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Trade and Occupational Employment in Mexico since NAFTA

Raymundo Miguel Campos-Vázquez,
José Antonio Rodríguez-López

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Abstract

TRADE AND OCCUPATIONAL EMPLOYMENT IN MEXICO SINCE NAFTA

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and

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We analyze the effects of trade liberalization on Mexican employment at an occupational level for the period from 1992 to 2009, ranking occupations by skill level. We find that the reduction in trade costs associated with Mexico's entry to NAFTA is related to larger employment expansions in low-skill occupations. This evidence runs counter to a story of skilled-biased technological change in Mexico, and in favour of a heterogeneous-firm model of trade in tasks where the offshoring cost of an occupation is positively related to its skill level. After NAFTA, labour demand for unskilled workers has increased and labour demand for skilled workers has been stagnant, even though supply of skilled workers has increased in the last 20 years. We provide intuitive evidence to identify a number of relevant bottlenecks in the Mexican economy that may be associated with these developments.

JEL classification: F16 (Trade and labour market interactions).

Keywords: Trade, employment, wages, inclusive growth.

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The ICITE project is being implemented under the auspices of a team at OECD. Douglas Lippoldt is the project manager and Secretary to ICITE. In relation to the ICITE working papers, Ania Jankowska and Monika Sztajerowska provided analytical, editorial and other substantive inputs, and Katjusha Boffa and Jacqueline Maher provided secretarial and administrative support. The OECD ICITE team is based in the Development Division, headed by Michael Plummer, and under the direction of Raed Safadi, OECD Deputy Director for Trade and Agriculture, and Ken Ash, OECD Director for Trade and Agriculture.

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This paper has been developed as an input to the ICITE project. The views expressed are those of the author(s) and do not necessarily reflect those of the OECD, OECD member country governments or partners of the ICITE initiative.

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Executive Summary

In light of the North American Free Trade Agreement (NAFTA), which came into effect in 1994, many changes were expected in Mexico. As the smallest and least developed economy in North America, economists predicted large movements in wages and employment levels. Following a Heckscher-Ohlin framework, the hypothesis was that as an unskilled-labour-abundant country, employment in unskilled-intensive sectors was going to expand, resulting in a decline in the wage gap between skilled and unskilled workers.

As one of the most prominent real world examples of trade liberalization in a North-South setting, many papers have used the Mexican NAFTA experience to analyze the validity of Heckscher-Ohlin implications, putting forward new theories to explain the deviations found in the data. Most of these studies, however, focus on the wage gap between skilled and unskilled workers and surprisingly, the study of the evolution of employment levels for different skill groups remains largely unexamined. Taking this into account, in this paper we analyze the effects of trade liberalization on Mexican employment at an occupational level.

The empirical approach in this paper is motivated by the growing literature on models of trade with offshoring possibilities. In the last decades production has become more fragmented, and it is now common to find goods whose production processes are split between many different countries. We view occupations as tasks and arrange them by level of skill. We use the urban labour force surveys in Mexico for the period from 1992 to 2009 and construct a panel with occupation-industry combinations as our units of analysis. With respect to trade, we use data on trade costs for Mexican exports to the United States – along with other trade variables.

We find that the reduction in trade costs associated with Mexico's entry to NAFTA is related to larger employment expansions in low-skill occupations. We obtain results consistent with a heterogeneous-firm model of trade in tasks where the offshoring cost of an occupation is positively related to its skill level, so that a decrease in overall offshoring costs has larger positive effects in the low-skill occupations. We find no evidence in favour of skill biased technological change.

The evidence presented in this paper for Mexico indicates that unskilled workers are benefiting more from trade than skilled workers. Demand for skilled workers has been stagnant after NAFTA, even though supply of skilled workers has increased. At the same time, most of Mexico's exports to the United States are in direct competition with those of China. We suggest the lack of growth for demand for skilled labour appears to be due to several bottlenecks in the Mexican economy.

There are indications that, among other possibilities, relevant constraints concern investment, availability of credit to the private sector, quality of education, and labour laws that create undue labour market rigidity. Such bottlenecks in turn cause a misallocation of inputs which decreases productivity and prevents further growth and employment creation. Addressing these bottlenecks could help both skilled and unskilled workers in the Mexican economy benefit from increased opportunities brought about by trade liberalisation and greater international economic integration

1. Introduction[1]

In light of the North American Free Trade Agreement (NAFTA), which came into effect in 1994, many changes were expected in Mexico. As the smallest and least developed economy in North America, economists predicted large movements in wages and employment levels. Following a Heckscher-Ohlin framework, the hypothesis was that, as an unskilled-labour-abundant country, employment in unskilled-intensive sectors was going to expand, resulting in a decline in the wage gap between skilled and unskilled workers. As one of the most prominent real world examples of trade liberalization in a North-South setting, many papers have used the Mexican NAFTA experience to analyze the validity of Heckscher-Ohlin implications, putting forward new theories to explain the deviations found in the data. Most of these studies, however, focus on the wage gap between skilled and unskilled workers and surprisingly, the study of the evolution of employment levels for different skill groups remains largely unexamined. Taking this into account, in this paper we analyze the effects of trade liberalization on Mexican employment at an occupational level. We find that the reduction in trade costs associated with Mexico's entry to NAFTA is related to larger employment expansions for low-skill occupations than for high-skill occupations.

The empirical approach in this paper is motivated by the growing literature on models of trade with offshoring possibilities (Feenstra, 2010). In the last decades production has become more fragmented, and it is now common to find goods whose production processes are split between many different countries. Motivated by that observation, Feenstra and Hanson (1996) propose a model of trade in intermediate inputs – ordered by skill intensity in the unit interval – where the fraction of offshored inputs is endogenously determined. Along the same lines, Grossman and Rossi-Hansberg (2008) propose a model of trade in tasks (or activities) with heterogeneous offshoring costs. In that framework, tasks are ordered by their offshoring costs and, as in Feenstra and Hanson (1996), the fraction that is offshored is endogenously determined. In this spirit, we view occupations as tasks and arrange them by level of skill. We then estimate a model that relates employment changes in occupation-industry groups to trade variables. We obtain results consistent with a heterogeneous-firm model of trade in tasks where the offshoring cost of an occupation is positively related to its skill level, so that a decrease in overall offshoring costs has larger positive effects in the low-skill occupations.

One of the most popular explanations for observed increases in the wage gap between skilled and unskilled workers in unskilled-labour-abundant countries – in spite of trade liberalization with skilled-labour-abundant countries – is the so-called skill-biased technological change.[2] The occupational approach in this paper provides a basis for looking for evidence of skill-biased technological change in Mexico. The alternative of classifying workers by level of education to proxy for the different levels of skill would be biased in favour of the skill-bias theory, as levels of education in Mexico have increased substantially over time for every type of worker. If instead we classify occupations by skill level (where the classification can indeed be based on the education level of each occupation at a base year), this problem disappears.

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2. There is an increase in the skilled-labour wage premium in an unskilled-labour-abundant country if the effect of the increase in the relative demand for skilled labour--caused by the skilled-biased technological change--dominates the Stolper-Samuelson effects of trade liberalization with more skill-abundant countries.

As mentioned above, we use occupation-industry combinations as our units of analysis. From Mexican national employment surveys, we construct a panel with 306 occupation-industry units (17 occupations and 18 industries) followed over 18 years (from 1992 to 2009). For our trade variables, given that most of Mexico's trade occurs with the United States, we use US data on imports from Mexico to construct different measures of trade costs. Moreover, we also include trade variables that control for the recent rise of China as the second most important US trading partner.[3]

The paper is organized as follows. In Section 2 we provide a brief review of the research on the effects of trade liberalization on Mexico's labour market. Section 3 describes the data and presents some stylized facts on occupations and trade. Section 4 presents our empirical approach and the estimation results. In Section 5 we discuss the implications of our results for the effects of Mexico's trade policy on the labour market. Finally, Section 6 concludes.

