03	-19.70	-10.27
2703	Knitted articles	Textiles, apparel & leather	-0.17	-19.25	-15.12
2711	Male cloths, except shirts and uniforms	Textiles, apparel & leather	-0.06	-18.13	-11.17
2717	Underwear	Textiles, apparel & leather	.	-17.50	-9.29
2721	Hats and caps	Textiles, apparel & leather	0.07	-18.33	-9.96
2722	Palm-made hats	Textiles, apparel & leather	-0.11	-18.00	-11.94
2723	Gloves, handkerchiefs, ties and scarfs	Textiles, apparel & leather	-0.31	-17.68	-14.00
2801	Tanned leather	Textiles, apparel & leather	-0.06	-17.55	-14.40
2811	Leather products, exc shoes and clothes	Textiles, apparel & leather	0.02	-13.69	-2.86
2812	Non-plastic shoes	Textiles, apparel & leather	0.01	-17.50	-15.50
2821	Sandals and similar articles	Textiles, apparel & leather	0.19	-18.75	-7.69
2901	Sawmill production	Wood products	0.07	-15.02	-2.79
3001	Wooden furniture	Wood products	-0.01	-15.42	-5.77
3002	Box Spring mattresses	Wood products	0.07	-15.00	-12.35
4201	Plastic tubes and contours	Chemical products	-0.02	-13.46	-3.33
4511	Bricks and tiles	Nonmetallic mineral products	0.07	-15.52	-5.20
4512	Refractory products	Nonmetallic mineral products	0.14	-14.16	-1.63
5601	Automobiles, trucks and tractors	Machinery & equipment	-0.01	-13.88	-1.97
5701	Metallic bodyworks and parts	Machinery & equipment	0.00	-14.02	-1.98
5902	Watches and clocks	Other manufacturing	-0.12	-17.37	-2.87
Maximum			0.50	-13.46	-1.63
Minimum			-0.41	-20.00	-20.40
Average			0.00	-16.88	-7.68

The change is calculated as the difference between the 2000-2002 and the 1989-1991 averages. The missing observations in the "Informality" column are due to the fact that such industries did not appear in the ENEU labour survey for some of the years considered here.

Figure 4. Changes in Informality and the Mexican Import Tariff 1989-91 to 2000-02
Most Liberalized Industries

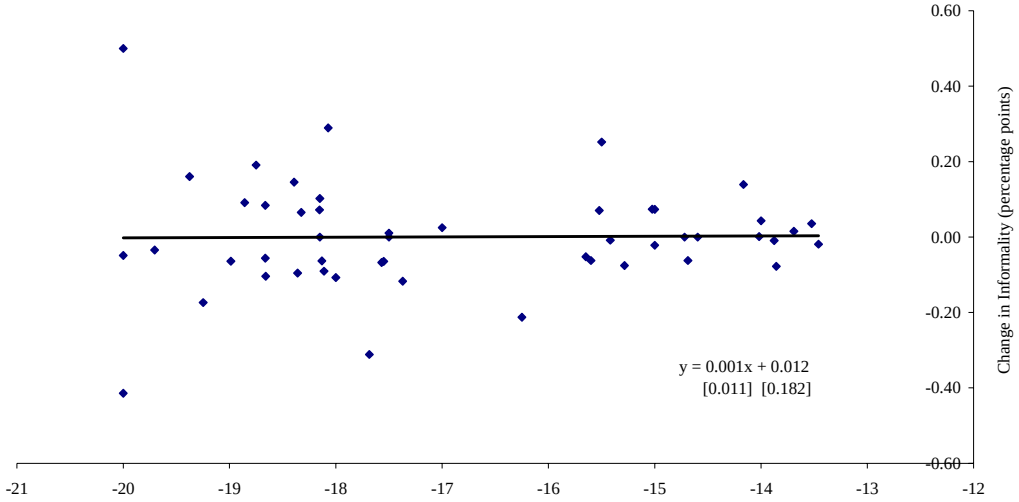


Figure 5. Changes in Informality and the U.S. Import Tariff 1989-91 to 2000-02
Most Liberalized Industries

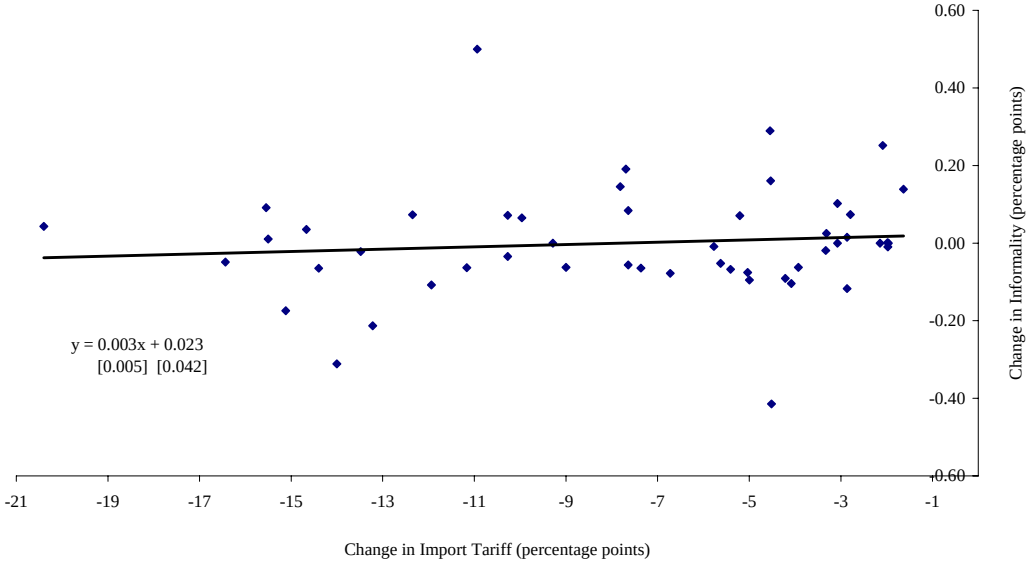


Table 6: 50 Less Liberalized Industries

INEGI Code	Description	Sector	Informality	Change Mex	Change US
201	Cattle	Farms, forestry & fishing	0.02	-1.85	0.00
203	Sheep	Farms, forestry & fishing	0.36	-10.77	-0.10
204	Goats	Farms, forestry & fishing	-0.10	-5.53	-0.20
207	Milk producer cattle and goats	Farms, forestry & fishing	-0.19	-7.80	-0.07
413	Other products from the sea	Farms, forestry & fishing	.	-8.00	0.00
501	Coal & graphite	Mining	-0.06	-6.29	0.00
511	Coke & anthracite	Mining	.	-7.91	0.00
701	Iron extraction	Mining	-0.02	-3.75	0.00
901	Limestone extraction	Mining	0.55	-10.00	0.00
911	Gypsum extraction	Mining	0.00	-6.67	0.00
921	Chippings & sand extraction	Mining	-0.03	-8.19	0.00
931	Extraction of clay, marble, quartz, etc.	Mining	0.02	-9.10	-0.05
941	Silica extraction	Mining	0.00	-10.00	0.00
1001	Fluorite extraction	Mining	-0.13	-10.00	0.00
1021	Salt & salt mines	Mining	-0.16	-10.00	0.00
1411	Corn milling	Food, beverages & tobacco	-0.01	-6.40	0.00
1801	Food for animals	Food, beverages & tobacco	0.03	-7.63	0.00
3023	Wood coffins	Wood products	-0.13	-9.22	0.00
3025	Other wooden products, exc. furniture	Wood products	-0.02	-4.58	0.00
3121	Paper made containers	Paper & printing	0.15	-7.43	0.00
3122	Cardboard made containers	Paper & printing	-0.05	-5.51	-0.02
3123	Other paper and cardboard products	Paper & printing	-0.06	-9.12	0.00
3201	Newspapers & magazines	Paper & printing	-0.03	-4.53	-0.02
3211	Printing, lithography & bookbinding	Paper & printing	0.01	-7.52	0.00
3301	Petroleum refining	Chemical products	-0.04	-9.90	0.00
3311	Lubricants & additives	Chemical products	0.06	-10.99	0.00
3501	Colourings & pigments	Chemical products	0.00	-7.73	-0.06
3521	Primary chemical products	Chemical products	-0.02	-9.99	0.00
3711	Cellulose & synthetic fibres	Chemical products	0.03	-9.78	-0.35
3801	Medicines	Chemical products	0.01	-9.04	-0.27
3901	Soaps, detergents and similar products	Chemical products	0.00	-10.97	0.00
4044	Other chemical products	Chemical products	0.15	-11.29	0.00
4401	Hydraulic cement	Nonmetallic mineral products	-0.03	-10.04	0.00
4521	Gypsum products	Nonmetallic mineral products	-0.04	-9.39	0.00
4522	Lime	Nonmetallic mineral products	0.00	-10.00	0.00
4701	Copper metallurgy and byproducts	Primary metals	0.00	-10.16	0.00
4711	Aluminum metallurgy	Primary metals	-0.09	-8.54	-0.21
4801	Metallic furniture	Machinery & equipment	-0.06	-9.81	-0.39
4911	Metallic structures, containers & platforms	Machinery & equipment	-0.01	-10.12	-0.20
5011	Tools for agriculture	Machinery & equipment	0.02	-10.83	-0.45
5041	Smelting of nonferrous metallic parts	Machinery & equipment	-0.04	-11.03	-0.42
5081	Kitchen pans	Machinery & equipment	0.11	-7.34	-0.45
5083	Other metallic products	Machinery & equipment	0.02	-9.74	-0.28
5112	M&E for the food industry	Machinery & equipment	0.12	-10.89	0.00
5151	Nonelectric extinguishers & pumps	Machinery & equipment	0.05	-10.07	-0.43
5171	Sewing machines	Machinery & equipment	-0.07	-10.87	0.00
5211	Electric industrial M&E	Machinery & equipment	-0.01	-11.06	-0.20
5301	Electric apparatuses and parts	Machinery & equipment	-0.04	-8.58	-0.11
5801	Ships	Machinery & equipment	-0.04	-10.18	0.00
5922	Candles	Other manufacturing	0.21	-10.06	-0.17
Maximum			0.55	-1.85	0.00
Minimum			-0.19	-11.29	-0.45
Average			0.01	-8.72	-0.09

The change is calculated as the difference between the 2000-2002 and the 1989-1991 averages. The missing observations in the "Informality" column are due to the fact that such industries did not appear in the ENEU labour survey for some of the years considered here.

Figure 6. Changes in Informality and the Mexican Import Tariff 1989-91 to 2000-02
Less Liberalized Industries

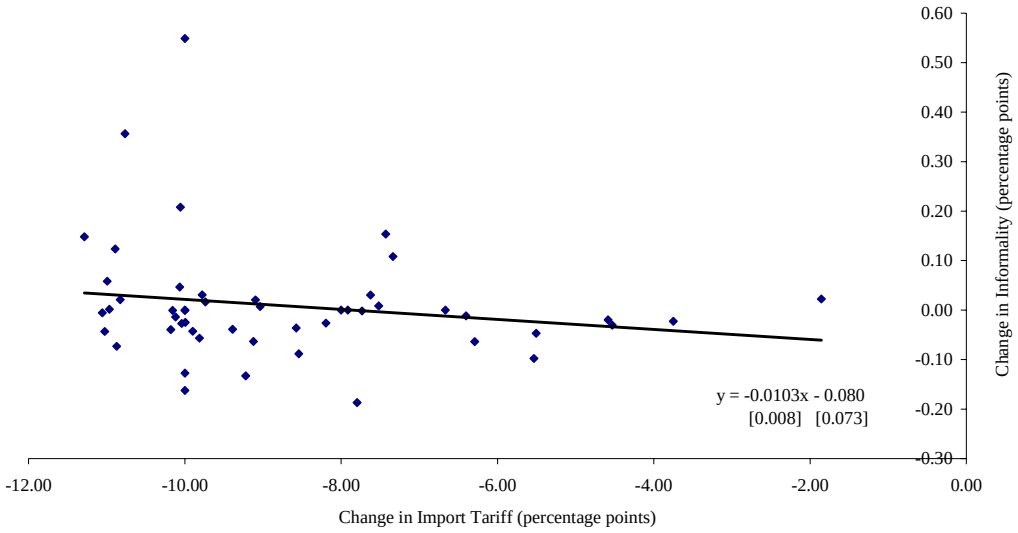


Figure 7. Changes in Informality and the U.S. Import Tariff 1989-91 to 2000-02
Less Liberalized Industries

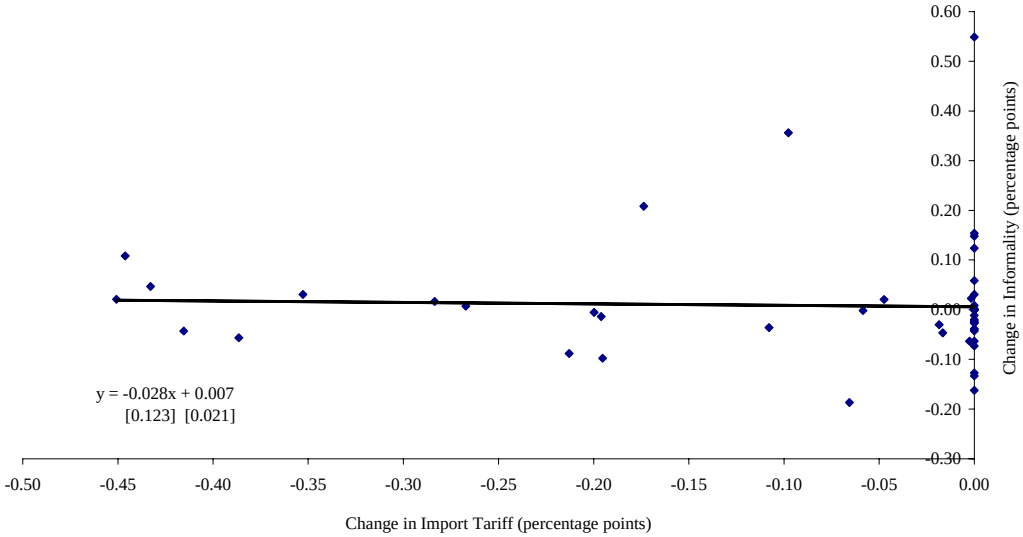


Table 7: Changes in Rates of Informality for the Non-tradable Sectors (Percentage Points)

Sector	1989-91 to 2000-02[a]
Petroleoum & coal extraction	5.4
Construction	2.1
Electricity, gas & water	1.8
Hotels, restaurants & trade	-0.5
Transport & storage	2.3
Financial services & real estate	8.0
Personal, professional and social services	1.7
Maximum	8.0
Minimum	-0.5
Average	3.0

Source: author's calculations based on the Mexican National Survey of Urban Labour (ENEU) INEGI, Diario Oficial de la Federacion (Mexico), and the NBER U.S. Tariff Database. [a] Changes calculated as the difference between the 2000-02 and the 1989-91 averages.