2. Literature review

The liberalization process has been widely studied in Mexico. In particular, the focus has been on the effect of trade on wage inequality. Since Mexico's access to the General Agreement on Tariffs and Trade (GATT) in 1986, Mexico reduced average tariffs by roughly 50% in just four years (Feliciano, 2001). Given that Mexico is a relatively unskilled-labour-abundant country, the Heckscher-Ohlin model and the Stolper-Samuelson theorem predict an increase in unskilled wages and a reduction in skilled wages, resulting in lower inequality. However, wage inequality in Mexico increased during the few years after GATT. Cragg and Eppelbaum (1996) argue that the wage inequality increase was mainly due to skill-biased technological change. Esquivel and Rodríguez-López (2003) find that the positive impact of trade was offset by technological progress in favour of skilled workers. However, after entering GATT, Mexican tariffs were reduced in unskilled-labour-intensive industries (Feliciano, 2001). This implies that Mexico protected skilled-labour-intensive industries and, as such, trade liberalization increased the demand for skilled workers through an increase in the relative price of skill-intensive goods, as argued by Robertson (2000, 2004). Nonetheless, Hanson and Harrison (1999) and Feliciano (2001) argue that most of the employment adjustment was within industries, which suggests minimal effects of traditional trade channels. On the other hand, Revenga (1997) uses establishment-level data for the period 1986-1990 and concludes that establishments in industries with larger reductions in tariffs reduced wages and employment due to the fall in tariff rates.

Given the abundant literature on the effect of trade on wage inequality, it is surprising that there is a dearth of evidence of the impact of trade on employment outcomes, in particular for the NAFTA adoption period. Hanson and Harrison (1999) and Feliciano (2001) analyze intersectoral movements and find little reallocation of workers after the trade liberalization process of 1986-1990. Using the Population Census 1990-2000, Hanson (2003) argues that the demand for skilled workers continued to increase after NAFTA. More recent evidence is presented by Aleman-Castilla (2006). In that paper, he estimates the effect of NAFTA on informality using labour force surveys in urban areas. He finds that reductions in Mexican import tariffs significantly reduce informality in the

3. In 2006, China displaced Mexico as the second major trading partner of the United States (only after Canada). Since then, Mexico remains in the third place.

tradable sectors. He also finds that a reduction in the US import tariff is related to a reduction in informality in industries that are relatively more export oriented. Robertson (2007) focuses on the effect of NAFTA on relative wages using data up to 2005. He argues that Mexican workers are now complements to US production workers, not substitutes. Moreover, he documents an expansion of assembly activities that increased the demand for unskilled workers. In sum, it appears that immediately after NAFTA the effects of further trade liberalization were not observed, but using more recent data – as in Robertson (2007) – some positive effects for unskilled workers are observed.

On related research, there are several references that discuss the effects of NAFTA on other outcomes such as productivity and foreign direct investment (FDI). For example, López-Córdova (2003) uses a panel of manufacturing plants for the period 1993-1999 and finds that productivity in manufacturing plants increased due to import penetration and access to the US market. He documents that in 1993 only 10% of imports from the US paid tariffs equal to less than 5% *ad valorem*. However, by 2000 93% of all manufacturing imports paid duties less or equal to 5%, and only 1% of imports paid duties 10% or higher. Hence, between 1993 and 2000 we observe a substantial decline in import duties between Mexico and its NAFTA partners. Kowalczyk and Davis (1998) show that Mexican tariffs phase outs are coordinated to US tariffs phase outs by industry. Using the Industrial Census at a four-digit industry level, Waldkirch (2010) focuses on the effect of foreign direct investment flows on productivity, employment, and wages in Mexico. First, he documents that the US provides 60% of FDI flows during the 1994-2005 period. Second, he shows that FDI flows go to the manufacturing and service sectors. Moreover, about 30% of FDI in manufacturing goes to *maquiladoras*. He finds that although FDI flows positively affect productivity, this effect is not observed in wages. Nonetheless, FDI flows positively affect the relative demand and wages for unskilled workers, a result similar to Robertson (2007). On the other hand, Aroca, Bosch and Maloney (2005) find that in the post-NAFTA period 1994-2002, dispersion increased in the form of several geographic income clusters, which is similar to the results in Hanson (2003). The source of the divergence is the consistent underperformance of the south of Mexico.

There is also literature on the general effects of NAFTA on Mexican exports. Feenstra and Kee (2007) show that NAFTA is responsible for increasing the variety of exports from Mexico to the United States. There is also evidence of increases in vertical integration and intra-industry trade of Mexican firms. Nevertheless, Moreno-Brid, Santamaria and Rivas-Valdivia (2005) mention that the increase in exports and trade should be taken with caution. They mention that added value of exports has not increased at the same rate as exports, and they point out the reliance of exports to imported intermediate goods and raw materials.

3. Data and stylized facts

In this section we describe the data we use and present some stylized facts on occupations and trade costs.

Mexican employment data

We use the *Labour Force Surveys* for Mexico from 1992 to 2009. The *Labour Force Surveys* are similar to the *Current Population Survey* (CPS) in the United States. Each household is interviewed for five consecutive quarters before leaving the sample. The questionnaire includes information on labour market outcomes and demographic characteristics of each household member. It is important to mention that the survey has changed over time. For example, before 1995 the sample is representative only for urban areas (100 000 people or more). Since 1995, the sample is representative at the national level. However, it is representative only in the second quarter. Since 2000, every quarter is representative at the national level. Since 2005, the Statistical Office uses a different survey that analyzes in more depth the reasons for unemployment and unionization. Nonetheless, the surveys from 1995-2010 are comparable across time at the national level. Since we want to use data beginning in 1992 (two years before NAFTA was implemented), we decided to use only the urban sample.

We use demographic characteristics of individuals and labour market outcomes (hours, wages, occupation, industry). All wages refer to hourly wages (labour income over weekly hours times 4.33). Wages are in constant pesos of September 2010. The occupation coding uses a national classification that is not comparable with other international systems. For the present analysis, we aggregate occupation codes to the two-digit level resulting in a data set containing 17 occupations.[4] The labour force surveys include two Industry Classification systems. Before 2005 a national classification system was used, and after 2005 the North American Classification System (NAICS) was adopted. We convert the national codes pre-2005 to NAICS. We end up with 16 manufacturing industries at the three-digit NAICS level and with two non-manufacturing industries at the two-digit NAICS level.

We drop from the sample those workers with invalid occupation or industry, or with missing information on demographic characteristics. We define a worker as an individual with positive hours of work. We restrict the sample to individuals with ages between 18 and 65. Finally, as the paper uses trade costs for manufacturing industries plus agriculture and mining, we drop the rest of the industries. Table 1 shows the industries we use in the study.

Table 2 shows the proportional employment share and the mean log hourly wage for each of the industries and the rest of the economy. We observe that the share of manufacturing employment in total employment decreased about 6 percentage points in the last ten years. Although not shown in the table, the sector that grew the most during the last ten years is services. The macroeconomic crisis of 1994-1995 hit wages hard. In 2000, most of the mean wages by industry were lower than in 1992. On the other hand, although the share of employment in manufacturing has declined in the last ten years, wages have generally increased during the same period.

4. Initially, we aggregated occupation codes at the three-digit level and ended up with about 100 occupations. However, the number of individuals in each occupation-industry cell was too small to work with.

Table 1. NAICS Industries

NAICS	Description
11	Agriculture
21	Mining, oil, and gas
311	Food and kindred products
312	Beverages and tobacco
313	Textiles and fabrics
315	Apparel and accessories
316	Leather and allied products
322	Paper
323	Printing
324	Petroleum and coal products
325	Chemicals
326	Plastics and rubber products
327	Non-metallic mineral products
331	Primary metal manufacturing
334	Computers and electronics
335	Electrical equipment, appliances
336	Transportation equipment
339	Miscellaneous

Table.2. Employment and wages across industries: 1992, 2000, 2009

	Employment %			Wages		
NAICS	1992	2000	2009	1992	2000	2009
11	1.25	0.69	0.65	3.00	3.13	3.17
21	0.34	0.39	0.39	3.55	3.78	4.03
311	3.06	3.14	3.02	3.14	3.04	3.09
312	1.16	0.84	0.64	3.19	3.11	3.23
313	1.04	0.95	0.44	3.16	3.04	3.11
315	2.14	2.65	1.69	3.11	2.92	3.01
316	1.39	1.11	0.82	3.33	3.11	3.18
322	0.52	0.48	0.43	3.20	3.14	3.18
323	0.82	0.69	0.68	3.37	3.11	3.31
324	0.22	0.23	0.15	3.54	3.76	3.93
325	1.64	1.29	0.76	3.46	3.30	3.50
326	1.41	1.09	0.9	3.24	3.17	3.16
327	1.12	0.95	0.57	3.28	3.16	3.23
331	0.43	0.49	0.4	3.42	3.31	3.35
334	0.91	1.6	0.88	3.39	3.25	3.28
335	0.88	1.26	0.71	3.36	3.26	3.29
336	1.87	2.52	1.72	3.36	3.25	3.34
339	4.53	4.68	4.06	3.29	3.11	3.26
Other	75.27	74.93	81.09	3.38	3.25	3.32

Note: Calculations by the authors. Urban sample for each year, workers 18-65 years old with valid industry, occupation and wage. Column of wage refers to the mean log hourly wage in constant pesos of September 2010.