In sum, the main conclusions from this preliminary analysis are the following:

- When looking at the average informality rate and import tariffs (figure 2), it is not clear that trade liberalization affects in some way the level of informality. At this stage, it is impossible to distinguish the effect of tariff elimination from an apparent change in the permanent level of informality and the effect of the Mexican financial crisis of 1995.
- The analysis of the data for the tradable sectors separately (figure 3) suggests that trade liberalization may have helped in reducing the rate of informality in some sectors more than in others, such as the *Primary metals* and *Farm, forestry & fishing* sectors.
- The statistics in table 4 show that the *Mining* sector is the one with the largest increase in informality and the smallest reduction in tariffs. However, there is not enough evidence of a linear and positive relationship between the level of the tariffs and informality across sectors since, for example, the sector with the largest tariff cuts (*Textiles, apparel & leather*) is not the one with the largest decrease in informality. Regarding the non-tradable sectors, table 7 shows that the average informality rate increased by about 3 percentage points during the period of study.

- Finally, the industry level data in tables 5 and 6 indicate that 50% of the most liberalized and 56% of the less liberalized industries experienced a decrease in their rates of informality between 1989 and 2002. The summary statistics at the bottom of these tables show that the average informality rate for the less liberalized industries increased by 0.01 percentage points more than that for the most liberalized ones. This could be suggesting that the larger the tariff cut, the more helpful trade liberalization becomes in reducing these rates.

6. Trade Liberalization and Informality: Econometric Analysis

Even though useful, the evidence presented in the previous section is inconclusive and a deeper analysis of the effect of trade liberalization on informality is required. This section aims at studying this relationship in a more formal way. The main strategy implemented here is a two-stage estimation process based on the one used by Goldberg, P. K. and N. Pavcnik (2003). The first step involves the estimation of a linear probability model of the form:

$$y_{ijt} = H_{ijt}\beta_{Ht} + I_{ijt} * ip_{jt} + \varepsilon_{ijt} \qquad (7)$$

where y_{ijt} is an indicator that takes the value of 1 if worker *i* in industry *j* at time *t* is employed in the informal sector, and it is equal to 0 if he is employed in the formal sector; H_{ijt} is a vector of worker characteristics such as years of schooling, a quadratic term on years of experience, marital status, gender, position within the household (whether he is the head of the family or not), and geographic location; I_{ijt} is a set of industry dummies that indicate worker *i*'s industry affiliation; and ε_{ijt} is the error term. The coefficients ip_{jt} capture the part of the variation in informal employment that cannot be explained by worker characteristics, but that is attributable to worker *i*'s industry affiliation. These coefficients should reflect the influence of any change in the market conditions at the industry level such as import tariff elimination, given that these tariffs are the same for all the firms in a particular industry. For this reason, they are the adequate measure of informality to link with the trade data.

Following Goldberg & Pavcnik, these coefficients are denoted *industry informality differentials*. Equation (7) is estimated separately for each year in the sample.

In the second stage, these industry informality differentials are pooled over time and regressed on the Mexican import tariff, the U.S. import tariff, a set of industry and time indicators, and a set of interactions between the industry dummies and a time trend. A weighted least squares estimation is used, with weights equal to the inverse of the variance of the informality differentials from the first stage.

Because of the rotating panel structure of the ENEU survey described in section 4, a fifth of the sample in any year appears as well in the following one, and this might be a source of autocorrelation for the error term in the second stage model. To account for this, the standard errors are computed using the Newey-West method with one lag. Regarding the first stage, Huber/White/sandwich standard errors clustered at the industry level are estimated in all the regressions.

6.1. First Stage Results

Apart from providing the estimates of the industry informality differentials, the first stage estimation is also useful to study the determinants of informal labour at the individual level. The results are reported in table 8. As expected from the human capital theory, the probability of being informal decreases with years of experience and schooling. It is also lower for married workers, but not for those cohabitating with a partner without being married. Males seem to be more likely to be informal than females. This result does not seem to support what Roberts, B. R. (1989) finds for the labour market of Guadalajara, but it is consistent with Goldberg, P. K. & N. Pavcnik (2003) findings for Colombia. The table also shows that the likelihood of informality is significantly lower for the head of the household and higher for the second provider of income in the family (*secondhead*). This seems to be a reasonable result if one considers that, as found by Roberts, B. R. (1989) and argued by Maloney, W. F. (1999), the deductions made for welfare in formal employment are perceived as a disadvantage by many workers. Since social welfare in Mexico normally covers not only the worker but his family as well, there is no benefit for the second provider of income to work in the formal sector and pay the welfare deductions to get his own social insurance, as he is already covered by the one from the head of the household.

Table 8: Linear Probability Model for Informality

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
experience	-0.003 ***	-0.003 ***	-0.002 *	-0.002 ***	-0.003 ***	-0.002 **	-0.002 **	-0.003 ***	-0.003 ***	-0.003 **	-0.002 **	-0.002 *	-0.002	-0.002
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
experience^2	0.00008 ***	0.00008 ***	0.00007 ***	0.00008 ***	0.00009 ***	0.00008 ***	0.00008 ***	0.00008 ***	0.00009 ***	0.00009 ***	0.00009 ***	0.00009 ***	0.00008 ***	0.00008 ***
	[0.00001]	[0.00002]	[0.00002]	[0.00002]	[0.00002]	[0.00001]	[0.00002]	[0.00002]	[0.00002]	[0.00001]	[0.00002]	[0.00002]	[0.00001]	[0.00001]
schooling	-0.006 **	-0.005 **	-0.004	-0.006 **	-0.006 **	-0.005	-0.005 *	-0.006 **	-0.005 **	-0.008 ***	-0.007 ***	-0.007 ***	-0.007 ***	-0.007 **
	[0.003]	[0.002]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.002]	[0.002]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]
married	-0.018	-0.018 *	-0.008	-0.014	-0.011	-0.020 ***	-0.017 ***	-0.022 ***	-0.018 ***	-0.020 ***	-0.017 **	-0.017 **	-0.018 ***	-0.010
	[0.011]	[0.011]	[0.009]	[0.009]	[0.009]	[0.006]	[0.006]	[0.005]	[0.007]	[0.006]	[0.007]	[0.006]	[0.006]	[0.007]
cohabitating	0.015 **	0.010	0.010	0.016 **	0.007	0.005	-0.002	-0.004	0.003	0.002	0.005	0.007	-0.001	0.005
	[0.007]	[0.010]	[0.008]	[0.006]	[0.008]	[0.008]	[0.007]	[0.007]	[0.005]	[0.005]	[0.004]	[0.005]	[0.004]	[0.004]
male	0.045 ***	0.045 ***	0.040 ***	0.043 ***	0.032 ***	0.028 **	0.027 **	0.028 **	0.023 *	0.024 *	0.015	0.011	0.011	0.011
	[0.011]	[0.011]	[0.012]	[0.012]	[0.013]	[0.013]	[0.013]	[0.013]	[0.014]	[0.013]	[0.014]	[0.015]	[0.016]	[0.016]
firsthead	-0.029 **	-0.017 *	-0.028 ***	-0.032 ***	-0.031 ***	-0.027 ***	-0.039 ***	-0.041 ***	-0.040 ***	-0.034 ***	-0.028 ***	-0.036 ***	-0.023 ***	-0.029 ***
	[0.012]	[0.010]	[0.009]	[0.011]	[0.011]	[0.010]	[0.011]	[0.012]	[0.011]	[0.009]	[0.007]	[0.007]	[0.006]	[0.007]
secondhead	0.063 ***	0.063 ***	0.056 ***	0.061 ***	0.067 ***	0.062 ***	0.051 ***	0.056 ***	0.054 ***	0.061 ***	0.054 ***	0.049 ***	0.056 ***	0.049 ***
	[0.017]	[0.019]	[0.019]	[0.019]	[0.016]	[0.019]	[0.016]	[0.014]	[0.013]	[0.013]	[0.012]	[0.012]	[0.013]	[0.011]
ln(population)	0.013	0.015	0.007	0.001	-0.014 *	-0.014	-0.013	-0.001	0.673	0.002	0.0003	0.0002	0.007 ***	0.002
	[0.009]	[0.011]	[0.011]	[0.008]	[0.008]	[0.009]	[0.008]	[0.006]	[1.603]	[0.008]	[0.003]	[0.003]	[0.003]	[0.002]
relative distance	0.010	0.014	0.030	0.026	0.054 **	0.054 *	0.076 ***	0.030	-2.981	0.057 **	0.041 *	0.031	0.035	0.106 ***
	[0.024]	[0.020]	[0.019]	[0.024]	[0.025]	[0.032]	[0.025]	[0.025]	[7.241]	[0.028]	[0.025]	[0.022]	[0.027]	[0.024]
high exposure	0.010	0.0006	-0.002	-0.002	-0.076 **	-0.108 ***	-0.076 ***	-0.043 **	2.141	-0.070 ***	-0.099 ***	-0.103 ***	-0.143 ***	-0.088 ***
	[0.023]	[0.019]	[0.020]	[0.017]	[0.031]	[0.030]	[0.022]	[0.017]	[5.209]	[0.018]	[0.024]	[0.030]	[0.030]	[0.023]
low exposure	0.010	0.079 ***	0.013	-0.001	-0.069 ***	-0.086 *	-0.064	0.026	2.357	-0.023	-0.104 ***	-0.091 ***	-0.068 **	-0.082 ***
	[0.023]	[0.025]	[0.029]	[0.024]	[0.024]	[0.050]	[0.041]	[0.026]	[5.605]	[0.028]	[0.033]	[0.031]	[0.026]	[0.025]
No. Obs.	60,334	62,441	63,082	114,637	123,460	126,976	130,054	138,384	147,271	153,622	173,095	183,999	190,405	184,229

***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. All regressions include city and industry dummies. Robust standard errors clustered at the industry level are shown in brackets.

Table 9: Average Year-to-Year Correlations of Estimated Informality Differentials by Sector

Sector	Average 1989-2002[1]
Farms, forestry & fishing	0.699
Mining	0.673
Food, beverage & tobacco	0.830
Textiles, apparel & leather	0.594
Wood products	0.909
Paper & printing	0.862
Chemical products	0.492
Nonmetallic mineral products	0.886
Primary metals	0.180
Machinery & equipment	0.767
Other manufacturing	0.651
Non-Tradable	0.920
Maximum	0.920
Minimum	0.180
Average	0.705

[1] Average correlation coefficients at the sector level of the industry informality differentials estimated with the linear probability model in the first stage.

Regarding the geographic characteristics, the probability of informality appears to be positively correlated with the natural logarithm of the population of the city were the worker lives, and also with the proximity to Mexico City (*relative distance*). However, the estimated coefficients are statistically significant only for a few years of the sample. Finally, the estimates indicate that the likelihood of informality is significantly lower for workers living in a state with high exposure to globalization (for 9 years of the sample) and higher for those living in a state with low exposure to it (for 8 years of the sample).

Although not reported, the regressions in the first stage also included a set of city dummy variables. In most of the cases these indicators were individually and jointly statistically significant, suggesting that geographic location is an important determinant of the likelihood of informality. Also, as for Brazil and Colombia in Goldberg, P. K. & N. Pavcnik (2003), the estimated informality differentials (i.e. the coefficients of the industry dummies) are correlated through time, with the year-to-

year correlation coefficients ranging from 0.74 to 0.95, and averaging 0.85. Table 9 breaks down these correlations by economic sector. The highest coefficients are those for the *Non-tradable*, *Wood products*, *Non-metallic mineral products* and *Paper & Printing* sectors; and the lowest ones are those for the *Primary Metals*, *Chemical products*, and *Textiles, apparel & leather* sectors. A high (low) year-to-year correlation could be indicative of a low (high) sensitivity of the likelihood of informality to changes in the level of import tariffs.

6.2. Second Stage Results

After controlling for individual characteristics and city fixed effects, the next step in this estimation procedure is to pool the informality differentials over time and to relate them to the import tariffs data. The estimated equation is of the following form:

$$ip_{jt} = T_{jt}\beta_T + Y_t\gamma_Y + D_j\delta_D + \left(D_j \times tr_t\right)\phi_{(D\times tr)} + \varepsilon_{jt} \qquad (8)$$

where ip_{jt} is the informality differential for industry *j* at time *t*, T_{jt} is the matrix of Mexican and U.S. import tariffs, Y_t is a matrix of year indicators, D_j is a matrix of industry indicators, $\left(D_j \times tr_t\right)$ refers to the set of interactions between the industry dummies and a time trend, and ε_{jt} is the error term. Identification of β_T therefore comes from within-industry fluctuations of T around a time trend. A Mexican and U.S. tariff of 0% is artificially assigned to the non-tradable industries, so that these industries are not dropped from the sample. In this way, these observations do not contribute to the estimation of the coefficients in β_T but they are useful in getting more precise estimates of the year effects γ_Y. The year indicators are included to remove the aggregate variation from all the other variables in the right-hand side of equation (8), like the tariff variables. Likewise, industry indicators are included to control for unobserved industry characteristics that may be constant through time. The inclusion of the interactions between the industry dummies and the trend accounts for the possibility that different industries may follow different paths through time, for example due to factors such as the Mexican crisis (by which export oriented industries benefited more from a depreciation of the peso than other industries).

Apart from using the standard import tariffs, the effect of trade liberalization on informality can also be estimated by using an input-output matrix to calculate an import tariff that reflects the taxes payable on imported inputs more precisely. The input-output matrix shows the intersectoral transactions at current producer prices, which can be expressed as shares of the total output of each sector. These shares are then used to construct a weighted tariff that reflects the interdependence of sectors in the production process. For example, suppose that the inputs that the *Mining* sector obtains from the *Machinery & equipment* sector represent 25% of its total output, the inputs from the *Chemical products* represent another 25%, and the rest of the inputs are obtained internally. If the average sector import tariffs were 15%, 20%, and 10% respectively, the weighted tariff for the *Mining* sector would be:

$$(0.25 \times 0.15) + (0.25 \times 0.20) + (0.50 \times 0.10) = 0.1375 \qquad (9)$$

or 13.75%. Furthermore, the input-output matrix also contains the share of imported inputs for each sector. Assuming for example that 35% of all inputs used in the *Mining* sector are imported, its weighted tariff (from now on the IOM tariff) becomes 4.81% (that is 0.1375 times 0.35 times 100). Therefore, apart from summarizing the intersectoral dependence, the IOM tariff also reflects the relative importance of imports across sectors. Among the virtues of this tariff, it makes now possible to assign a real import tariff to the non-tradable sectors, because of their interactions with the tradable ones. Its disadvantage is that the input-output matrix data for Mexico is not publicly available at the industry level, so this tariff can only be calculated at the sector level. Nevertheless, this alternative approach is explored here, as it might be useful to shed more light in understanding the effect of trade liberalization on informality for the whole economy. There are four matrices available and unfortunately the most recent one is from 1980[15]. The weights used to generate the IOM tariff are the average weights derived from these matrices (1970, 1975, 1978 and 1980). Although these do not capture the evolution of the intersectoral relationships between 1989 and 2002 (which might have been affected by the trade liberalization process) they should at least reflect their historical interactions.

[15] The matrices were originally generated by the Mexican central bank, and later on by INEGI. The publicly available versions contain aggregated data for 18 economic sectors. They can be found at http://www.inegi.gob.mx/est/default.asp?c=1629 .

Table 10. Effect of Trade Liberalization on Informality

		(a)	(b)	(c)
1	Mex Tariff	0.392 ***	0.504 ***	0.283 ***
		[0.128]	[0.133]	[0.077]
	No. Obs.	4737	4403	4403
2	US Tariff	-0.144	-0.086	-0.124
		[0.252]	[0.193]	[0.163]
	No. Obs.	4697	4376	4360
3	IOM Tariff	0.080 **	0.058	0.044 **
		[0.037]	[0.036]	[0.022]
	No. Obs.	4737	4403	4403
4	Mex Tariff	0.338 **	0.491 ***	0.275 ***
		[0.144]	[0.144]	[0.085]
	US Tariff	-0.139	-0.123	-0.148
		[0.249]	[0.190]	[0.162]
	IOM Tariff	0.042	0.007	0.011
		[0.042]	[0.038]	[0.024]
	No. Obs.	4697	4376	4360

***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. All regressions include year dummies, industry dummies and industry trends. Newey-West standard errors with 1 lag are shown in brackets.

(a) Current tariffs

(b) 1-year lagged tariffs

(c) Sum of current and 1-year lagged tariffs

Finally, as mentioned above, equation (8) is estimated using weighted least squares with weights equal to the inverse of the variance of the informality differentials from the first stage, and the standard errors are computed using the Newey-West method with one lag.

Table 10 reports the estimates of equation (8). Column (a) presents the estimates obtained for the current values of the import tariffs. When the informality differentials are regressed on each one of the tariffs separately (panels 1 to 3) it can be seen that both the Mexican and the IOM tariffs have positive and significant coefficients. Panel 1 indicates that a 1-percentage point decline in the current Mexican import tariff reduces the probability of informality in a given industry by 0.392 percentage points. This effect falls to 0.338 when the three import tariffs are used together in the regression of panel 4, but remains statistically significant at a 5% level. The significance of the IOM coefficient is lost in this last specification.

Column (b) explores the possibility that adjustments in the likelihood of informality with respect to changes in the level of import tariffs may require some time to take place. Using the 1-year lagged values instead, the column reports larger effects for the Mexican tariff and smaller ones for the U.S. and the IOM tariffs. Only the first one is statistically significant. According to panel 4, a 1-percentage point decrease in the Mexican import tariff is related to a 0.491 percentage point reduction in the probability of informality.

The last column in the table uses the sum of the current and the 1-year lagged tariffs as regressors, so as to summarize the dynamic effects found in the other two. The estimates confirm the importance of the Mexican import tariff. Panel 4 indicates that a two-year cumulated reduction of 1-percentage point in this tariff generates a 0.275 percentage point reduction in the probability of informality. A significant effect for the IOM tariff is also obtained when this is used separately as regressor, but it is not robust to the inclusion of the other tariffs in the equation.

All the estimated coefficients for the U.S. import tariff are not significantly different from zero, and this is likely to be the case if one recalls that the U.S. tariffs on Mexican imports were already low before NAFTA due to the GSP (see previous section), and that it is precisely the Mexican import tariff the one that is changing the most after 1994. As for the IOM tariff, the estimates in table 10 are all of positive sign, and this would in principle support hypothesis (a) in section 2: lower Mexican import tariffs would allow Mexican firms to obtain cheaper inputs, machinery and equipment from the United States, which could lead to an increase in productivity and to a reduction of informality. However, the fact that the estimated coefficients for this tariff are not statistically significant for any of the regressions in panel 4 may also indicate that the effect of trade liberalization has not spread throughout the non-tradable sectors.

Another possibility worth exploring is that trade liberalization may have different effects on the rate of informality in industries with different degrees of exposure to trade. For example, an export oriented industry may benefit more from the elimination of the U.S. import tariff than other industries, or perhaps an industry with a relatively high share of imported inputs or means of production benefits more from the elimination of the Mexican import tariff. To see if this is the case, equation (8) is modified in order to include a set of interactions between the tariffs and the following measures of exposure to trade:

Table 11: Exposure to Trade By Sector

	1994-2002 Average Values		
Sector	**Exporter[a]**	**Importer[b]**	**Import Penetration[c]**
Mining	0.001	0.001	0.021
Food, beverage & tobacco	0.053	0.037	0.451
Textiles, apparel & leather	0.120	0.056	0.603
Wood products	0.102	0.035	0.385
Paper & printing	0.040	0.103	1.160
Chemical products	0.128	0.060	0.504
Nonmetallic mineral products	0.128	0.036	0.622
Primary metals	0.246	0.112	0.364
Machinery & equipment	0.227	0.078	24.983
Other manufacturing	0.147	0.066	1.768
Maximum	0.246	0.112	24.983
Minimum	0.001	0.001	0.021
Average	0.119	0.058	3.086

Source: author's calculations based on the Annual Industrial Survey (INEGI). [a] Net sales in foreign markets as a share of the market value of total output. [b] Share of machinery and equipment of production that is imported directly. [c] Imports of final products as a share of the market value of total output.

- *Exporter*, an industry's net sales in foreign markets as a share of the market value of its total output.
- *Importer*, the share of an industry's machinery and equipment of production that is imported directly.
- *Import Penetration*, an industry's imports of final products as a share of the market value of its total output.

The data used to generate the first two measures comes from the Annual Industrial Survey, carried out by INEGI, and which objective is to generate information about the trends of the main economic variables of the national manufacturing sector. INEGI follows a non-probabilistic sampling procedure to determine the group of manufacturing plants that will be surveyed. It excludes *maquiladoras*, basic petrochemical plants, refineries, and also micro-industry plants (i.e. plants with less than 15 employees). Among other things, this source contains annual measures of total employment, remunerations, operating costs, output, sales, income, assets, and depreciation for industries in the manufacturing sectors. The sample available for this study covers the period 1994 through 2002, and it is aggregated at the 6-digit level,

following the International Standard Industrial Classification. The data on final product imports used in constructing the third variable comes from the international trade statistics generated by the BANXICO-INEGI-SAT-Secretariat of Economy work group, and that is publicly available from INEGI[16]. The period covered is 1993 through 2002. The three variables were calculated for each industry in each available year. Table 11 summarizes these measures at the sector level. The *Primary metals* sector is the one with the highest levels of relative exports and imports of machinery and equipment, while the *Mining* sector is the one with the lowest levels. Regarding import penetration, the *Machinery & equipment*, *Other manufacturing* and *Paper & printing* sectors seem to import more final products than the ones they produce domestically.

The 1994-2002 industry averages of these variables were multiplied by the import tariffs to generate interactions for the whole 1989-2002 period. These new covariates are included in the estimation of an equation like the one in (8). The results are reported in table 12. The estimates for the current values of the tariffs in column (a) indicate that for a given reduction in the Mexican import tariff, the rate of informality decreases less in industries with higher levels of import penetration than in other industries. This may be so because those industries were already under strong foreign competition before NAFTA and had previously adjusted their levels of informal workers, or maybe because this foreign competition increased with NAFTA, forcing some firms in those industries to increase their informal labour force instead of reducing it. Also, the elimination of the U.S. import tariff helps in reducing the rate of informality in industries that are relatively more export oriented. Firms for which the main market is the U.S. benefit more from the elimination of the U.S. import tariffs on Mexican products than firms for which the main market is the domestic one. Regarding the IOM tariff, there is a modest positive effect of trade liberalization on informality for industries with a higher degree of import penetration.

The results for the 1-year lagged values in column (b) indicate that these effects are only contemporary, as none of the estimated coefficients for the interactions is significantly different from zero. Finally, the estimates for the two-year cumulated

[16] BANXICO is the Mexican Central Bank and SAT is the Tax System Administration. Data available in Banco de Información Económica, INEGI's website: http://dgcnesyp.inegi.gob.mx/cgi-win/bdieintsi.exe/NIVJ1001640016#ARBOL.

Table 12. Informality and Exposure to Trade

	(a)	(b)	(c)
Mex Tariff	0.334 *	0.613 ***	0.328 ***
	[0.200]	[0.208]	[0.123]
Mex Tariff * Importer	0.095	-2.379	-0.905
	[2.321]	[2.217]	[1.331]
Mex Tariff * Imp.Penetration	-0.015 **	-0.009	-0.007
	[0.007]	[0.009]	[0.005]
US Tariff	-0.527 *	-0.308	-0.448 **
	[0.291]	[0.229]	[0.203]
US Tariff * Exporter	5.922 **	3.181	3.907 ***
	[2.364]	[1.976]	[1.493]
IOM Tariff	0.039	-0.026	-0.010
	[0.060]	[0.054]	[0.034]
IOM Tariff * Importer	0.010	0.592	0.306
	[0.486]	[0.415]	[0.262]
IOM Tariff * Imp.Penetration	0.002 **	0.001	0.0009 *
	[0.0008]	[0.001]	[0.0005]
No. Obs.	4697	4376	4360

***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. All regressions include year dummies, industry dummies and industry trends. Newey-West standard errors with 1 lag are shown in brackets.

(a) Current tariffs

(b) 1-year lagged tariffs

(c) Sum of current and 1-year lagged tariffs

tariffs in column (c) confirm the importance of most of the effects identified in column (a).

The last part of the analysis in this section consists of looking at the impact of trade liberalization on the industry's employment share, the composition of informality (i.e. its effect on self-employment, informal salaried, and unpaid workers, separately), and the size of the labour force of firms. The employment share of a particular industry is measured as its fraction of total employment in the economy. As described in section 4, self-employment is measured as those persons in an industry that run a firm of 6 or less employees and that do not have any kind of social or health insurance. Similarly, the informal salaried are the persons that work for a firm of any size and that do not have any kind of social or health insurance. Likewise, the unpaid workers are the workers that do not receive any kind of payment. Finally, firm's labour force size is measured as the natural logarithm of the total labour force in the industry's average

Table 13. Effect of Trade Liberalization on Employment Shares, Composition of Informality, and the Size of Firms

		Employment Share[1]	Total Informality	Self-Employment	Informal Salaried	Unpaid Workers	ln(Labour Force)[1]
1	Mex Tariff	-0.010	0.392 ***	0.219 **	0.096	0.077	-0.312
		[0.021]	[0.128]	[0.092]	[0.102]	[0.059]	[0.346]
	No. Obs.	4746	4737	4737	4737	4737	4732
2	US Tariff	-0.033 *	-0.144	-0.312 *	0.451 **	-0.283 ***	-0.840
		[0.020]	[0.252]	[0.173]	[0.182]	[0.108]	[0.699]
	No. Obs.	4706	4697	4697	4697	4697	4692
3	IOM Tariff	-0.488	0.080 **	0.048 *	0.008	0.024 *	-0.332
		[0.758]	[0.037]	[0.027]	[0.029]	[0.013]	[9.254]
	No. Obs.	4746	4737	4737	4737	4737	4732
4	Mex Tariff	-0.001	0.338 **	0.185 *	0.097	0.056	-0.400
		[0.011]	[0.144]	[0.099]	[0.113]	[0.070]	[0.449]
	US Tariff	-0.031 *	-0.139	-0.308 *	0.449 **	-0.279 ***	-0.761
		[0.017]	[0.249]	[0.173]	[0.180]	[0.109]	[0.707]
	IOM Tariff	-0.451	0.042	0.025	0.0002	0.016	7.711
		[0.669]	[0.042]	[0.029]	[0.033]	[0.017]	[12.029]
	No. Obs.	4706	4697	4697	4697	4697	4692

***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. All regressions include year dummies, industry dummies and industry trends. [1]All the estimates are obtained using weighted least squares, with weights equal to the number of observations available for each industry-year. Newey-West standard errors with 1 lag are shown in brackets.

firm, and it is estimated from the data collected by the ENEU survey when the interviewed workers are asked about the total number of people in their workplaces.

The industry's employment share and the average firm's labour force size are computed for each industry in each year of the sample, and are then regressed on the import tariffs using the model in equation (8). For the cases of self-employment, informal salaried and unpaid workers, the econometric strategy is the same two-stage procedure as the one used for total informality above. The results are reported in table 13. The estimates in the first column indicate that trade liberalization has generated some labour force reallocations across industries through the elimination of the U.S. import tariff on Mexican products: a 1-percentage point reduction in this tariff increases an industry's employment share by 0.033 percentage points. This result is consistent with the theory in Melitz (2003), as it would suggest that the new profit opportunities in the U.S. market induce firms in more liberalized industries to increase their labour demand.

The second to fifth columns in table 13 refer to the composition of informality. The second column is simply repeating column (a) from table 10, in order to compare it with the results for each type of informality separately. The third to fifth columns

present these results. They indicate two main things: first, that a 1-percentage point reduction in the Mexican import tariff on U.S. products reduces informal self-employment by 0.185 percentage points, and it does not seem to affect significantly the probability of becoming an informal salaried or an unpaid worker. Second, they also indicate that a 1-percentage point reduction in the U.S. import tariff increases the likelihood of informal self-employment and unpaid work by 0.308 and 0.279 percentage points respectively, while it reduces the probability of informal salaried employment by 0.449 percentage points. Even though the coefficient for the U.S. tariff is larger (in absolute terms) than the coefficient from the Mexican tariff in the case of the informal self-employed, the overall effect of trade liberalization on this type of informality is very likely to be determined by the second one because, as shown in table 1, the average Mexican tariff is higher than the U.S. one for every year in the sample.