Trade data

Our most important trade variables are trade costs. To obtain a measure of bilateral trade costs between Mexico and the United States, we rely on US import data from the United States International Trade Commission (USITC). Given NAFTA, we assume that trade cost rates are similar for Mexican and US exporters. Hence, at the ten-digit Harmonized System (HS) level and for yearly data from 1989 to 2009, we obtain the following variables on US imports from Mexico: imports customs value (before duties or any other charges), import duties, and import charges (freight and insurance). We then convert the data to our NAICS classification in Table 1 using the concordance tables created by Pierce and Schott (2011). Then, for industry j at time t, we create three trade cost measures: a *tariff rate* (τ_{jt}), a *freight rate* (f_{jt}), and a *total cost rate* (c_{jt}), where

$$\tau_{jt} = \frac{\text{duties}_{jt}}{\text{customsvalue}_{jt}},$$

$$f_{jt} = \frac{\text{import charges}_{jt}}{\text{customsvalue}_{jt}},$$

and $c_{jt} = \tau_{jt} + f_{jt}$. Following the same procedure for US imports from China, we create the trade costs variables τ^*_{jt}, f^*_{jt} and c^*_{jt} where the * denotes trade cost measures for China.

We obtain US import and export price indexes from the International Price Program (IPP) of the Bureau of Labour Statistics (BLS). Given that international indexes using the NAICS classification are only available since 2005, we use four-digit HS indexes and then use the concordance tables of Pierce and Schott (2011) to convert them to NAICS. At the end, we have US import and export price indexes for each of our industries in Table 4.1 from 1992 to 2009. We use p^M_{jt} and p^X_{jt} to represent, respectively, the logarithm of the US import and export price index in industry j and time t.

Finally, we create a measure of US import penetration for each of our industries during the period 1992-2009. For this purpose, we use the customs value of total US imports and total US exports from the USITC at the ten-digit HS level, and use the same procedure to convert them to our NAICS classification. We then get the total value of shipments for each NAICS industry from the US Census. Thus, we calculate

$$m_{jt} = \frac{\text{imports}_{jt}}{\text{shipments}_{jt} + \text{imports}_{jt} - \text{exports}_{jt}},$$

where m_{jt} denotes the import penetration in the US in industry j at time t

Some stylized facts

In this section we describe some facts about Mexico's trade dynamics, the composition of occupations, and trade costs.

Mexico's trade

Even before Mexico's entry into NAFTA, the United States was by far Mexico's most important trading partner. Using data from the Mexican national statistics institute, INEGI, Figure 1 illustrates this fact and shows the evolution of the Mexico-United States trade balance. In Figure 1a, we present the ratio of Mexico's non-oil exports to the United States to total non-oil exports, and a similar ratio for imports.[5] In 1993, exports to the United States accounted for more than 85% of total non-oil exports, reaching 90% in 2000, and then a relatively sharp decline started around 2004 that left the share at about 80% in the last three years. The share of non-oil imports from the United States, on the other hand, declined substantially from its 73% share in 2000. By 2010, the share of imports from the United States was about 45%. The difference in the evolution of these shares is reflected in the Mexico-United States non-oil trade balance (as proportion of Mexico's GDP) in Figure 1b. From a deficit of 1.4% in 1994, Mexico ran a 2.6% surplus in 1995, with an increasing trend that reached about 8% by 2010.[6]

5. Between 1993 and 2010, non-oil exports and non-oil imports accounted on average for 88% and 94% of total exports and total imports, respectively.

6. In spite of the large trade surpluses with the United States, Mexico ran non-oil trade deficits in all years, with the exception of 1995 (surplus of 0.3%).

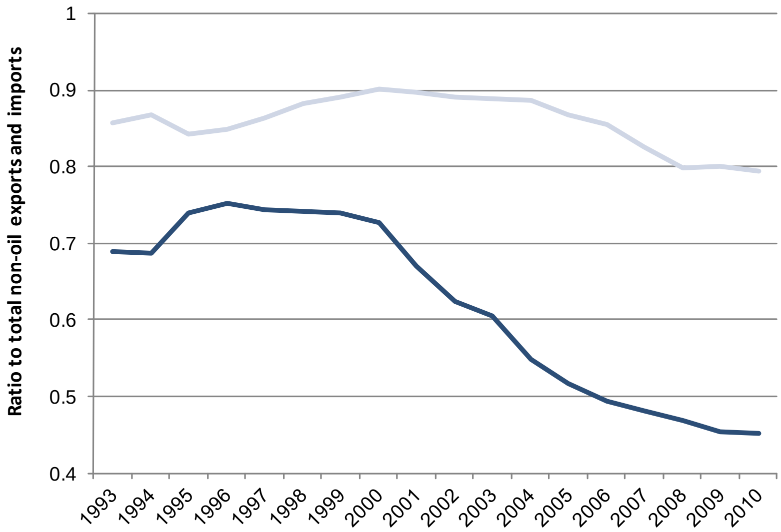
With NAFTA – and helped also by the large peso depreciation at the end of 1994 – the importance of trade in Mexico's economy more than doubled in just two years. For example, while the value of non-oil exports to the United States in 1993 was equivalent to 8.7% of Mexico's GDP, by 1995 this proportion had increased to more than 19%. Since then, that fraction has remained between 18.5% and 21.5% (in 2010, the proportion was 20.3%). We should also note that the vast majority of Mexican exports are manufactures: between 1993 and 2010, the share of manufacturing exports in total non-oil exports ranged between 93% and 97% per year.

Also from INEGI, Figure 2 shows the composition of Mexican exports and imports by type of good. For exports, we observe in Figure 2a that the most important change in composition occurred between 1992 and 2002, with the share of capital goods increasing from 12.4% to more than 26.9%, while the share of intermediate goods' exports decreased from 62.3% to 46.5%. By 2010 the proportions are 48.6% for intermediate goods, 28.7% for consumption goods, and 22.7% for capital goods. On the other hand, with the exception of a jump from 1994 to 1995, the composition of imports has remained without major changes throughout the period. The imports of intermediate goods account most of the years for more of 75% of total imports, with the other 25% split almost equally between consumption and capital goods. These facts are consistent with the recent theories of offshoring, with Mexico importing intermediate goods that are used in the production of consumption and capital goods for the domestic and export markets.

Table 3 shows the evolution of production, employment and wages in the manufacturing sector. Production, employment and wages are represented using an index in which the base year is 2003. From 1993 to 2000 we observe a large increase in production in the manufacturing sector. However, since the year 2000, production in the manufacturing sector has been stagnant or at least not growing at the same rate as before 2000. Employment and wages are available since 2003, and we observe that manufacturing employment has contracted since 2003 and it has not recovered. Indeed, there is a 14% decline in employment in the manufacturing sector from 2003 to 2009 (a 10% decline if we consider the period 2003-2010). Wages show an increase during the same period. These results are consistent with Table 2 which finds a decrease in the share of manufacturing employment and an increase in wages. In sum, Mexico appears to have benefitted from trade during the immediate period after NAFTA, but evidence in recent years points out a decline in manufacturing employment.

Figure 1. Mexico's trade with the United States

A. Non-oil exports (solid) and imports (dashed) to/from the United States



B. Non-oil trade balance with the United States

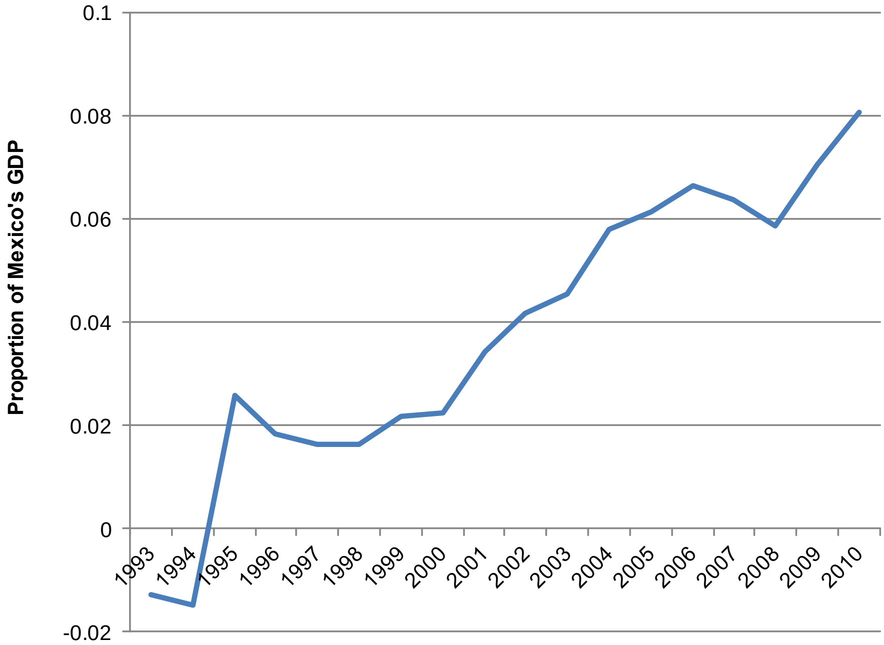
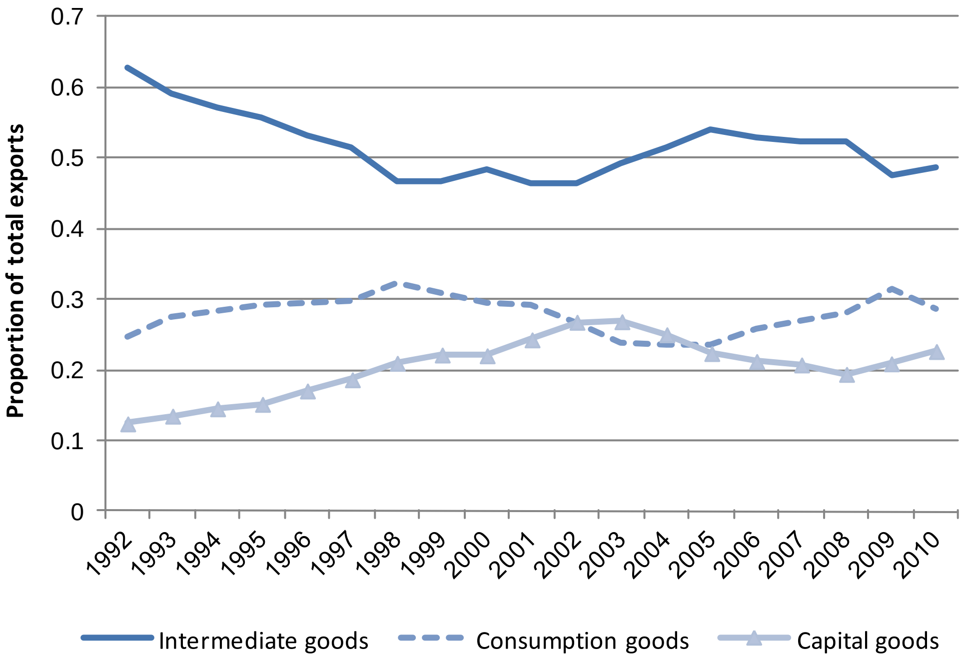


Figure 2. Mexico's composition of trade by type of goods

A. Exports



B. Imports

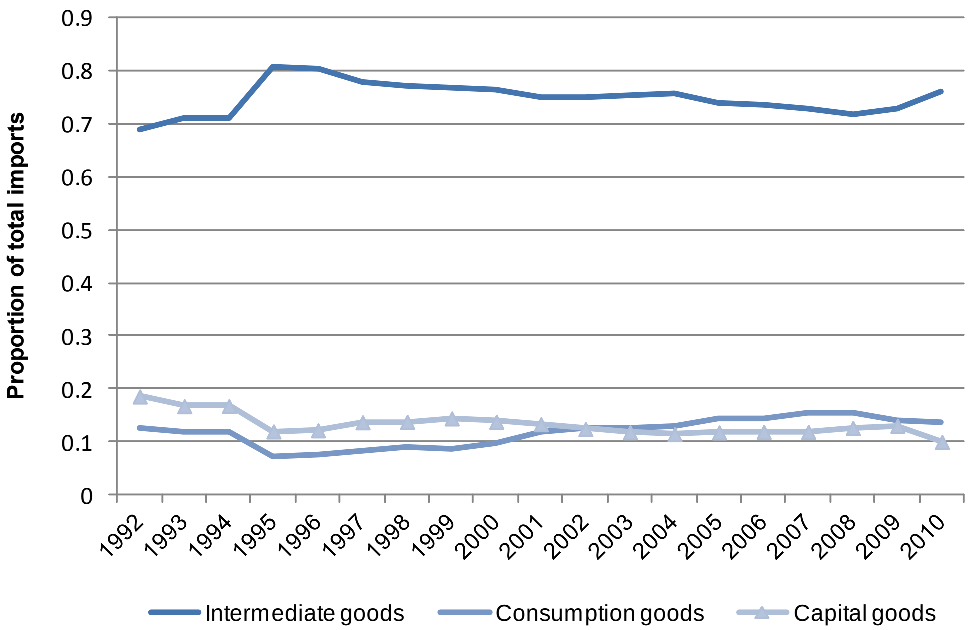


Table 3. Production, employment and wages, 1993-2009

	Manufacturing Index 2003=100		
Year	**Production**	**Workers**	**Average wage**
1993	75.0		
2000	104.8		
2003	100.0	100.0	100.0
2005	111.8	96.0	102.3
2007	114.3	97.2	102.8
2009	111.5	86.0	106.2

Note: Data obtained from INEGI. Production, Workers and Average Wage are constructed using year 2003 as a reference. Those variables refer to manufacturing production index, number of workers in manufacturing industries, and average wage in manufacturing industries. Average wage is in real terms. All numbers are available in a monthly basis, we take as a reference month December of each year.

Based on our classification from Table 1, in Table 4 we take a closer look into the industry composition of US imports from Mexico in 1992, 2000 and 2009. For comparison purposes, we also include data on US imports from China. For Mexico, note that four industries account for more than 65% of its exports to the United States in those years: they are – in order of importance – Transportation equipment (336), Computers and electronics (334), Mining, oil, and gas (21), and Electrical products, appliances (335). For China, exports to the United States in Computers and electronics (334) are by far the most important in recent years.

As we mentioned above, China displaced Mexico as the second major trading partner of the United States since 2006. Table 5 shows the shares of the US imports from Mexico and China in each industry's total imports. Thus, it allows us to identify the industries that are driving China's rise, and it gives us some insights on the effects for Mexico. The last row in the Table shows the total share of each country in total US imports. We can see that Mexico's share rose to 11.6% by 2000, and then declined to 10.8% by 2009. On the other hand, the share of China grew dramatically between 2000 and 2009, rising from 8.8% to 18.2%. At the industry level, we observe that Mexico's shares increased between 1992 and 2000, and then they stagnated. In only one industry, Electrical products and appliances (335), Mexico has a share larger than 20%. For Mexico's most important exporting industry, Transportation equipment (336), its share was about 19% by 2009. This industry, however, does not seem to be affected by China's rise (in 2009, China's share in this industry was only 1.9%). Impressively, China's share in nine (out of 18) of the industries was larger than 30% by 2009. Its most important exporting sector, Computers and electronics (334), accounted for 38.3% of the US imports in that industry in 2009 – a substantial increase from the 9.8% share in 2000. For that industry, Mexico's share declined from 13.3% to 12.7% (sector 334 is the second most important exporting industry in Mexico).

Table 4. Composition of US Imports from Mexico and China (by NAICS code)

NAICS	Mexico			China		
	1992	2000	2009	1992	2000	2009
11	6.10%	2.80%	4.30%	2.10%	0.80%	0.60%
21	14.50%	8.40%	15.80%	2.10%	0.30%	0.10%
311	1.80%	0.90%	2.70%	0.80%	0.60%	1.10%
312	0.90%	1.00%	1.70%	0.00%	0.00%	0.00%
313	0.70%	1.10%	0.80%	4.30%	2.30%	3.30%
315	3.70%	7.00%	2.50%	20.40%	8.90%	11.20%
316	1.00%	1.10%	0.80%	18.30%	12.20%	6.60%
322	0.40%	0.30%	0.60%	0.50%	0.70%	1.00%
323	0.60%	0.20%	0.30%	1.30%	0.70%	0.90%
324	0.80%	0.90%	2.20%	0.20%	0.40%	0.10%
325	2.80%	2.00%	2.20%	1.90%	1.70%	3.20%
326	0.70%	0.90%	1.30%	1.80%	2.70%	3.10%
327	1.70%	1.30%	1.20%	1.60%	2.50%	1.60%
331	2.20%	1.90%	4.60%	0.70%	1.20%	1.40%
334	18.60%	27.00%	19.80%	11.60%	26.30%	35.40%
335	9.60%	8.10%	9.50%	6.80%	9.10%	7.40%
336	26.40%	28.80%	22.20%	0.90%	2.40%	1.90%
339	7.60%	6.10%	7.50%	24.70%	27.40%	21.00%