Also, given that the effect of trade liberalization on total informality is mainly through the elimination of the Mexican import tariff (as shown in the second column of table 13), the consequence of the reduction in the U.S. tariffs seems to be principally a reallocation of workers within the informal sector. That is, while the elimination of the Mexican tariff increases the incentives for people in the informal self-employment sub-sector to move into the formal sector, the elimination of the U.S. tariff may be simply inducing people in the informal salaried sub-sector to move into the informal self-employment and the unpaid work sub-sectors.

A possible interpretation of these results could be the following. Trade liberalization makes it more attractive for owners of firms to become formal, as it is only through formality that they can take advantage of the cheaper and better inputs, machinery or equipment produced in the U.S. (because formal firms are the only ones that can get involved in trade). Owners of firms in the informal sector are concentrated either in the self-employment or in the unpaid work sub-sectors (regarding the unpaid workers, about 97% of the people in this category works for a family business, and the median age is approximately 23 years[17]. A good example of this type of worker could then be a student that helps his parents running a family-owned restaurant every day after classes). Thus, when trade liberalization takes place, those informal employees that could either run their own informal firm or work in a family business instead of being

[17] Average values calculated from the 1989-2002, April-June ENEU interviews.

employed by someone else would be more attracted to move into self-employment or into unpaid work in the family business, as the potential profits that they could derive from those activities are now greater due to the lower trade costs. In other words, within the informal sector, trade liberalization could be making more profitable to become an entrepreneur than to remain employed in someone else's firm as an informal salaried.

Finally, the last column in table 13 shows the estimates from regressing the natural logarithm of the size of the average firm's labour force. Trade liberalization does not seem to have any significant effect on the size of the labour force, at least as reported by interviewed workers.

Summing up, the econometric analysis in this section shows the following conclusions:

- From the first stage results, the probability of informal employment decreases with years of experience and schooling. It is also lower for married and female workers. Within a household, the likelihood of informality is significantly lower for the first provider of income and significantly higher for the second provider, which supports the results of Roberts, B. R. (1989) and Maloney, W. F. (1999).
- Regarding geographic location, the results imply that the probability of informality varies significantly across cities. It is also higher for workers that live closer to Mexico City than to the U.S.-Mexico border, and lower for workers living in a state with high exposure to globalization, as defined by Hanson, G. H. (2004).
- Industry affiliation is also an important determinant of informality. As for Brazil and Colombia in Goldberg, P. K. & N. Pavcnik (2003), the estimated informality differentials are correlated through time, particularly in the *Non-tradable*, *Wood products*, *Non-metallic mineral products* and *Paper & Printing* sectors.
- From the second stage results, the estimates suggest a significant effect of trade liberalization on the probability of informal employment. Specifically, a 1-percentage point decline in the Mexican import tariff is associated with a 0.392 percentage point reduction in the likelihood of informality. The U.S. import tariff does not seem to have a significant effect, which is a reasonable outcome considering its already low level in the pre-NAFTA period. The analysis also

suggests that the benefits of trade liberalization have not spread over to the labour force in the non-tradable sectors in a statistically significant sense.

- When the import tariffs are interacted with different measures of exposure to trade for the manufacturing sectors, the analysis indicates that for a given reduction in the Mexican import tariff, informality decreases less in industries with higher levels of import penetration. Likewise, the elimination of the U.S. import tariff helps in reducing the rate of informality in industries that are relatively more export oriented.
- Finally, trade liberalization affects the employment shares and the composition of informality across industries, but it does not seem to have an impact on the size of the firm's labour force. The level of the U.S. import tariff is negatively related to the industry's share of total employment. The elimination of the Mexican import tariff reduces self-employment in the tradable industries, and the elimination of the U.S. import tariff seems to have a reallocation effect within the informal labour force, from informal salaried to either self-employment or unpaid work.

Overall, the econometric analysis provides supporting evidence for the hypothesis that the tariff elimination process undertaken by Mexico when joining NAFTA in 1994 has helped in reducing the incidence of informality. The next section studies the effect of trade liberalization on the industry wage differentials and the intra-industry formal-informal wage gap.

7. Trade Liberalization and Wages

The analysis in the previous section shows that trade liberalization in Mexico is significantly related to reductions in the probability of informal employment within the tradable economic sectors. This finding provides empirical support for one of the implications of the theoretical model discussed in section 2. This section analyzes the effect of tariff elimination on wages and the formal-informal wage differential.

The econometric analysis here starts by estimating the effect of import tariffs elimination on industry wage differentials, in order to complement the results of previous studies with the ENEU data. A two-stage approach similar to the one used for informality in the previous section is implemented. The first step consists of estimating a log-wage equation of the following form:

$$\lg wage_{ijt} = H_{ijt}\beta_{Ht} + I_{ijt} * ip_{jt} + \varepsilon_{ijt} \quad (10)$$

where $\lg wage_{ijt}$ is the natural logarithm of the wage for worker *i* in industry *j* at time *t*, H_{ijt} is a vector of worker characteristics and geographic location variables, I_{ijt} is a set of industry dummies that indicate worker *i*'s industry affiliation, and ε_{ijt} is the error term. The coefficients ip_{jt} capture the part of the variation in wages that is attributable to worker *i*'s industry affiliation. These coefficients are denoted *industry wage differentials* and they capture the difference in wages that is attributable to industry affiliation. Equation (10) is estimated separately for each year in the sample. As with informality, in the second stage these industry wage differentials are pooled over time and regressed on the Mexican import tariff, the U.S. import tariff, the IOM tariff, a set of industry and time indicators, and a set of interactions between the industry dummies and a time trend. A weighted least squares estimation is used, with weights equal to the inverse of the variance of the wage differentials from the first stage.

The results for the first stage are reported in table 14. They indicate that wages increase with years of experience and schooling, are higher for married people and for those cohabitating with a partner. They are also higher for males, for the head of the household and for the second provider of income, when compared to the other members of the family. Regarding the geographic characteristics, the estimates show that earnings increase with the population size of the city in which the worker lives, that they are higher for people living in states with high and low exposure to globalization than for those living in states with an intermediate level of exposure, and that they are higher in places closer to the U.S.-Mexico border than to Mexico City, which agrees with the findings of Hanson, G. H. (2003). Although not reported, the regressions in table 14 also included a set of city dummies, which in most of the cases where both individually and jointly significant. The estimated industry wage differentials are correlated through time, but not as strongly as the informality differentials in the previous section. The year-to-year correlation coefficients range from 0.29 to 0.80 and averaging 0.55. This suggests that wages could be highly sensitive to changes in the level of import tariffs.

Table 14. Linear Regression of ln(Wages)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
experience	0.025 ***	0.026 ***	0.026 ***	0.028 ***	0.028 ***	0.028 ***	0.027 ***	0.027 ***	0.025 ***	0.024 ***	0.021 ***	0.021 ***	0.020 ***	0.018 ***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
$experience^2$	-0.00030 ***	-0.00031 ***	-0.00030 ***	-0.00033 ***	-0.00033 ***	-0.00032 ***	-0.00030 ***	-0.00029 ***	-0.00026 ***	-0.00026 ***	-0.00023 ***	-0.00023 ***	-0.00023 ***	-0.00020 ***
	[0.00002]	[0.00002]	[0.00002]	[0.00003]	[0.00002]	[0.00002]	[0.00002]	[0.00002]	[0.00002]	[0.00002]	[0.00001]	[0.00002]	[0.00002]	[0.00001]
schooling	0.072 ***	0.076 ***	0.079 ***	0.083 ***	0.085 ***	0.088 ***	0.088 ***	0.090 ***	0.089 ***	0.085 ***	0.081 ***	0.083 ***	0.080 ***	0.076 ***
	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.005]	[0.004]
married	0.088 ***	0.108 ***	0.102 ***	0.106 ***	0.106 ***	0.099 ***	0.102 ***	0.093 ***	0.104 ***	0.114 ***	0.098 ***	0.103 ***	0.097 ***	0.098 ***
	[0.007]	[0.008]	[0.010]	[0.008]	[0.009]	[0.008]	[0.007]	[0.007]	[0.010]	[0.010]	[0.010]	[0.010]	[0.008]	[0.009]
cohabitating	0.018	0.018	0.012	0.015	0.028 *	0.016	0.023	0.021 *	0.010	0.035 ***	0.031 ***	0.033 **	0.027 ***	0.027 **
	[0.019]	[0.013]	[0.019]	[0.013]	[0.016]	[0.014]	[0.017]	[0.012]	[0.016]	[0.011]	[0.011]	[0.014]	[0.010]	[0.011]
male	0.059 ***	0.057 ***	0.034	0.017	0.020	0.013	0.008	0.009	0.002	0.016	0.030	0.047 **	0.054 **	0.052 **
	[0.020]	[0.019]	[0.024]	[0.028]	[0.030]	[0.030]	[0.026]	[0.029]	[0.024]	[0.023]	[0.025]	[0.023]	[0.023]	[0.021]
firsthead	0.108 ***	0.125 ***	0.123 ***	0.111 ***	0.118 ***	0.119 ***	0.111 ***	0.114 ***	0.120 ***	0.119 ***	0.128 ***	0.121 ***	0.125 ***	0.108 ***
	[0.011]	[0.014]	[0.012]	[0.008]	[0.010]	[0.013]	[0.011]	[0.007]	[0.010]	[0.010]	[0.010]	[0.008]	[0.009]	[0.009]
secondhead	0.049 ***	0.056 ***	0.064 ***	0.064 ***	0.064 ***	0.067 ***	0.077 ***	0.067 ***	0.064 ***	0.064 ***	0.074 ***	0.063 ***	0.059 ***	0.051 ***
	[0.010]	[0.011]	[0.010]	[0.009]	[0.015]	[0.009]	[0.009]	[0.008]	[0.010]	[0.007]	[0.009]	[0.008]	[0.008]	[0.009]
ln(population)	0.020 **	0.037 ***	0.170 ***	0.124 ***	0.072 ***	0.126 ***	0.069 ***	0.015	14.914 ***	16.446	0.011 ***	0.020 ***	-0.009	-0.004 **
	[0.008]	[0.007]	[0.014]	[0.010]	[0.014]	[0.015]	[0.014]	[0.011]	[3.734]	[12.249]	[0.002]	[0.004]	[0.008]	[0.002]
relative distance	-0.432 ***	-0.547 ***	-0.503 ***	-0.432 ***	-0.164 ***	-0.342 ***	-0.100 ***	-0.169 ***	5.871 ***	-74.285	-0.116 ***	-0.248 ***	-0.144 ***	-0.203 ***
	[0.036]	[0.039]	[0.034]	[0.028]	[0.022]	[0.030]	[0.029]	[0.029]	[1.567]	[55.248]	[0.017]	[0.048]	[0.016]	[0.038]
high exposure	0.097 ***	0.0323	0.399 ***	0.312 ***	0.314 ***	0.265 ***	0.226 ***	-0.149 ***	-26.133 ***	51.983	0.017	0.094 ***	0.611 ***	0.106 ***
	[0.025]	[0.024]	[0.025]	[0.019]	[0.039]	[0.025]	[0.032]	[0.021]	[6.595]	[38.841]	[0.030]	[0.028]	[0.097]	[0.022]
low exposure	0.084 ***	0.076 ***	0.323 ***	0.473 ***	-0.037	0.625 ***	0.291 ***	0.094 **	-25.735 ***	63.108	0.193 ***	-0.102 ***	0.671 ***	0.108 ***
	[0.024]	[0.025]	[0.035]	[0.030]	[0.058]	[0.068]	[0.068]	[0.044]	[6.481]	[46.925]	[0.039]	[0.024]	[0.099]	[0.034]
No. Obs.	52,716	53,743	53,711	97,987	102,574	106,323	108,302	115,633	122,504	130,862	148,642	159,810	164,539	159,643

***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. All regressions include city dummies and industry indicators. Robust standard errors clustered at the industry level are shown in brackets

In the second stage the industry wage differentials are pooled over time and regressed on the Mexican, the U.S. and the IOM tariffs, a set of year and industry fixed effects, and a set of interactions between the industry dummies and a time trend, as specified in the following equation, which parallels equation (8) in the previous section:

$$ip_{jt} = T_{jt}\beta_T + Y_t\gamma_Y + D_j\delta_D + (D_j \times tr_t)\eta_{(D\times tr)} + \varepsilon_{jt} \qquad (11)$$

As before, a Mexican and U.S. tariff of 0% is artificially assigned to the non-tradable industries. The year indicators are included to remove the aggregate variation from all the other variables in the right-hand side of equation (11). The industry indicators are included to control for unobserved industry characteristics that may be constant through time. The inclusion of the interactions between the industry dummies and the trend accounts for the possibility that different industries may follow different paths through time. Therefore, as with informality in equation (8), identification of β_T comes from within-industry fluctuations of T around a time trend.

Table 15 reports the estimates of equation (11). All but one of the estimated coefficients are negative, indicating a negative correlation between import tariffs and industry wage differentials. Column (a) presents the estimates obtained for the current values of the import tariffs. There is a negative and significant effect on wages coming from the elimination of the IOM tariff, and this effect is robust to the inclusion of the Mexican and the U.S. import tariff in the estimated equation (panel 4). Column (b) explores the possibility that adjustments in wages with respect to changes in the level of import tariffs may require some time to take place. Using the 1-year lagged values, the column reports smaller effects for the Mexican and the U.S. import tariffs, but again only the one from the IOM tariff is statistically significant at a 5% level. Column (c) summarizes the dynamic effects by using the sum of the current and the 1-year lagged tariffs as regressors. Panels 3 and 4 confirm the relevance of the changes in the IOM import tariffs for changes in wage differentials.

The conclusion from the estimates in table 15 is that the elimination of the IOM import tariff has contributed to the increase in wages. Industries with larger cuts in tariffs experienced larger increases in wages, and this result is valid both for the tradable and the non-tradable sectors. It is important to stress what the significant

Table 15. Effect of Trade Liberalization on Wages

		(a)	(b)	(c)
1	Mex Tariff	0.290	-0.205	-0.145
		[0.180]	[0.168]	[0.096]
	No. Obs.	4720	4388	4388
2	US Tariff	-0.216	-0.044	-0.085
		[0.315]	[0.356]	[0.208]
	No. Obs.	4680	4361	4345
3	IOM Tariff	-0.121 **	-0.129 **	-0.074 ***
		[0.052]	[0.052]	[0.029]
	No. Obs.	4720	4388	4388
4	Mex Tariff	-0.128	-0.038	-0.048
		[0.188]	[0.183]	[0.104]
	US Tariff	-0.246	-0.074	-0.108
		[0.316]	[0.359]	[0.209]
	IOM Tariff	-0.116 **	-0.134 **	-0.076 **
		[0.055]	[0.056]	[0.031]
	No. Obs.	4680	4361	4345

***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. All regressions include year dummies, industry dummies and industry trends. Newey-West standard errors with 1 lag are shown in brackets.