Table 5. Shares of Mexico and China in Total US Imports (by NAICS code)

	Mexico			China		
NAICS	1992	2000	2009	1992	2000	2009
11	12.00%	14.50%	18.20%	3.30%	3.00%	4.10%
21	10.10%	13.10%	11.70%	1.10%	0.30%	0.10%
311	4.60%	6.20%	10.30%	1.70%	2.70%	6.80%
312	6.50%	15.20%	16.60%	0.20%	0.20%	0.20%
313	3.00%	9.30%	5.80%	14.10%	15.00%	41.50%
315	3.80%	13.80%	5.20%	16.40%	13.20%	39.10%
316	2.40%	6.60%	5.20%	33.60%	53.30%	69.50%
322	1.10%	2.10%	4.20%	1.20%	3.20%	12.80%
323	5.90%	6.80%	7.50%	9.70%	16.20%	41.20%
324	2.40%	2.80%	4.00%	0.40%	0.90%	0.30%
325	3.20%	3.30%	2.00%	1.70%	2.10%	4.90%
326	2.90%	6.70%	7.30%	6.10%	14.50%	30.50%
327	8.90%	10.80%	13.60%	6.30%	15.90%	31.20%
331	3.20%	5.50%	12.10%	0.80%	2.60%	6.30%
334	6.50%	13.30%	12.70%	3.20%	9.80%	38.30%
335	18.40%	25.30%	26.10%	10.20%	21.50%	33.90%
336	8.40%	16.70%	19.30%	0.20%	1.00%	2.80%
339	4.70%	6.60%	7.80%	12.10%	22.20%	36.70%
Total	6.70%	11.60%	10.80%	5.20%	8.80%	18.20%

Occupations

In this paper we use occupations to separate workers by skill level. Our approach is very simple: we sort occupations by skill level in a base year – using an education or a wage variable – and keep that ranking constant for our entire period of study. If we are interested in analyzing the effects of trade on employment changes by skill level, this is a more appropriate approach than using changes in employment by education levels. The reason is that education levels in Mexico have increased over time for every type of workers in the last two decades. Hence, a trade and employment analysis that uses education changes to approach for skill changes would likely be biased in favour of a skill-biased technological change story.

We classify workers in 17 occupations. Table 6 shows a description of each occupation and presents the percentage of workers with finished high-school (or more) in each of them for 1992 and 2010. We can observe that, as mentioned above, there was an increase in the education level in each of them (with the obvious exception of Professionals).

Table 6. Occupations and Education Levels (finished high-school or more)

Code	Description	1992	2010	Change
11	Professionals	100%	100%	0%
12	Technicians	69%	81%	12%
13	Education workers	62%	70%	8%
14	Arts and sports workers	50%	61%	11%
21	Managers in the government and private sector	81%	93%	12%
41	Agriculture and forestry workers	12%	31%	19%
51	Manufacturing: white collars (supervisors, quality)	42%	52%	10%
52	Manufacturing: blue collars (repair, maintenance)	12%	24%	12%
53	Manufacturing: blue collar (machine operators)	10%	21%	11%
54	Manufacturing: blue collars (helpers)	11%	21%	11%
55	Machinery and transportation workers (drivers)	6%	22%	15%
61	Management and service supervisors	73%	85%	12%
62	Clerical services workers	59%	65%	6%
71	Sales workers	33%	46%	14%
72	Street workers	5%	10%	5%
81	Personal service workers	15%	23%	8%
83	Protective service workers	13%	26%	13%

Note: For each occupation, the table shows the percent of workers with finished high-school.

In Table 7 we present the ranking of these occupations using the education indicator for 1992 in Table 6. We also present an alternative ranking based on the median hourly wage in 1992. Based on education, Street worker is the lowest-skill occupation, and Professional is the highest-skilled occupation. Sales workers are in the median and all blue-collar manufacturing workers are below the median. Based on the median wage, helpers (blue-collar) in the manufacturing industry and agricultural workers are the lowest-skilled occupations. Drivers of the manufacturing industry are in the median. The rankings are very similar, with a correlation of 0.824.

Table .7. Occupations and skill rankings

Code	Description	Ranking by	
		Education	Wage
72	Street workers	1	4
55	Machinery and transportation workers (drivers)	2	9
53	Manufacturing: blue collar (machine operators)	3	6
54	Manufacturing: blue collars (helpers)	4	1.5
41	Agriculture and forestry workers	5	1.5
52	Manufacturing: blue collars (repair, maintenance)	6	7
83	Protective service workers	7	5
81	Personal service workers	8	3
71	Sales workers	9	8
51	Manufacturing: white collars (supervisors, quality)	10	11
14	Arts and sports workers	11	13
62	Clerical services workers	12	10
13	Education workers	13	15
12	Technicians	14	12
61	Management and service supervisors	15	14
21	Managers in the government and private sector	16	17
11	Professionals	17	16

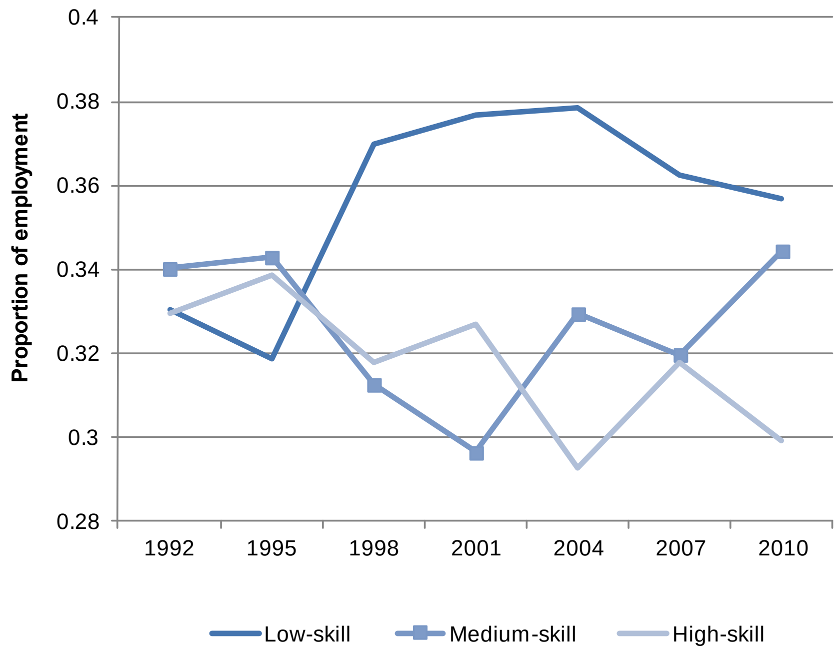
Note: Rankings are based in 1992 data, with 1 corresponding to the lowest-skill occupation and 17 to the highest-skill occupation. The education ranking is based on the percentage of workers with finished high-school. The wage ranking is based on median hourly wages.

Using these rankings, we separate out the occupations in three skill levels: low-skill, medium-skill, and high-skill. We split them so that about one third of workers in 1992 are in each group. Hence, using the education ranking we have that the low-skill group is composed by occupations ranked from 1 to 5, the medium-skill group is composed by occupations ranked from 6 to 9, and the high-skill group is composed by occupations ranked from 10 to 17. Using the wage ranking, occupations ranked from 1.5 to 6 are the low-skill group, from 7 to 9 are the medium-skill group, and from 10 to 17 are the high-skill group. It is the case that the high-skill groups are identical in both rankings. In Figure 3 we show the share of each group on total employment. No matter if the occupations' ranking is based on education or wages, we observe similar – and very suggestive – patterns. Comparing the initial and final year, the low-skill group and the high-skill group moved in opposite directions in similar proportions: the share of the low-skill group increased, while the share of the high-skill group decreased. On the other hand, the share of the medium-skill group had a U-shape pattern, decreasing until 2001 and then increasing to reach in 2009 its initial (1992) levels.