(a) Current tariffs

(b) 1-year lagged tariffs

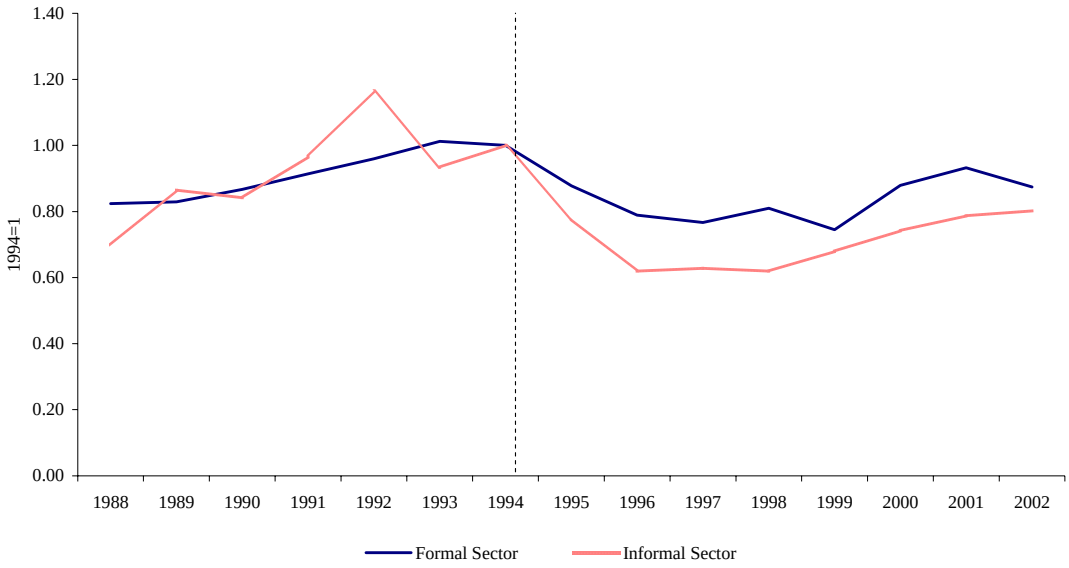
(c) Sum of current and 1-year lagged tariffs

effect on the IOM tariff could mean here: typically, domestic industries lobby for higher tariffs to protect their output and hence the wages paid to their workers. The estimates in table 15 seem to suggest instead that industries with higher levels of protection are hurt because their inputs become more expensive.

The next step is to estimate the effect of trade liberalization on the formal-informal wage gap. As pointed out by Robbins, D. (1996), empirical work relating trade liberalization and income distribution has identified the important anomaly that the former has helped in shifting income towards high-skilled labour by increasing its relative demand in many developing countries[18]. Considering that the average years of schooling in the formal sector is typically higher than in the informal sector (see table 3), the effects of this skill-biased technological change should also be present

[18] Anomaly in the sense that this result is not what would be predicted by the standard Hecksher-Ohlin model of the International Economics theory, considering that low-skilled labour is the abundant factor of production in LDCs.

Figure 8. Average Real Hourly Wages



when comparing these two. To see this, figure 8 plots the average real hourly wages (in 2002 pesos) for the formal and the informal sectors in Mexico using the April-June ENEU interviews with 1994 as the base year. The chart clearly shows that after enacting NAFTA in 1994 average wages in the informal sector have remained lower than their counterpart in the formal sector. From 1989 to 1994 inclusive, real hourly wages in the informal sector represented on average 99.02% of the real hourly wages in the formal sector. From 1995 to 2002 this figure dropped to 81.03%. Table 16 presents the changes of the formal-informal wage gap and the import tariffs at the sector level over the period 1989 through 2002[19]. The wage gap index increased in 12 out of 18 sectors during those years. The largest increase is of 2.23 points for the *Primary metals* sector, while the largest decrease is of 3.39 points for the *Personal, professional and social services* sector. Although not reported in the table, while the average change in the wage gap for the tradable sectors is positive and equal to 0.66 points, it is negative and equal to -0.74 points for the non-tradable ones. This could be indicative of a negative relationship between the level of the tariffs and the wage differentials, which seems to be confirmed by figures 9 and 10: within the tradable

[19] The changes in the wage gap are calculated as follows: For each year and economic sector the wage gap in real hourly wages is obtained by taking the difference between real wages in the formal and the informal sectors. The resulting series is expressed setting the estimated gap for 1994 as the base observation (1994=1). The change in the wage gap is then obtained as the difference between the 1989-1991 and the 2000-2002 average values of this index.

Table 16: Change in Import Tariffs and Formal-Informal Wage Differential by Sector

	1989-91 to 2000-02[a]		
Sector	**Wage Differential[b]**	**Mex**	**US**
Tradables:			
Farms, forestry & fishing	0.32	-12.6	-1.3
Mining	-0.59	-8.1	-0.2
Food, beverage & tobacco	1.75	-12.6	-3.3
Textiles, apparel & leather	0.89	-15.5	-9.2
Wood products	0.11	-9.3	-3.4
Paper & printing	0.28	-10.6	-0.7
Chemical products	1.00	-11.4	-1.5
Nonmetallic mineral products	-0.23	-12.7	-1.5
Primary metals	2.23	-11.5	-1.4
Machinery & equipment	0.04	-12.0	-0.8
Other manufacturing	1.45	-13.7	-0.6
Non-tradables:			
Petroleoum & coal extraction	-0.48		
Construction	-3.35		
Electricity, gas & water	0.18		
Hotels, restaurants & trade	0.95		
Transport & storage	1.00		
Financial services & real estate	-0.08		
Personal, professional and social services	-3.39		
Maximum	2.23	-8.1	-0.2
Minimum	-3.39	-15.5	-9.2
Average	0.12	-11.8	-2.2

Source: author's calculations based on the ENEU survey (INEGI), Diario Oficial de la Federacion (Mexico), and the NBER U.S. Tariff Database. [a] Changes calculated as the difference between the 2000-02 and the 1989-91 averages. [b] Wage gap calculated as the difference between average real hourly wages between the formal and the informal sectors (2002 pesos, 1994=1).

Figure 9. Changes in Wage Differentials and the Mexican Import Tariffs 1989-91 to 2000-02
Tradable Sectors

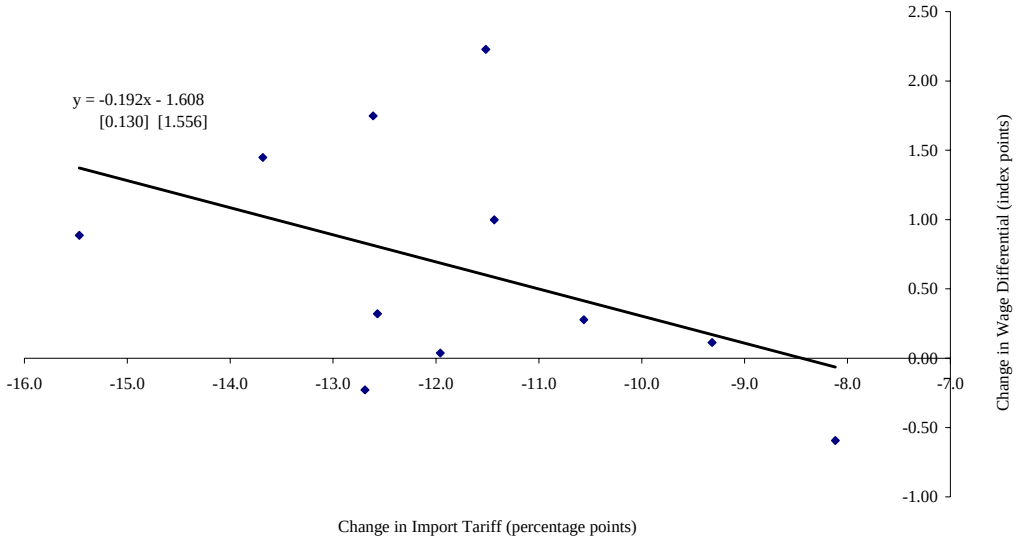
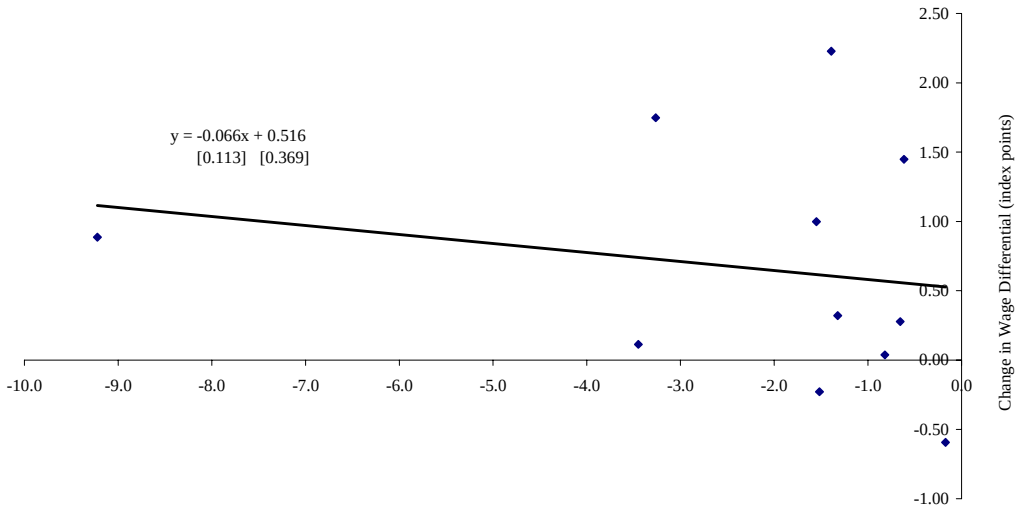


Figure 10. Changes in Wage Differentials and the U.S. Import Tariffs 1989-91 to 2000-02
Tradable Sectors



sectors larger reductions in both the Mexican and the U.S. import tariffs are associated with larger increases in the formal-informal wage gap.

In order to estimate the effect of trade liberalization on the formal-informal wage gap formally, equation (10) is modified in the following way:

$$\lg wage_{ijt} = H_{ijt}\beta_{Ht} + (H_{ijt} \times f_{ijt})\delta_{(H\times f)t} + I_{ijt} * ip_{jt} + (I_{ijt} \times f_{ijt})\phi_{(I\times f)jt} + \varepsilon_{ijt} \qquad (12)$$

where $(H_{ijt} \times f_{ijt})$ is a matrix of interactions between the vector H_{ijt} and an indicator for formality f_{ijt} that takes the value of 1 if worker *i* in industry *j* at time *t* works in the formal sector and 0 otherwise; $(I_{ijt} \times f_{ijt})$ is a matrix of interactions between the industry dummies and the formality indicator; and the rest of the terms are as defined before. The new coefficients $\delta_{(H\times f)t}$ capture the part of the variation in wages that is attributable to differences in individual and geographic characteristics between the formal and the informal workers. The coefficients $\phi_{(I\times f)t}$ are denoted *within-industry formal-informal wage differentials* and they capture the difference in wages between formal and informal workers that is attributable to industry affiliation. Equation (12) is estimated separately for each year in the sample. As before, in the second stage these formal-informal wage differentials are pooled over time and regressed on the Mexican import tariff, the U.S. import tariff, the IOM tariff, a set of industry and time indicators, and a set of interactions between the industry dummies and a time trend.

The results for the first stage are reported in table 17. The interactions with the formality indicator suggest that there are not important differences in returns to potential experience between the formal and the informal workers, but the effects of more years of schooling, being the head of a household, living in a bigger city, living closer to the U.S.-Mexico border, or living in a state with low exposure to globalization are in general significantly larger for the formal workers. As with the previous estimations, the regressions in table 17 also included a set of city dummies, and the interactions of these with the formality indicator. In most of the cases these variables where both individually and jointly significant, indicating that geographic location is an important determinant of earnings, and that its effect varies across formal and informal workers. The estimated formal-informal wage differentials are correlated through time, with year- to-year correlation coefficients ranging from 0.12

Table 17. Linear Regression of ln(Wages)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
experience	0.026 ***	0.024 ***	0.027 ***	0.028 ***	0.027 ***	0.027 ***	0.025 ***	0.025 ***	0.023 ***	0.023 ***	0.019 ***	0.020 ***	0.019 ***	0.017 ***
	[0.001]	[0.002]	[0.002]	[0.001]	[0.002]	[0.001]	[0.002]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
experience*formal	-0.004 **	0.002	-0.002	-0.002	0.001	-0.0002	0.004 *	0.003 *	0.004 **	0.0005	0.001	0.001	0.0002	0.001
	[0.002]	[0.003]	[0.002]	[0.001]	[0.001]	[0.002]	[0.002]	[0.002]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
experience^2	-0.00033 ***	-0.00032 ***	-0.00034 ***	-0.00035 ***	-0.00034 ***	-0.00034 ***	-0.00030 ***	-0.00029 ***	-0.00026 ***	-0.00028 ***	-0.00024 ***	-0.00025 ***	-0.00026 ***	-0.00022 ***
	[0.00002]	[0.00003]	[0.00002]	[0.00003]	[0.00003]	[0.00002]	[0.00002]	[0.00002]	[0.00002]	[0.00002]	[0.00002]	[0.00002]	[0.00002]	[0.00002]
experience^2*formal	0.00008 ***	0.00001	0.00007 **	0.00005 **	0.00004 *	0.00006 ***	-0.000001	0.00001	0.00001	0.00005 **	0.00005 **	0.00005 **	0.00008 ***	0.00006 ***
	[0.00002]	[0.00003]	[0.00003]	[0.00002]	[0.00002]	[0.00002]	[0.00003]	[0.00003]	[0.00002]	[0.00003]	[0.00002]	[0.00002]	[0.00002]	[0.00002]
schooling	0.063 ***	0.063 ***	0.062 ***	0.069 ***	0.067 ***	0.070 ***	0.066 ***	0.070 ***	0.070 ***	0.065 ***	0.060 ***	0.061 ***	0.057 ***	0.054 ***
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.005]	[0.005]	[0.004]	[0.005]	[0.004]	[0.004]
schooling *formal	0.012 ***	0.021 ***	0.026 ***	0.022 ***	0.029 ***	0.030 ***	0.036 ***	0.033 ***	0.034 ***	0.032 ***	0.033 ***	0.036 ***	0.037 ***	0.036 ***
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.005]	[0.005]	[0.005]	[0.004]	[0.004]	[0.004]	[0.004]
married	0.115 ***	0.151 ***	0.125 ***	0.144 ***	0.134 ***	0.115 ***	0.135 ***	0.120 ***	0.140 ***	0.143 ***	0.128 ***	0.144 ***	0.124 ***	0.136 ***
	[0.012]	[0.013]	[0.018]	[0.010]	[0.011]	[0.009]	[0.009]	[0.010]	[0.010]	[0.011]	[0.012]	[0.008]	[0.010]	[0.008]
married*formal	-0.048 ***	-0.072 ***	-0.041 *	-0.071 ***	-0.046 ***	-0.026 **	-0.061 ***	-0.051 ***	-0.069 ***	-0.056 ***	-0.053 ***	-0.074 ***	-0.048 ***	-0.069 ***
	[0.014]	[0.015]	[0.023]	[0.013]	[0.014]	[0.012]	[0.010]	[0.011]	[0.010]	[0.012]	[0.013]	[0.009]	[0.011]	[0.010]
cohabitating	0.051 **	0.067 ***	0.047 *	0.057 ***	0.061 ***	0.035 ***	0.064 ***	0.052 ***	0.044 **	0.066 ***	0.065 ***	0.071 ***	0.049 ***	0.058 ***
	[0.023]	[0.016]	[0.026]	[0.014]	[0.018]	[0.013]	[0.021]	[0.013]	[0.018]	[0.010]	[0.010]	[0.015]	[0.011]	[0.012]
cohabitating*formal	-0.079 ***	-0.105 ***	-0.083 ***	-0.099 ***	-0.078 ***	-0.044 *	-0.100 ***	-0.079 ***	-0.078 ***	-0.068 ***	-0.077 ***	-0.079 ***	-0.047 ***	-0.063 ***
	[0.026]	[0.025]	[0.026]	[0.021]	[0.023]	[0.024]	[0.024]	[0.017]	[0.021]	[0.013]	[0.014]	[0.017]	[0.012]	[0.013]
male	0.111 ***	0.102 ***	0.085 ***	0.057 *	0.059	0.061 **	0.052	0.063 **	0.033	0.054 **	0.085 ***	0.095 ***	0.095 ***	0.095 ***
	[0.021]	[0.021]	[0.030]	[0.029]	[0.037]	[0.031]	[0.032]	[0.029]	[0.021]	[0.021]	[0.018]	[0.017]	[0.020]	[0.019]
male*formal	-0.078 ***	-0.070 ***	-0.077 ***	-0.057 *	-0.057 *	-0.075 ***	-0.066 **	-0.087 ***	-0.045 *	-0.053 **	-0.084 ***	-0.073 ***	-0.062 ***	-0.065 ***
	[0.024]	[0.022]	[0.028]	[0.029]	[0.033]	[0.029]	[0.031]	[0.027]	[0.023]	[0.023]	[0.018]	[0.022]	[0.022]	[0.020]
firsthead	0.132 ***	0.163 ***	0.128 ***	0.123 ***	0.152 ***	0.149 ***	0.135 ***	0.130 ***	0.140 ***	0.146 ***	0.150 ***	0.143 ***	0.151 ***	0.136 ***
	[0.015]	[0.024]	[0.023]	[0.010]	[0.015]	[0.015]	[0.015]	[0.011]	[0.016]	[0.013]	[0.014]	[0.010]	[0.014]	[0.013]
firsthead*formal	-0.040 ***	-0.062 **	-0.008	-0.021 *	-0.063 ***	-0.058 ***	-0.049 ***	-0.033 ***	-0.044 ***	-0.050 ***	-0.045 ***	-0.044 ***	-0.051 ***	-0.052 ***
	[0.015]	[0.024]	[0.027]	[0.012]	[0.019]	[0.016]	[0.019]	[0.012]	[0.016]	[0.013]	[0.017]	[0.012]	[0.014]	[0.015]
secondhead	0.052 ***	0.089 ***	0.073 ***	0.055 ***	0.071 **	0.071 ***	0.082 ***	0.072 ***	0.054 ***	0.068 ***	0.075 ***	0.064 ***	0.061 ***	0.054 ***
	[0.016]	[0.021]	[0.019]	[0.014]	[0.028]	[0.014]	[0.014]	[0.009]	[0.014]	[0.009]	[0.009]	[0.012]	0.010	0.013
secondhead*formal	-0.012	-0.055 **	-0.017	0.010	-0.017	-0.010	-0.006	-0.007	0.023	-0.001	0.003	0.0005	0.001	0.0004
	[0.018]	[0.022]	[0.023]	[0.020]	[0.028]	[0.018]	[0.018]	[0.013]	[0.016]	[0.012]	[0.012]	[0.016]	[0.013]	[0.014]
ln(population)	0.006	0.033 ***	0.163 ***	0.114 ***	0.087 ***	0.133 ***	0.126 ***	0.005	9.644	0.076 ***	0.014 ***	0.031 ***	0.043 ***	0.039 ***
	[0.011]	[0.008]	[0.016]	[0.014]	[0.020]	[0.020]	[0.011]	[0.016]	[6.184]	[0.014]	[0.002]	[0.004]	[0.004]	[0.003]
ln(population)*formal	0.040 ***	0.043 ***	0.065 ***	0.034 ***	0.041 ***	0.033 ***	0.034 ***	0.021 ***	10.883	0.025 ***	-0.011 ***	-0.013 ***	-0.018 ***	-0.020 ***
	[0.005]	[0.004]	[0.004]	[0.005]	[0.004]	[0.004]	[0.005]	[0.004]	[8.399]	[0.005]	[0.003]	[0.005]	[0.005]	[0.005]
relative distance	-0.512 ***	-0.606 ***	-0.537 ***	-0.383 ***	-0.210 ***	-0.357 ***	-0.237 ***	-0.199 ***	-43.703	-0.526 ***	-0.198 ***	-0.419 ***	-0.387 ***	-0.350 ***
	[0.035]	[0.059]	[0.032]	[0.042]	[0.030]	[0.050]	[0.029]	[0.045]	[27.920]	[0.032]	[0.025]	[0.067]	[0.031]	[0.048]
relative distance*formal	0.062	0.035	0.064	-0.103 *	-0.042	0.035	0.261 ***	0.260 ***	-180.655	0.265 ***	0.284 ***	0.243 ***	0.250 ***	0.236 ***
	[0.045]	[0.042]	[0.045]	[0.053]	[0.063]	[0.059]	[0.041]	[0.037]	[139.976]	[0.048]	[0.035]	[0.074]	[0.039]	[0.055]
high exposure	0.064 *	0.0299	0.378 ***	0.336 ***	0.341 ***	0.297 ***	0.367 ***	-0.185 ***	-16.786	0.081 ***	0.002	0.107 ***	0.185 ***	0.167 ***
	[0.036]	[0.051]	[0.043]	[0.033]	[0.060]	[0.046]	[0.040]	[0.025]	[10.913]	[0.027]	[0.019]	[0.018]	[0.017]	[0.018]
high exposure*formal	0.109 **	0.1234 ***	0.204 ***	-0.010	0.039	0.084	0.185 ***	0.137 ***	-150.909	0.061	-0.046 *	-0.052 **	-0.112 ***	-0.091 ***
	[0.047]	[0.045]	[0.043]	[0.050]	[0.055]	[0.057]	[0.044]	[0.040]	[116.869]	[0.038]	[0.025]	[0.026]	[0.031]	[0.025]
low exposure	0.097 **	0.073	0.292 ***	0.467 ***	-0.076	0.647 ***	0.611 ***	0.074	30.724	0.351 ***	0.221 ***	-0.101 ***	0.243 ***	0.155 ***
	[0.043]	[0.047]	[0.048]	[0.053]	[0.083]	[0.093]	[0.056]	[0.075]	[19.787]	[0.055]	[0.033]	[0.029]	[0.027]	[0.028]
low exposure*formal	0.028	0.263 ***	0.150 ***	0.114 **	0.376 ***	0.163 **	0.276 ***	0.055	34.766	0.184 ***	-0.109 **	0.067	-0.278 ***	-0.021
	[0.052]	[0.044]	[0.046]	[0.053]	[0.080]	[0.080]	[0.053]	[0.055]	[26.860]	[0.044]	[0.050]	[0.051]	[0.065]	[0.052]
No. Obs.	52,716	53,743	53,711	97,987	102,574	106,323	108,302	115,633	122,504	130,862	148,642	159,810	164,539	159,643

***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. All regressions include city dummies, industry dummies, and interactions of these with an indicator for formality. Robust standard errors clustered at the industry level are shown in brackets

Table 18. Effect of Trade Liberalization on Wage Differentials

		(a)	(b)	(c)
1	Mex Tariff	-0.169 [0.319]	-0.356 [0.352]	-0.074 [0.191]
	No. Obs.	3938	3710	3710
2	US Tariff	-0.695 [0.760]	-1.450 ** [0.585]	-0.949 ** [0.371]
	No. Obs.	3938	3964	3680
3	IOM Tariff	0.115 [0.108]	0.003 [0.120]	0.052 [0.065]
	No. Obs.	3968	3710	3710
4	Mex Tariff	-0.289 [0.352]	-0.334 [0.379]	-0.097 [0.209]
	US Tariff	-0.633 [0.751]	-1.399 ** [0.581]	-0.904 ** [0.370]
	IOM Tariff	0.138 [0.117]	0.022 [0.129]	0.051 [0.070]
	No. Obs.	3938	3694	3680

***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. All regressions include year dummies, industry dummies and industry trends. Newey-West standard errors with 1 lag are shown in brackets.

(a) Current tariffs

(b) 1-year lagged tariffs

(c) Sum of current and 1-year lagged tariffs

to 0.70 and averaging 0.36. This suggests that the formal-informal wage gap could also be highly sensitive to changes in the level of import tariffs.

In the second stage the within industry formal-informal wage differentials are pooled over time and used as the dependent variable in the estimation of the following equation, which parallels equations (8) and (11) above:

$$\phi_{(I\times f)jt} = T_{jt}\beta_T + Y_t\gamma_Y + D_j\delta_D + \left(D_j \times tr_t\right)\eta_{(D\times tr)} + \varepsilon_{jt} \qquad (13)$$

Table 18 reports the estimates of equation (13). Column (a) presents the estimates obtained for the current values of the import tariffs. None of the estimates in this column is significantly different from zero. The coefficients for the Mexican and the U.S. import tariffs are negative, indicating a negative correlation with the formal-informal wage differentials. Column (b) explores the possibility that adjustments in the wage differentials with respect to changes in the level of import tariffs may require some time to take place. Using the 1-year lagged values, the column reports

larger effects for the Mexican and the U.S. import tariffs, but only the second one is statistically significant at a 5% level. Column (c) summarizes the dynamic effects by using the sum of the current and the 1-year lagged tariffs as regressors. Panels 2 and 4 confirm the relevance of the changes in the U.S. import tariffs for changes in the wage gap. The conclusion from the estimates in table 18 is that the elimination of the U.S. import tariff contributes to the increase of the formal-informal wage differential, but this effect takes some time to show up. This result may also suggest that wages in Mexico are somewhat sticky, as they do not adjust to changes in the economic environment immediately after these take place. Given the insignificance and the large standard errors of the estimates of the IOM tariff, it can also be said that this result is valid for the tradable sectors only. The evidence in this subsection supports the predictions from the dynamic industry model with firm heterogeneity in section 2, and is also in line with the results from previous studies regarding the effect of trade liberalization on the distribution of wages.

8. Conclusions

This paper has investigated the relationship between trade liberalization and informality in Mexico during the 1990s. Using the Melitz, M. J. (2003) model of heterogeneous firms to analyse the possible implications of trade liberalization on the rate of informality, it is predicted that by making more profitable to some firms to enter the formal sector, by forcing the less productive informal firms to exit the industry, and by inducing the most productive formal firms to engage in trade, trade liberalization could reduce the incidence of informality, particularly in industries characterized by higher levels of aggregate productivity. Both the exit of the least productive firms and the additional export sales gained by the more productive firms reallocate market shares towards the more productive firms and contribute to an aggregate productivity gain. The increased labour demand by the more productive firms and the new entrants tends to increase more the real wages in industries that experience larger tariff cuts. The empirical analysis provides supporting evidence for this view. Reductions in the Mexican import tariffs are found to be significant in reducing the likelihood of informality in the tradable sectors. This result contrasts with the findings of Goldberg, P. K. & N. Pavcnik (2003) for Brazil and Colombia,

but one has to keep in mind that liberalization of trade in those countries has been rather different from the 1990s Mexican experience. The analysis in this paper also indicates that for a given reduction in the Mexican import tariff, informality decreases less in industries with higher levels of import penetration; and that for a given reduction in the U.S. import tariff, informality decreases more in industries that are relatively more export oriented. It is also found that trade liberalization affects the employment shares and the composition of informality across industries, but it does not seem to have an impact on the size of the labour force of firms, as reported by workers when asked about the number of people in their workplaces.

Finally, the paper also presented evidence of an increase in industry wage differentials and a widening effect of trade liberalization on the formal-informal wage gap. Previous empirical works relating trade liberalization and the income distribution find that the former has disproportionately benefited high-skilled labour by increasing its relative demand in many developing countries. Considering that the level of skills in the formal sector is typically higher than in the informal sector, a skill-biased technological change seems to be also present when comparing these two.

References

ATTANASIO, O., P. K. GOLDBERG, and N. PAVCNIK (2003): "Trade Reforms and Wage Inequality in Colombia," *NBER Working Paper Series*, 9830.

BALDWIN, J., and W. GU (2006): "The Impact of Trade on Plant Scale, Production Run-Length and Diversification," *Economic Analysis Research Paper Series No. 038. Statistics Canada*.

CRAGG, M., and M. EPELBAUM (1996): "The Premium for Skills in Ldcs: Evidence from Mexico," *Journal of Development Economics*, Vol 51, pp. 99-116.

CURRIE, J., and A. HARRISON (1997): "Sharing the Costs: The Impact of Trade Reform on Capital and Labor in Morocco," *Journal of Labor Economics*, Vol. 15, pp. S44-S71.

DIXIT, A., and J. STIGLITZ (1977): "Monopolistic Competition and Optimum Product Diversity," *American Economic Review*, Vol. 67, pp.297-308.