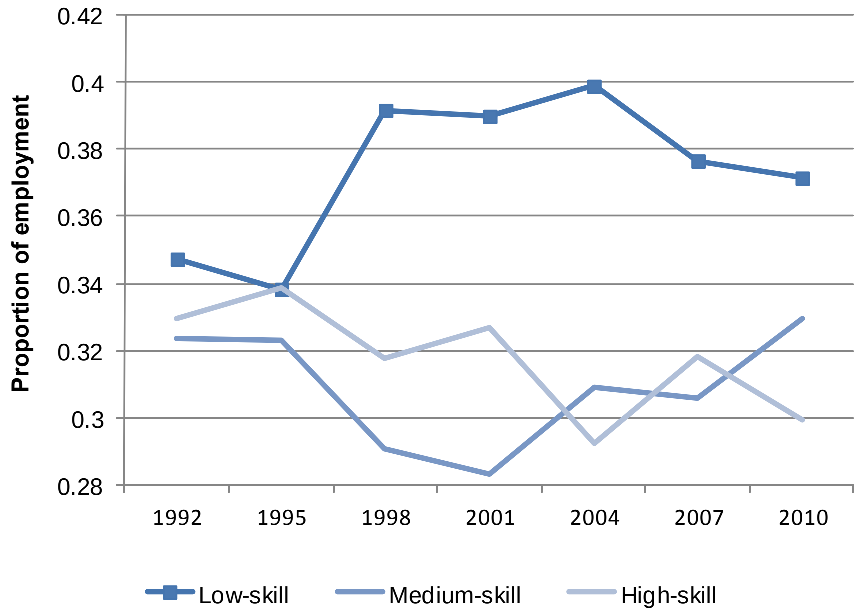
The story in Figure 3 is not one of skill-biased technological change in Mexico. On the contrary, it shows that NAFTA coincided with an increase in the importance of low-skill employment and a decrease in the importance of high-skill employment. Only in the last years, from 2004 to 2010, we observe that the medium-skill group begins to regain its initial share in Mexican employment.

Figure 3. Occupational shares by skill level

(a) Ranked by education in 1992



(b) Ranked by wage in 1992



Trade costs

Trade costs are the most important determinants of trade flows between countries. In section 3 we described our trade cost measures: the tariff rate, the freight rate, and the total cost. Compared to a typical model of trade, the tariff rate represents variable trade costs, and the freight rate is a proxy for fixed trade costs. In Tables 8 and 9 we present these measures of trades costs (at the NAICS level) for Mexico and China's exports to the United States in 1992 and 2009.

For Mexico, in the last row of Table 8 we see that the weighted average for the total cost of exporting to the United States declined from an already small value of 4.5% of imports customs value in 1992, to 1.2% in 2009. While in 1992, the 4.5% was split in 2.5% of the tariff rate and 2% of the freight rate, by 2009 the tariff rate was just 0.1%. Indeed, by 2009 the highest tariff rate for Mexico was the 0.6% for NAICS industry 315 (Apparel and accessories). For the freight rate, by 2009 the largest rate was for agricultural goods (sector 11), with a 4.4% rate (which also corresponded to the largest total cost rate).

For China, we see in Table 9 that the weighted total trade cost rate declined from 14.8% in 1992 to 8.3% 2009, with the average tariff rate declining from 7.9% to 3.7%, and the average freight rate decreasing from 6.9% to 4.6%. By 2009, the lowest trade cost rate – of 2.3% – corresponded to industry 334 (Computers and electronics), which is also China's most important exporting sector.

Table .8. Trade costs for Mexico's exports to the United States

NAICS	Tariff rate (τ)		Freight rate (f)		Total cost (c)	
	1992	2009	1992	2009	1992	2009
11	3.5%	0.0%	7.0%	4.4%	10.5%	4.4%
21	0.4%	0.0%	4.4%	1.7%	4.9%	1.7%
311	7.1%	0.0%	4.2%	2.4%	11.3%	2.4%
312	2.6%	0.0%	4.5%	3.3%	7.2%	3.3%
313	6.7%	0.4%	2.0%	1.2%	8.7%	1.6%
315	9.9%	0.6%	1.1%	0.7%	11.0%	1.3%
316	8.0%	0.1%	1.2%	0.5%	9.2%	0.6%
322	0.3%	0.0%	4.0%	2.7%	4.3%	2.7%
323	1.7%	0.0%	1.1%	1.3%	2.8%	1.3%
324	0.9%	0.0%	7.8%	2.4%	8.6%	2.4%
325	1.3%	0.0%	4.5%	2.2%	5.8%	2.2%
326	1.0%	0.1%	1.7%	1.4%	2.6%	1.5%
327	4.0%	0.1%	5.5%	2.9%	9.5%	3.0%
331	2.0%	0.0%	1.8%	0.6%	3.8%	0.6%
334	2.8%	0.0%	0.3%	0.3%	3.2%	0.3%
335	2.3%	0.2%	0.6%	0.9%	2.9%	1.1%
336	1.9%	0.1%	0.9%	0.5%	2.9%	0.6%
339	1.5%	0.1%	1.0%	0.8%	2.5%	1.0%
Average	**2.5%**	**0.1%**	**2.0%**	**1.1%**	**4.5%**	**1.2%**

Table 9. Trade costs for China's exports to the United States

NAICS	Tariff rate (τ^*)		Freight rate (f^*)		Total cost (c^*)	
	1992	2009	1992	2009	1992	2009
11	0.6%	0.4%	6.3%	6.3%	6.9%	6.7%
21	0.7%	0.4%	13.4%	15.2%	14.1%	15.5%
311	3.4%	2.9%	11.6%	8.9%	15.0%	11.7%
312	2.7%	0.2%	27.7%	17.4%	30.4%	17.6%
313	8.0%	7.5%	5.7%	6.5%	13.7%	13.9%
315	12.1%	14.4%	6.0%	4.2%	18.1%	18.6%
316	11.9%	11.0%	6.2%	4.7%	18.1%	15.7%
322	3.9%	1.1%	9.4%	10.2%	13.4%	11.3%
323	4.9%	0.1%	8.3%	5.8%	13.2%	5.9%
324	2.1%	0.0%	13.4%	5.1%	15.5%	5.1%
325	4.9%	2.2%	7.3%	5.9%	12.2%	8.1%
326	4.3%	4.4%	8.6%	8.2%	12.8%	12.7%
327	10.0%	4.5%	14.2%	12.0%	24.2%	16.5%
331	2.2%	1.4%	8.4%	5.2%	10.5%	6.5%
334	4.9%	0.2%	3.3%	2.1%	8.1%	2.3%
335	5.0%	3.0%	5.8%	5.8%	10.8%	8.8%
336	5.5%	3.4%	9.1%	5.8%	14.6%	9.2%
339	6.0%	1.7%	8.9%	6.3%	14.9%	7.9%
Average	**7.9%**	**3.7%**	**6.9%**	**4.6%**	**14.8%**	**8.3%**

4 Empirical approach and estimation

Theoretical motivation

The empirical approach in this paper follows recent theoretical models of offshoring. Hence, it is appropriate to review some of their characteristics and implications.

Feenstra and Hanson (1996) introduce a two-country model with a continuum of inputs in the interval [0,1]. These inputs – that can also be thought of as tasks or activities – are combined for the production of a final good, but the origin of each of the inputs can be either country. The inputs are ordered by skill intensity so that inputs close to zero are low-skill inputs, and inputs closer to 1 are high-skill inputs. Given some structural difference between the countries with respect to the price of unskilled labour relative to skill labour, inputs in the interval $[0, z^*]$ are produced in the country with the lowest relative price for unskilled labour, and the remaining fraction in the other country.

If there is a shock that moves z^* to the right, so that more inputs are produced in the unskilled-labour-abundant country, the model predicts an increase in the relative demand for skilled labour in both countries because: 1) the skilled-labour-abundant country stops producing the inputs between the old and new z^*, which are less skill intensive than the inputs between the new z^* and 1; and 2) the unskilled-labour abundant country starts producing the inputs between the old and the new z^*, which are more skill intensive than the inputs between 0 and the old z^*. Hence, this model predicts an increase in the relative demand for skill in both countries.

Along the same lines, the trade-in-tasks model of Grossman and Rossi-Hansberg (2008) orders tasks in the unit interval by their costs of offshoring. As in the Feenstra-Hanson model, there is a z^* that determines the cut off for tasks performed in the low-cost country. A decrease in the overall cost of offshoring drives z^* up and generates similar effects as in the Feenstra-Hanson model, with one exception: the productivity effect. As firms in the high-cost country become more "productive" due to the decrease in the offshoring cost, they produce more and hence demand more (unskilled and skilled) tasks. Thus, contrary to the Feenstra-Hanson result, it is possible that a strong productivity effect could generate an increase in the relative demand of unskilled tasks in the low-cost country.

Furthermore, the model of Grossman and Rossi-Hansberg (2008) can be extended with heterogeneous firms à la Melitz (2003).[7] With heterogeneous firms and a fixed cost of offshoring, there exists a productivity cut off level that separates out offshoring and not-offshoring firms in the country with the high cost of labour. Only the most productive firms will offshore. If there is a decrease in the overall cost of offshoring – either the variable or the fixed cost of offshoring – z^* increases as in the Grossman-Rossi-Hansberg model and the same effects are present. There is also a new effect due to firm heterogeneity: the offshoring cut off productivity level declines so that more firms begin to offshore. These new offshoring firms increase the demand for low-skill occupations (up to the new z^*) in the low-cost country. Therefore, this model reinforces the productivity effect and can generate an increase in the relative demand of less-skilled occupations.