FEENSTRA, R. C., J. ROMALIS, and P. K. SCHOTT (2002): "U.S. Imports, Exports and Tariff Data, 1989-2001," *NBER Working Paper Series*.

FERNANDES, A. M. (2003): "Trade Policy, Trade Volumes, and Plan-Level Productivity in Colombian Manufacturing Industries," *The World Bank Development Research Group. Policy Research Working Paper*, 3064.

FERREIRA, P. C., and J. L. ROSSI (2003): "New Evidence from Brazil on Trade Liberalization and Productivity Growth," *International Economic Review*, Vol. 44, pp. 1383-1405.

GOLDBERG, P. K., and N. PAVCNIK (2003): "The Response of the Informal Sector to Trade Liberalization," *Journal of Development Economics*, 72, p. 463-496.

HANSON, G. H. (1994): "Regional Adjustment to Trade Liberalisation," *National Bureau of Economic Research*, Working Paper No. 4713.

— (2003): "What Has Happened to Wages in Mexico since Nafta? Implications for Hemispheric Free Trade," *University of California, San Diego and NBER*.

— (2004): "Globalization, Labour Income, and Poverty in Mexico," *University of California, San Diego and NBER*.

HANSON, G. H., and A. HARRISON (1999): "Trade Liberalization and Wage Inequality in Mexico," *Industrial and Labor Relations Review*, Vol. 52, pp. 271-288.

HARRISON, A. (1994): "Productivity, Imperfect Competition and Trade Reform," *Journal of International Economics*, Vol. 36, p. 53-73.

KATE, A. T., C. MACARIO, and G. NIELS (2000): "Mexico: Export Promotion Policies on the Cutting Edge," in *Export Growth in Latin America: Policies and Performance*: Boulder, Colo.: L. Rienner Publishers, c2000., 183 p.

MALONEY, W. F. (1999): "Does Informality Imply Segmentation in Urban Labor Markets? Evidence from Sectoral Transitions in Mexico," *The World Bank Economic Review*, Vol. 13, p. 275-302.

MATTAR, J. (1998): "Export Promotion in Mexico," *Integration and Trade 4/5. Institute for the Integration of Latin America and the Caribbean, Inter-American Development Bank*.

MELITZ, M. J. (2003): "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, Vol. 71, pp. 1695-1725.

NICITA, A. (2004): "Who Benefited from Trade Liberalization in Mexico?" *World Bank Policy Research Working Paper 3265*.

PAVCNIK, N. (2002): "Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants," *The Review of Economic Studies*, Vol. 69, No. 1, p.245-276.

REVENGA, A. (1995): "Employment and Wage Effects of Trade Liberalization," *The World Bank. Latin America and the Caribbean. Human Resources Operations Division. Country Operations 1 and the Environment Division.*

ROBBINS, D. (1996): "Trade Liberalization and Income Distribution," *NBER Working Paper Series*, Working Paper 5693.

ROBERTS, B. R. (1989): "Employment Structure, Life Cycle, and Life Chances: Formal and Informal Sectors in Guadalajara," in *The Informal Economy. Studies in Advanced and Less Developed Countries*, ed. by A. Portes, M. Castells, and L. A. Breton. Baltimore & London: The John Hopkins University Press.

TIBOUT, J., and M. WESTBROOK (1995): "Trade Liberalization and the Dimensions of Efficiency Change in Mexican Manufacturing Industries," *Journal of International Economics*, Vol. 39, p.53-78.

Appendix A: Proof that P_0 does not change with trade liberalization

In a model like the one described in section 2, an equilibrium will be characterized by a mass of firms $M = M_I + M_F + M_X$ and an *ex post* distribution of productivities $\mu(\varphi)$ over a subset of $(0,\infty)$. $\mu(\varphi)$ is conditional on successful entry to the industry and is truncated at φ^*:

$$\mu(\varphi) = \begin{cases} \dfrac{g(\varphi)}{1-G(\varphi^*)} & \text{if } \varphi \geq \varphi^* \\ 0 & \text{otherwise} \end{cases} \qquad \text{(A.1)}$$

The average productivities in different sectors of the industry are determined by the *ex post* productivity distribution and the zero-profit productivity cut-offs. Let $\tilde{\varphi}$ be the weighted average productivity across all firms. Then:

$$\tilde{\varphi}(\varphi^*) = \left[\frac{1}{1-G(\varphi^*)}\int_{\varphi^*}^{\infty}\varphi^{\sigma-1}g(\varphi)d\varphi\right]^{\frac{1}{\sigma-1}}$$

$$\tilde{\varphi}_F(\varphi_F^*) = \left[\frac{1}{1-G(\varphi_F^*)}\int_{\varphi_F^*}^{\infty}\varphi^{\sigma-1}g(\varphi)d\varphi\right]^{\frac{1}{\sigma-1}} \quad \text{(A.2)}$$

$$\tilde{\varphi}_X(\varphi_X^*) = \left[\frac{1}{1-G(\varphi_X^*)}\int_{\varphi_X^*}^{\infty}\varphi^{\sigma-1}g(\varphi)d\varphi\right]^{\frac{1}{\sigma-1}}$$

The average productivity across all firms, $\tilde{\varphi}$, is based only on market share differences between firms. If some firms are formal or trading, then this average will not reflect the additional shares of more productive firms. Furthermore, neither of these averages reflect the proportions α, β, and τ of output units that are "gained" and "lost" in passing to the formal sector and to the trading sub-sector, respectively. Let $\tilde{\varphi}_t$ be the weighted productivity average that reflects these differences. $\tilde{\varphi}_t$ can be written as:

$$\tilde{\varphi}_t = \left\{\frac{1}{M}\left[M_I\tilde{\varphi}^{\sigma-1} + M_F\left[(1+\alpha)(1+\beta)^{-1}\tilde{\varphi}_F\right]^{\sigma-1} + M_X\left[(1+\alpha)(1+\beta)^{-1}\tau^{-1}\tilde{\varphi}_X\right]^{\sigma-1}\right]\right\}^{\frac{1}{\sigma-1}} \quad \text{(A.3)}$$

$\tilde{\varphi}_t$ can then be used to obtain expressions for the aggregate prices and expenditure levels, *P* and *R* respectively. In particular:

$$P_0 = Q^{\frac{1}{\sigma}}P = \frac{r(\tilde{\varphi}_t)}{q(\tilde{\varphi}_t)^{\rho}} = \frac{q(\tilde{\varphi}_t)^{1-\rho}}{\rho\tilde{\varphi}_t} \quad \text{(A.4)}$$

This implies that the derivative of P_0 with respect to $\tilde{\varphi}_t$ is equal to:

$$\frac{\partial P_0}{\partial\tilde{\varphi}_t} = \frac{\rho\tilde{\varphi}_t(1-\rho)q(\tilde{\varphi}_t)^{-\rho}q'(\tilde{\varphi}_t) - q(\tilde{\varphi}_t)^{1-\rho}\rho}{(\rho\tilde{\varphi}_t)^2} \quad \text{(A.5)}$$

and its sign depends on the sign of the numerator. For example, for it to be positive:

$$\tilde{\varphi}_t(1-\rho)q'(\tilde{\varphi}_t) - q(\tilde{\varphi}_t) > 0 \quad \text{(A.6)}$$

or,

$$\frac{\tilde{\varphi}_t q'(\tilde{\varphi}_t)}{q(\tilde{\varphi}_t)} > \frac{1}{(1-\rho)} = \sigma \tag{A.7}$$

but the left-hand side of this inequality is also equal to σ, as it is simply the elasticity of $q(\tilde{\varphi}_t)$ with respect to $\tilde{\varphi}_t$. Hence, the numerator in (A.5) is equal to zero, implying that P_0 is not affected by changes in $\tilde{\varphi}_t$.

Appendix B: Proof of Proposition 1

The formal proofs for points 1 and 3 of proposition 1 are the same as in the original model in Melitz, M.J. (2003), and therefore there are not repeated here. The way in which trade liberalization works is the following: a decrease in τ to $\tau' < \tau$ will induce an increase in the industry's cut-off productivity level φ^* to $\varphi^{*\prime} > \varphi^*$, and a decrease in the cut-off productivity level for the trading sub-sector φ_X^* to $\varphi_X^{*\prime} < \varphi_X^*$. There are two potential channels through which trade can affect the distribution of surviving firms. The first one is through the increase in product market competition, which in the present model is not operative due to the assumption of monopolistic competition under C.E.S. preferences. The second channel operates through the domestic factor market where firms compete for labour. As mentioned in section 2.2, expanded exposure to trade offers new profit opportunities only to the more productive firms who can cover the entry cost f_X, and it also induces more entry of new firms to the industry, as prospective firms respond to the higher potential returns associated with a good productivity draw. The increased labour demand by the more productive firms and new entrants bids up the real wages and forces the least productive firms to exit. From equation (6), it can be seen that φ_F^* is an increasing function of real wages, w, so that this would also translate into an increase in the cut-off productivity level for formality:

$$\frac{\partial \varphi_F^*}{\partial \tau} = \frac{1}{\rho}\left\{\frac{w^{1/(1-\rho)}\left[(1+\alpha)f_F - (1-\gamma\varepsilon)f_I\right]}{kB}\right\}^{\frac{1-2\rho}{\rho}} w^{\frac{\rho}{1-\rho}} \frac{\partial w}{\partial \tau} < 0 \tag{B.1}$$

because $\frac{\partial w}{\partial \tau} < 0$. The fact that both φ^* and φ_F^* increase with trade liberalization means that there will be an ambiguous effect on the size of the labour force in the informal sector. The fact that φ_X^* and τ decrease with trade liberalization translates into an increase in the labour force of the trading-formal sub-sector. To see this formally, recall that the prices and output in each one of the sectors are given by the following equations:

$$p_I = \frac{w}{\rho\varphi} \qquad q_I = Q\left[\frac{w}{P\rho\varphi}\right]^{-\sigma}$$

$$p_F = \frac{(1+\alpha)w}{\rho(1+\beta)\varphi} \quad q_F = Q\left[\frac{(1+\alpha)w}{P\rho(1+\beta)\varphi}\right]^{-\sigma} \tag{B.2}$$

$$p_X = \frac{\tau(1+\alpha)w}{\rho(1+\beta)\varphi} \quad q_X = Q\left[\frac{\tau(1+\alpha)w}{P\rho(1+\beta)\varphi}\right]^{-\sigma}$$

Therefore, using equation (2), the labour demands in each sector can be written as:

$$\ell_I(\varphi) = f_I + Q\left[\frac{P\rho}{w}\right]^{\sigma} \varphi^{\sigma-1}$$

$$\ell_F(\varphi) = f_F + Q\left[\frac{P\rho(1+\beta)}{(1+\alpha)w}\right]^{\sigma} \varphi^{\sigma-1} \tag{B.3}$$

$$\ell_X(\varphi) = f_X + Q\left[\frac{P\rho(1+\beta)}{\tau(1+\alpha)w}\right]^{\sigma} \varphi^{\sigma-1}$$

And total employment in the industry is given by:

$$L = L_e + \int_{\varphi^*}^{\varphi_F^*} \ell_I(\varphi)\mu(\varphi)d\varphi + \int_{\varphi_F^*}^{\infty} \ell_F(\varphi)\mu(\varphi)d\varphi + \int_{\varphi_X^*}^{\infty} \ell_X(\varphi)\mu(\varphi)d\varphi \tag{B.4}$$

where L_e is the labour used by new entrants for investing in the industry's fixed entry cost f_e (see Melitz, M.J (2003)), and $\mu(\varphi)$ is the *ex-post* distribution of productivities defined in equation (A.1). In equilibrium, the market clearing condition

for investment workers requires L_e to be equal to the total investment by new entrants, $M_e f_e$, where M_e is the total number of new entrants to the industry. Also, in equilibrium, stability requires that the mass of successful entrants exactly replaces the mass of incumbents who are hit with the bad shock and exit: $p_{in} M_e = \delta M$, where p_{in} is the probability of successful entry into the industry (e.g. of drawing a productivity parameter $\varphi \geq \varphi^*$) and δ is the probability of being hit by a bad shock in every period. These two equilibrium conditions together with the free entry condition to the industry $\bar{\pi} = \delta f_e / \left[1 - G\left(\varphi^*\right)\right]$ (where $\bar{\pi}$ are the average profits in the industry) imply that the labour force employed in investment by new entrants can be written as:

$$L_e = M_e f_e = \frac{\delta M}{p_{in}} f_e = M\bar{\pi} \tag{B.5}$$

From equation (B.5) is easy to see that trade liberalization increases the labour demand of the new entrants: a decrease in τ increases φ^*, which in turn increases $\bar{\pi}$. Therefore, L_e increases as well. On the other hand, it is also easy to see the positive impact of trade liberalization on the employment share of the trading-formal sub-sector. Using the last equation in (B.3) together with equation (A.1) in the last term of the right-hand side of equation (B.4):

$$\int_{\varphi_X^*}^{\infty} \ell_X(\varphi)\mu(\varphi)d\varphi = \frac{1}{1 - G\left(\varphi^*\right)} \int_{\varphi_X^*}^{\infty} \left[f_X + Q\left(\frac{P\rho(1+\beta)}{\tau(1+\alpha)w} \right)^{\sigma} \varphi^{\sigma-1} \right] g(\varphi)d\varphi \tag{B.6}$$

which is clearly negatively related to τ: when τ decreases, the term in brackets increases, φ^* increases so that $1/\left[1 - G\left(\varphi^*\right)\right]$ increases, and φ_X^* decreases so that the area of integration increases as well. Thus, the employment share of the trading-formal sub-sector increases with trade liberalization. Finally, consider the employment share of the formal sector in the domestic market. Using again equation (A.1) together with the second equation in (B.3) in the second integral on the right-hand side of equation (B.4):

$$\int_{\varphi_F^*}^{\infty} \ell_F(\varphi)\mu(\varphi)d\varphi =$$

$$= \frac{1}{1-G(\varphi^*)} \int_{\varphi_F^*}^{\infty} \left[f_F + Q\left(\frac{P\rho(1+\beta)}{(1+\alpha)w} \right)^{\sigma} \varphi^{\sigma-1} \right] g(\varphi)d\varphi =$$

$$= \frac{1-G(\varphi_F^*)}{1-G(\varphi^*)} f_F + Q\left(\frac{P\rho(1+\beta)}{(1+\alpha)w} \right)^{\sigma} \frac{1}{1-G(\varphi^*)} \int_{\varphi_F^*}^{\infty} \varphi^{\sigma-1} g(\varphi)d\varphi =$$

$$= \frac{1-G(\varphi_F^*)}{1-G(\varphi^*)} f_F + Q\left(\frac{P\rho(1+\beta)}{(1+\alpha)w} \right)^{\sigma} \frac{1-G(\varphi_F^*)}{1-G(\varphi^*)} \tilde{\varphi}_F(\varphi_F^*)^{\sigma-1} =$$

$$= \frac{1-G(\varphi_F^*)}{1-G(\varphi^*)} \left\{ f_F + Q\left(\frac{P\rho(1+\beta)}{(1+\alpha)w} \right)^{\sigma} \tilde{\varphi}_F(\varphi_F^*)^{\sigma-1} \right\} \tag{B.7}$$

where $\tilde{\varphi}_F(\varphi_F^*)$ is the average productivity in the formal sector, as defined in equation (A.2). From this last expression it can already be seen that the relationship between τ and the employment share of the formal sector (and hence of the informal sector) is ambiguous. The derivative of $\tilde{\varphi}_F(\varphi_F^*)$ with respect to τ is negative, as φ_F^* increases with a decrease in τ and $\tilde{\varphi}_F$ is increasing in φ_F^*. However, the sign of the derivative of $[1-G(\varphi_F^*)]/[1-G(\varphi^*)]$ cannot be determined, as it depends on the shape of the distribution $g(\varphi)$ and the specific values of the parameters in the model:

$$\frac{\partial}{\partial\tau} \frac{1-G(\varphi_F^*)}{1-G(\varphi^*)} = \frac{-g(\varphi_F^*)[1-G(\varphi^*)]\frac{\partial\varphi_F^*}{\partial\tau} + g(\varphi^*)[1-G(\varphi_F^*)]\frac{\partial\varphi^*}{\partial\tau}}{[1-G(\varphi^*)]^2} \tag{B.8}$$