Empirical Approach

With the previous background, in this section we present an empirical model that allows us to identify shifts in the types of occupations embodied in trade. The equation to estimate is

$$\Delta e_{ijt} = \alpha_{ij} + \alpha_t + \beta \Delta \tau_{jt} + \gamma \Delta \tau_{jt} \times r_i + \delta X_{jt} + \rho Z_{ijt} + \varepsilon_{ijt}, \qquad (1)$$

where e_{ijt} is the log employment in occupation i and industry j at time t; α_{ij} and α_t denote occupation-industry and time fixed effects, respectively; τ_{jt} is the tariff rate as defined in section 3; $r_i \in (0,2)$ is the ranking of occupation i, with a value of 1 for the occupation at the median; X_{jt} is a vector of trade controls for industry j at time t; Z_{ijt} denotes a vector of occupation-industry controls at time t; and ε_{ijt} is the error.

We present first our benchmark regression, and then present our results for other specifications. In our benchmark regression, we use the ranking based on education (per cent of workers with high school or more) as r_i --the occupation ranked 1 (lowest-

7. See Groizard, Ranjan, and Rodríguez-López (2011) for an extension along these lines.

skilled) has a value r_1 close to zero, the occupation in the median has a value r_9 equal to 1, and the occupation ranked 17 (highest-skilled) has a value r_{17} close to 2. We also include the following variables in the vector of trade controls, X_{jt} : the change in the total trade cost rate for US imports from China (Δc^*_{jt}), the interaction of Δc^*_{jt} with r_i , and the log difference in the US import price index (Δp^M_{jt}). For the vector of occupation-industry controls, Z_{ijt} , we include the log hourly wage, the share of informal workers, the share of self-employed workers, the average age, and the share of females. In our estimation we include occupation-industry fixed effects and time fixed effects. Table 10 presents the results.

Table 10. Benchmark regression results

Dependent variable: Δe_{ijt}	
$\Delta \tau_{jt}$	-10.712**
	(4.426)
$\Delta \tau_{jt} \times r_i$	5.651*
	(3.300)
Trade controls (X_{jt} **)**	
Δc^*_{jt}	-0.434
	(0.542)
$\Delta c^*_{jt} \times r_i$	0.895*
	(0.529)
Δp^M_{jt}	-0.158
	(0.104)
Occupation-industry controls (Z_{jt} **)**	
$\log(\text{Hourly wage})_t$	0.028
	(0.053)
$\text{Informal} - \text{workers share}_t$	0.194
	(0.123)
$\text{Self} - \text{employed share}_t$	-0.412*
	(0.215)
Age_t	-0.007*
	(0.004)
Female share_t	-0.186
	(0.116)
Occupation-industry fixed effects	Yes
Time fixed effects	Yes
Observations	4349

Note: ** and *denote statistical significance at a 5 and 10% levels, respectively. Clustered standard errors in parentheses.

Our two coefficients of interest, $\hat{\beta} = -10.712$ and $\hat{\gamma} = 5.651$, are statistically significant at 5 and 10% levels, respectively. These coefficients imply that after a decrease of 0.01 in the tariff rate, the employment response for each occupation is in the interval $(-0.59\%, 10.71\%)$. The response of the lowest-skilled occupation is close to 10.71%, the response of the median occupation is 5.06%, and the response of the highest-skilled occupation is close to -0.59%. Therefore, after a decrease in the tariff rate, low-skill occupations have larger employment expansions. This is the most important result of the paper and, as we show below, it is very robust.

With respect to the trade controls, the only significant variable is the total trade cost rate for US imports from China interacted with our occupations' ranking variable ($\Delta c^*_{jt} \times r_i$). The coefficient is positive and close to 0.90, and it implies that a decrease in trade costs between the United States and China has a negative impact on occupations in Mexico, with a stronger negative effect on high-skill occupations. Note that the coefficient for the lowest-skilled occupation is close to 0, for the median-skill occupation is close to 0.9, and for the highest-skilled occupation is close to 1.80. This is an interesting result, as it highlights that China is competing with – and affecting more – Mexico in more sophisticated occupations. For the coefficient on the US import price index, although it has the expected sign (higher US import prices implying lower demand for Mexican goods, and hence lower employment in Mexico), it is not statistically significant. For the occupation-industry controls, only the share of self-employed workers and the average age are statistically significant.

It is important to mention that in other regressions, we also include as trade controls the freight rate for Mexican exports to the United States, the trade costs for China split in tariff and freight rates, and our import penetration measure. However, they were highly insignificant and did not have any effects in the magnitude and statistical significance of our coefficients of interest.

Table 11 shows robustness tests of the main result. The column titled "Benchmark" refers to the results found in Table 10. The next five columns modify the main regression to corroborate the robustness of the main findings. Column (1) estimates the same regression but with no explanatory variables like age, share of informal or self-employed workers, age and female. The results barely change. Even including the vector of explanatory variables, we could have some bias due to unobserved components. In order to control for any unobserved component, we interact every explanatory variable with each other. In total, we add 36 more explanatory variables resulting from those interactions and the results are very similar to the main findings. The only difference is that the coefficient associated with variable ($\Delta c^*_{jt} \times r_i$) is no longer significant at the 10% level. However, the magnitude of the estimate is very similar to the previous estimates.

In order to show that the occupation-industry fixed effects are not driving the results, we estimate the regression with a different set of fixed effects. We include in the regression industry fixed effects and occupation fixed effects but not the interaction between the two. This regression controls for any permanent component at the industry or occupation level. We find very similar results to the main findings. On the other hand, it is also possible that if we modify the ranking variable our results may change. The main results use the ranking provided by the per cent of workers with high school or more in each occupation in 1992. Column (4) uses the ranking provided by the median wage in each occupation in 1992. We observe that the results barely change compared to the rest of the columns. Also, previous regressions do not weight the occupation-industry cells by employment. Column (5) shows the results for the main regressions but using weights (we use the natural logarithm of employment in 1992 as our weights). The results for Mexican tariffs are slightly lower in absolute value while the results for Chinese trade costs are similar to previous columns.[8]

Table 11. Robustness tests

Dependent variable: Δe_{ijt}	**Benchmark**	**[1]**	**[2]**	**[3]**	**[4]**	**[5]**
$\Delta \tau_{jt}$	-10.712**	-0.466**	-11.204**	-10.668*	-.646**	-8.950*
	(4.426)	(4.489)	(4.461)	(5.465)	(4.416)	(3.577)
$\Delta \tau_{jt} \times r_i$	5.651*	5.612*	5.665*	5.659*	5.550*	4.599
	(3.300)	(3.286)	(3.298)	(3.254)	(3.184)	(2.857)
Trade controls (X_{jt} **)**						
Δc^*_{jt}	-0.434	-0.441	-0.458	-0.339	-0.321	-0.453
	(0.542)	(0.537)	(0.555)	(0.484)	(0.469)	(0.517)
$\Delta c^*_{jt} \times r_i$	0.895*	0.894*	0.909	0.808*	0.806*	0.892*
	(0.529)	(0.521)	(0.554)	(0.450)	(0.443)	(0.498)
Δp^M_{jt}	-0.158	-0.156	-0.159	-0.155	-0.139	-0.122
	(0.104)	(0.104)	(0.105)	(0.092)	(0.089)	(0.090)
Occupation-industry fixed effects	Yes	Yes	Yes	Separated	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Control Xs	Yes	No	Yes	Yes	Yes	Yes
Interactions Xs	No	No	Yes	No	No	Yes
Weighted Regression	No	No	No	No	No	Yes
Observations	4349	4349	4349	4349	4349	4349

Note: ** and * denote statistical significance at a 5 and 10 percent levels, respectively. Clustered standard errors in parentheses. Column 3 indicates separated Occupation and Industry Fixed Effects (it means that the regression includes occupation fixed effects and industry fixed effects separately, and not as occupation × industry fixed effects).

In sum, we find evidence that a decrease in the tariff rate applied to Mexican goods in the United States is related to an increase in employment in Mexico for unskilled workers. Moreover, we find evidence that a decrease in trade costs for China in the US market is associated with decreases in employment in all occupations, but with stronger effects on the most skilled occupations. Those results are important to understand the role of trade in employment in Mexico as well as the growing role of China in US markets. Although the results shown in Table 10 and 11 are very stable across specifications, we note that our main results are only statistically significant at the 10% level. Future research using the same methodology as proposed in this paper may be used in order to

8. In results not reported, we also estimate the regression using a different base year for our rankings of occupations and we also estimate the coefficients weighting for a different year to 1992. In general the results follow the same patterns as in Table 11.

corroborate the results. For example, a larger sample like the Population Census 2010 may be helpful in obtaining lower standard errors.

5. Discussion

The evidence presented in this paper is consistent with the evidence shown by Robertson (2007) and Waldkirch (2010) in the sense that unskilled workers are benefiting more from trade than skilled workers. In fact, Campos-Vazquez (2010) shows that demand for top qualified occupations also has not grown in Mexico during the last 15 years. On one hand, the evidence points out that unskilled workers are benefiting more, which decreases inequality in a high inequality country like Mexico. However, on the other hand, this should be worrisome given the recent increase in the supply of skilled workers has not been satisfied by employers (using the labour force surveys, we obtained an increase of 12 percentage points in the share of finished high-school workers between 1988 and 2010). In order to corroborate this result with our data, we ranked the occupation-industry wages in 1992 and observe their employment growth during the period (restricted only to agriculture, mining and manufacturing industries). In general, we observe the largest increase in employment for manufacturing blue collar workers across industries which are in deciles 3 and 4 (results not shown). The pattern we find is very similar to what Goos and Manning (2007) refer to as “job polarization”. We observe that the largest employment increase is for low paid occupations-industries. Employment in the high-paid occupation-industries has not increased. This pattern is very similar to the results shown in Figure 3.

Although an analysis of why skilled workers specifically have not increased their share in manufacturing is out of the scope of the paper, we can mention some potentially binding constraints. The quality of education in Mexico is relatively poor. Among 15-year-old individuals, the OECD (2010) reports that Mexico has the lowest proficiency in science among OECD countries and occupies the 47th place among 56 countries in which the test was applied. There is no evidence on quality of education at the college level, but if patterns among 15-year-old individuals consistent with their later performance, then this suggests that college workers will have difficulty competing in a highly integrated world economy. In contrast, in the same study, the OECD reports that Chinese students are among the top performers in the test. These comparisons of education performance are crucial as the lack of quality of education may deter some segments of the population from reaping the benefits of trade. This is especially true with the rise of China and its accession to the World Trade Organization. Given the similarity of exports from both Mexico and China to the United States (Tables 4 and 5, and the results in Gallagher, Moreno-Brid and Porzecanski (2008)), it would appear that Mexico needs to improve the quality of education afforded to its workforce in order to prevent losing ground.

Furthermore, a review of indicators of labour market rigidity suggests the potential for the Mexican economy to benefit from reforms to increase labour market flexibility. One of the reasons why we observe small inter-sectoral movements in Mexico is due to the rigid labour laws. Using the rigidity of employment index from the World Bank, Mexico has an index score of 41, while similar countries like Chile and Colombia have an index score equal to 18 and 10 respectively. Even China has a lower rigidity of employment index with a value of 31. Kambourov (2009) shows that a rigid labour market deters sectoral reallocation. In particular, he analyzes the cases of Chile and Mexico. Chile liberalized after a labour reform, while Mexico did not. He mentions that after 12 years of the beginning of liberalization, the sectoral reallocation in Mexico is 30% slower than in Chile. If the labour market does not allow sectoral reallocation, the benefits of trade decrease. Using micro data for China, Hsieh and Klenow (2009) show that if we allow sectoral reallocation in order to equalize productivity across establishments to the US level, then Total Factor Productivity (TFP) would increase by close to 50% in China. Hanson (2010) cites a working paper of Hsieh and Klenow about TFP in Mexico. Hanson (2010) mentions that gains in TFP of equalizing productivity across establishments implies an increase of 100% in TFP in manufacturing and even 250-300% increase in the nonmanufacturing sector. Moreover, Hsieh and Klenow (2010) conclude that the largest determinant of differences in income levels across countries is TFP, and that one of the main reasons why TFP varies across countries is the misallocation of inputs across firms and industries. Rigid labour laws play a key role in explaining the misallocation of inputs. More research is needed in order to understand whether employment for skilled workers is being deterred in some way by rigid labour laws for the case of Mexico.

Another relevant constraint to further employment creation in Mexico appears to be the limited access to credit. Credit to the private sector is small. Hanson (2010) shows that domestic credit to the private sector declined for the years from 2001 to 2008. While the average credit as a per cent of GDP was 25 during 1991-2000, average credit during the period 2001-2008 was 18%. Hanson (2010) suggests this is due to difficulties of creditors in seizing assets from borrowers. Investment is also low. Capital formation has been stagnant at 21-26% of GDP in the last decade. According to Moreno-Brid, Santamaria and Rivas-Valdivia (2005), capital formation needs to be at least 25% to sustain a 5% annual economic expansion. Lack of credit and investment are important if Mexico wants to develop a stronger domestic market, as suggested by Blecker and Esquivel (2010). As shown above, close to 80% of Mexican exports go to the US market. Hence, the Mexican business cycle is strongly correlated to booms and busts in the US market. Indeed, Becker and Esquivel (2010) argue that the only reason for such a strong correlation is the lack of a domestic engine for the Mexican economy.

Finally, Mexican exports are facing strong competition from China since China's WTO entry. Gallagher, Moreno-Brid and Porzecanski (2008) calculate that over 70% of Mexico's exports are threatened by China's exports to the United States. They also show that Mexico is losing ground to China in all sectors, but especially in the high-tech export sectors. From Tables 4 and 5, note also the decrease of Mexico's share in the US imports of Computer and electronics (334), while China's share increased dramatically. They calculate that Mexico gained 1.7% in competitiveness during 1997-2005, but China gained 17.9% during the same period. Moreover, Gallagher, Moreno-Brid and Porzecanski (2008) argue that there is no evidence of modernization of Mexico's manufacturing industry. Hence, it may be that without increased investment and expanded implementation of improved technology in the economy, Mexico's exports will continue to be under threat of Chinese exports to the US market.

In sum, the evidence presented above points to multiple bottlenecks which appear to be constraining Mexico’s employment creation and ability to adapt to changing economic conditions in the increasingly integrated global economy. Even though the per cent of workers with high school and college degrees has increased, their share of employment in top paid occupations did not. This is true for the tradable sector and for the Mexican economy at large. Moreover, quality of education appears to be lagging. Another possible constraint to the increased participation of skilled workers may be the rigidity of labour laws. These laws appear to inhibit sectoral reallocation which in turn would hamper increases in TFP and growth in the economy.[9] Furthermore, credit and investment to the private sector are low which implies lower employment levels and lower investments in technology. But returns to those investments will be low if the quality of the workforce is not optimal. As China's exports continue to gain market share in the United States, Mexico is at a critical crossroads and will need to address such bottlenecks in order to boost its competitiveness. Indeed, it seems that the various policy reforms cited above are complementary, and that solving one particular problem will not effectively address the lack of employment opportunities and economic growth in the Mexican economy.

6. Conclusion

In this paper we analyze the effects of trade liberalization on Mexican employment since NAFTA at an occupational level. Even though there are many studies that look into the effects of trade liberalization on Mexican wage inequality, the study of its effects on employment levels has been, with few exceptions, left behind. We use the urban labour force surveys in Mexico for the period from 1992 to 2009 and construct a panel with occupation-industry combinations as our units of analysis. Using data on trade costs for Mexican exports to the United States – along with other trade variables – we find that the reduction in trade costs associated with Mexico's entry to NAFTA is related to larger employment expansions in low-skill occupations. These results are consistent with implications of new models of trade involving heterogeneous firms and heterogeneous offshoring costs. We find no evidence in favour of skill biased technological change.

The evidence presented in this paper is consistent with the evidence shown by Robertson (2007) and Waldkirch (2010) in the sense that unskilled workers are benefiting more from trade than skilled workers. Demand for skilled workers has been stagnant after NAFTA, even though supply of skilled workers has increased. At the same time, most of Mexico's exports to the United States are in direct competition with those of China. We suggest the lack of growth for skilled labour appears to be due to several bottlenecks in the Mexican economy. Among other possibilities, these constraints concern investment, availability of credit to the private sector, quality of education, and labour laws that create undue labour market rigidity. Such bottlenecks in turn cause a misallocation of inputs which decreases productivity and prevents further growth and employment creation. Addressing these bottlenecks could help both skilled and unskilled workers in the Mexican economy benefit from increased opportunities brought about by trade liberalisation and greater international economic integration.

9. However, setting the path for a more flexible Mexican labour market would need to be discussed along with the implementation of an unemployment insurance scheme (not existent in Mexico).

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