Looking at the numerator of (B.8), $1-G(\varphi^*) > 1-G(\varphi_F^*)$ given that $\varphi^* < \varphi_F^*$. Using equations (5) and (6), $\left|\frac{\partial\varphi_F^*}{\partial\tau}\right| < \left|\frac{\partial\varphi^*}{\partial\tau}\right|$ whenever $\frac{f_F}{f_I} < \left[\frac{(1+\beta)^{\rho}}{1+\alpha}\right]^{\frac{1}{1-\rho}}$, and $g(\varphi_F^*) > g(\varphi^*)$ when the distribution $g(\varphi)$ is sufficiently skewed to the left. In such a case, the share of employment in the formal sector increases with trade liberalization.

Appendix C: Proof of Proposition 2

The only difference with respect to the proof in proposition 1 in appendix B is that now it is not possible to determine a unique sign of the derivative of φ_F^* with respect to τ. Recall that:

$$\varphi_F^* = \left\{ \frac{w^{1/(1-\rho)} \left[(1+\alpha) f_F - (1-\gamma\varepsilon) f_I \right]}{kB} \right\}^{\frac{1-\rho}{\rho}} \tag{C.1}$$

where $B = \left(\frac{1+\beta}{1+\alpha} \right)^{\frac{\rho}{1-\rho}} - (1-\gamma\varepsilon)$. Considering that now β is also affected by trade liberalization, so that $\frac{\partial \beta}{\partial \tau} < 0$:

$$\begin{aligned} \frac{\partial \varphi_F^*}{\partial \tau} &= \frac{w^{2\rho}}{\rho B^{1/\rho}} \left\{ \frac{(1+\alpha) f_F - (1-\gamma\varepsilon) f_I}{k} \right\}^{\frac{1-\rho}{\rho}} \left[B \frac{\partial w}{\partial \tau} - w(1-\rho) \frac{\partial B}{\partial \tau} \right] = \\ &= \frac{w^{2\rho}}{\rho B^{1/\rho}} \left\{ \frac{(1+\alpha) f_F - (1-\gamma\varepsilon) f_I}{k} \right\}^{\frac{1-\rho}{\rho}} \left\{ B \frac{\partial w}{\partial \tau} - \frac{\rho w}{1+\alpha} \left(\frac{1+\beta}{1+\alpha} \right)^{\frac{2\rho-1}{1-\rho}} \frac{\partial \beta}{\partial \tau} \right\} \end{aligned} \tag{C.2}$$

the sign of $\frac{\partial \varphi_F^*}{\partial \tau}$ is undetermined, as $\frac{\partial w}{\partial \tau} < 0$ and $\frac{\partial \beta}{\partial \tau} < 0$. Thus, in general it is not possible to say whether φ_F^* increases or decreases, inducing less or more firms to enter the formal sector after trade liberalization. However, using the results for market share reallocations, it is possible to find cases in which the sign of $\frac{\partial \varphi_F^*}{\partial \tau}$ is uniquely determined. To begin, , recall that revenues from sales to the foreign market increase after trade liberalization, so that $\frac{\partial r_X(\varphi)}{\partial \tau} < 0$. Using the last pair of equations in (B.2):

$$\frac{\partial r_X(\varphi)}{\partial \tau} = \frac{\partial}{\partial \tau} QP^{\sigma} \varphi^{\sigma-1} \left[\frac{\rho(1+\beta)}{\tau(1+\alpha)w} \right]^{\sigma-1} =$$

$$= (\sigma-1) QP^{\sigma} \varphi^{\sigma-1} \left[\frac{\rho(1+\beta)}{\tau(1+\alpha)w} \right]^{\sigma-2} \left\{ \frac{\tau w \rho \frac{\partial \beta}{\partial \tau} - \rho\tau(1+\beta)\frac{\partial w}{\partial \tau} - \rho(1+\beta)w}{\tau^2(1+\alpha)w^2} \right\} < 0 \quad \text{(C.3)}$$

For this inequality to hold, the numerator of the last term in the right-hand side has to negative:

$$\tau w \rho \frac{\partial \beta}{\partial \tau} - \rho\tau(1+\beta)\frac{\partial w}{\partial \tau} - \rho(1+\beta)w < 0$$

$$\Leftrightarrow \quad \eta_{1+\beta,\tau} - \eta_{w,\tau} < 1 \quad \text{(C.4)}$$

On the other hand, total revenues in the trading-formal sub-sector, $(1+\tau^{1-\sigma}) r_F(\varphi)$, also increase after trade liberalization, as there is a market share reallocation towards these firms. Thus, using the second pair of equations in (B.2):

$$\frac{\partial}{\partial \tau}(1+\tau^{1-\sigma}) r_F(\varphi) = \frac{\partial}{\partial \varphi}(1+\tau^{1-\sigma}) QP^{\sigma} \varphi^{\sigma-1} \left[\frac{\rho(1+\beta)}{(1+\alpha)w} \right]^{\sigma-1} =$$

$$= (\sigma-1) QP^{\sigma} \varphi^{\sigma-1} \left[\frac{\rho(1+\beta)}{(1+\alpha)w} \right]^{\sigma-1} \left\{ -\tau^{-\sigma} + \frac{(1+\tau^{1-\sigma}) \left[w \frac{\partial \beta}{\partial \tau} - (1+\beta)\frac{\partial w}{\partial \tau} \right]}{(1+\beta)w} \right\} < 0 \quad \text{(C.5)}$$

As before, for this inequality to hold, the last term in the right-hand side has to be negative, or:

$$(1+\tau^{1-\sigma}) \left[w \frac{\partial \beta}{\partial \tau} - (1+\beta)\frac{\partial w}{\partial \tau} \right] < \frac{(1+\beta)w}{\tau^{\sigma}}$$

$$\Leftrightarrow \quad \eta_{1+\beta,\tau} - \eta_{w,\tau} < \frac{1}{\tau^{\sigma-1}+1} \quad \text{(C.6)}$$

Since $\tau > 1$, then $\frac{1}{\tau^{\sigma-1}+1} < 1$. Therefore, equations (C.4) and (C.6) together imply that:

$$\eta_{1+\beta,\tau} - \eta_{w,\tau} < \frac{1}{\tau^{\sigma-1}+1} \tag{C.7}$$

Now, rewrite revenues $r_X(\varphi)$ as a function of φ_F^*, using expressions in (B.2):

$$\frac{r_X(\varphi)}{r_F(\varphi_F^*)} = \left[\frac{\varphi}{\tau\varphi_F^*}\right]^{\sigma-1} \Leftrightarrow r_X(\varphi) = \left[\frac{\varphi}{\tau\varphi_F^*}\right]^{\sigma-1} r_F(\varphi_F^*) = QP^{\sigma}\varphi^{\sigma-1}\left[\frac{(1+\alpha)w}{\rho(1+\beta)\varphi_F^*}\right]^{\sigma-1} \tag{C.8}$$

The derivative of (C.8) with respect to τ is equal to:

$$\frac{\partial r_X(\varphi)}{\partial \tau} = \\ = (\sigma-1)QP^{\sigma}\varphi^{\sigma-1}\left[\frac{(1+\alpha w)}{\rho(1+\beta)\varphi_F^*}\right]^{\sigma-2}\left\{\frac{(1+\alpha)\left[(1+\beta)\frac{\partial w}{\partial \tau} - \frac{w(1+\beta)}{\varphi_F^*}\frac{\partial \varphi_F^*}{\partial \tau} - w\frac{\partial \beta}{\partial \tau}\right]}{(1+\beta)^2\varphi_F^*}\right\} \tag{C.9}$$

and it is negative because of (C.3). Thus, it has to be the case that:

$$(1+\beta)\frac{\partial w}{\partial \tau} - \frac{w(1+\beta)}{\varphi_F^*}\frac{\partial \varphi_F^*}{\partial \tau} - w\frac{\partial \beta}{\partial \tau} < 0 \Leftrightarrow \eta_{w,\tau} - \eta_{\varphi_F^*,\tau} - \eta_{1+\beta,\tau} < 0 \tag{C.10}$$

Now, (C.7) can be used to determine the possible signs of $\eta_{\varphi_F^*,\tau}$. Consider first the case when $\eta_{1+\beta,\tau} - \eta_{w,\tau} = 0$. Then it must be that $\eta_{\varphi_F^*,\tau} > 0$ for (C.10) to hold. Therefore, when the elasticity of productivity in the formal sector with respect to τ is equal to the elasticity of wages, $\frac{\partial \varphi_F^*}{\partial \tau} > 0$ and more firms are induced to leave the

informal sector. In this case, using (B.8) it can be seen that the share of employment in the formal sector will increase.

Consider now the case when $\eta_{1+\beta,\tau} - \eta_{w,\tau} < 0$. This implies that $\eta_{\varphi_F^*,\tau} > 0$ and sufficiently large for (C.10) to hold. Thus, when the elasticity of productivity in the formal sector with respect to τ is larger than the elasticity of wages (in absolute terms), $\frac{\partial \varphi_F^*}{\partial \tau} > 0$ and more firms are induced to leave the informal sector. In this case, (B.8) implies that the share of employment in the formal sector will also increase.

Finally, consider the case in which $0 < \eta_{1+\beta,\tau} - \eta_{w,\tau} < \frac{1}{\tau^{\sigma-1}+1}$. For (C.10) to hold, it is required that: (a) $\eta_{\varphi_F^*,\tau} \geq 0$ or (b) $0 > \eta_{\varphi_F^*,\tau} > \eta_{w,\tau} - \eta_{1+\beta,\tau} > -\frac{1}{\tau^{\sigma-1}+1}$. If (a) holds, then $\frac{\partial \varphi_F^*}{\partial \tau} \geq 0$ and the share of employment in the formal sector increases or stays the same after trade liberalization. On the other hand, if (b) holds, then the share of employment in the formal sector will decrease with reductions in τ.

CENTRE FOR ECONOMIC PERFORMANCE
Recent Discussion Papers

762	L. Rachel Ngai Roberto M. Samaniego	An R&D-Based Model of Multi-Sector Growth
761	Mariano Bosch	Job Creation and Job Destruction in the Presence of Informal Labour Markets
760	Christian Hilber Frédéric Robert-Nicoud	Owners of Developed Land Versus Owners of Undeveloped Land: Why Land Use is More Constrained in the Bay Area than in Pittsburgh
759	William Nickell	The CEP-OECD Institutions Data Set (1060-2004)
758	Jean Eid Henry G. Overman Diego Puga Matthew Turner	Fat City: the Relationship Between Urban Sprawl and Obesity
757	Christopher Pissarides	Unemployment and Hours of Work: the North Atlantic Divide Revisited
756	Gilles Duranton Henry G. Overman	Exploring the Detailed Location Patterns of UK Manufacturing Industries Using Microgeographic Data
755	Laura Alfaro Andrew Charlton	International Financial Integration and Entrepreneurship
754	Marco Manacorda Alan Manning Jonathan Wadsworth	The Impact of Immigration on the Structure of Male Wages: Theory and Evidence from Britain.
753	Mariano Bosch William Maloney	Gross Worker Flows in the Presence of Informal Labour Markets. The Mexican Experience 1987-2002
752	David Marsden	Individual Employee Voice: Renegotiation and Performance Management in Public Services
751	Peter Boone Zhaoguo Zhan	Lowering Child Mortality in Poor Countries: the Power of Knowledgeable Parents

750	Evangelia Vourvachaki	Information and Communication Technologies in a Multi-Sector Endogenous Growth Model
749	Mirko Draca Raffaella Sadun John Van Reenen	Productivity and ICT: A Review of the Evidence
748	Gilles Duranton Laurent Gobillon Henry G. Overman	Assessing the Effects of Local Taxation Using Microgeographic Data
747	David Marsden Richard Belfield	Pay for Performance Where Output is Hard to Measure: the Case of Performance Pay for Teachers
746	L Rachel Ngai Christopher A. Pissarides	Trends in Hours and Economic Growth
745	Michael White Alex Bryson	Unions, Job Reductions and Job Security Guarantees: the Experience of British Employees
744	Wendy Carlin Andrew Charlton Colin Mayer	Capital Markets, Ownership and Distance
743	Carlos Thomas	Equilibrium Unemployment and Optimal Monetary Policy
742	Tobias Kretschmer Katrin Muehlfeld	Co-Opetition and Prelaunch in Standard Setting for Developing Technologies
741	Francesco Caselli Nicola Gennaioli	Dynastic Management
740	Michael Noel Mark Schankerman	Strategic Patenting and Software Innovation
739	Nick Bloom Stephen Bond John Van Reenen	Uncertainty and Investment Dynamics
738	Sami Napari	The Early Career Gender Wage Gap

The Centre for Economic Performance Publications Unit
Tel 020 7955 7673 Fax 020 7955 7595 Email info@cep.lse.ac.uk
Web site http://cep.lse.ac.uk