Trade and Occupational Employment in Mexico since NAFTA

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Outline

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Focus: Wage gap between skilled and unskilled workers

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Main result:

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

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In our case:

- We see occupations as tasks and arrange them by level of skill
- Then we estimate a model that relates employment changes in occupation-industry groups to trade variables

Outline

Mexico's trade

Even before Mexico's entry into NAFTA, the U.S. was by far Mexico's most important trading partner

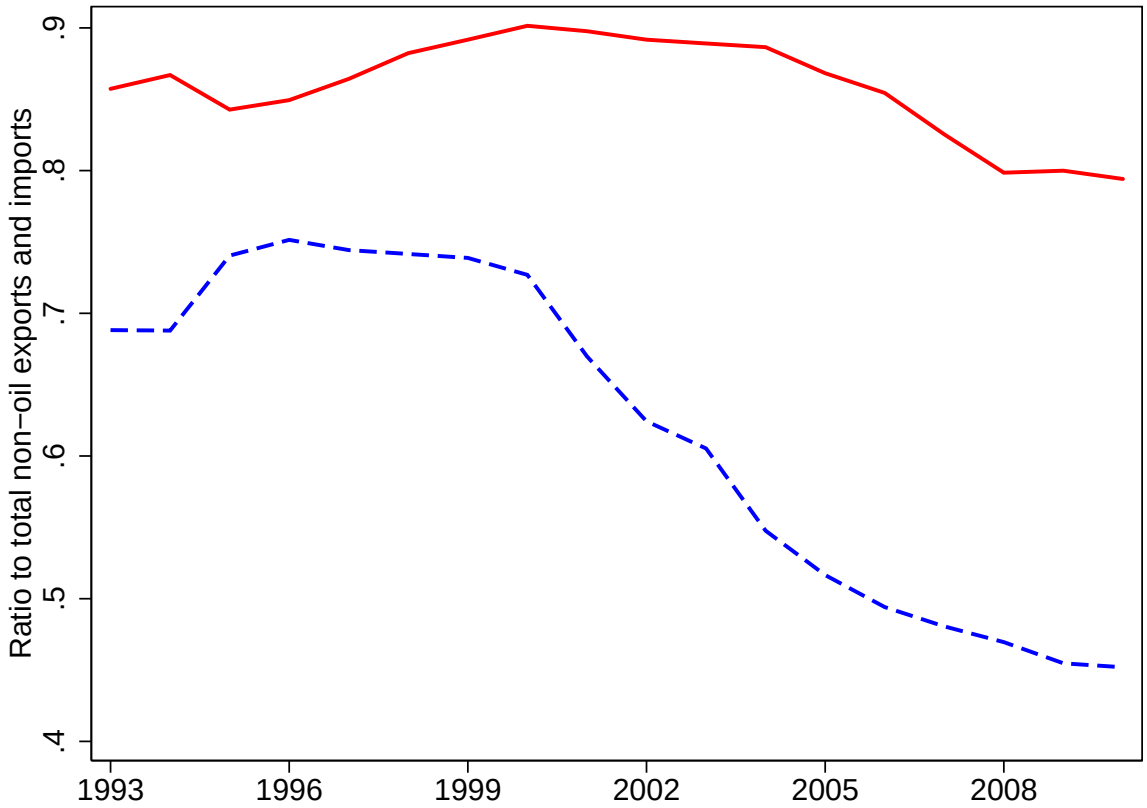
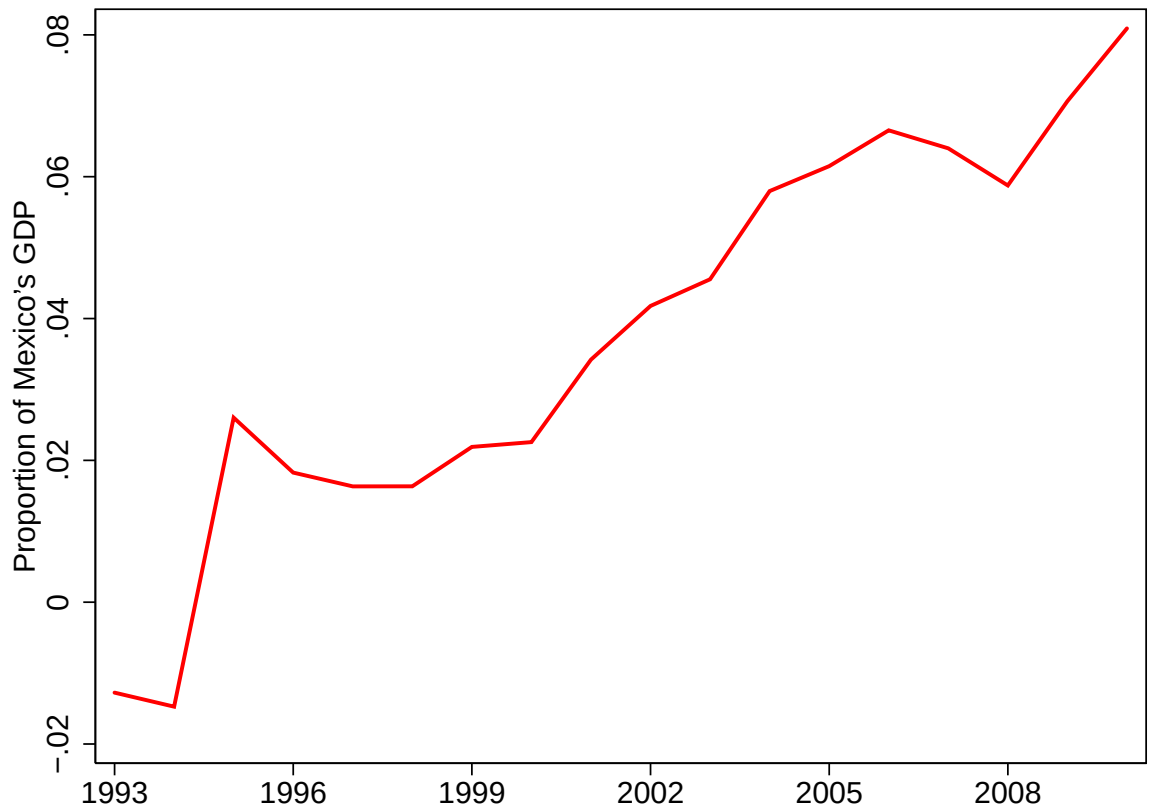


Figure: Non-oil exports (solid) and imports (dashed) to/from the U.S.

Non-oil trade balance with the U.S.



More on Mexico's trade

- 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
  - While the value of non-oil exports to the U.S. in 1993 was equivalent to about 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%)

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  - Since then, that fraction has remained between 18.5% and 21.5% (in 2010, the proportion was 20.3%)
- 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

Table: 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

Employment in manufacturing

- The share of manufacturing employment in total employment decreased about 6 percentage points in the last 10 years
- In 2000, most of the mean wages by industry were lower than in 1992
- Wages recovered in the last 10 years, but are still below the 1992 levels

Production, employment and wages in manufacturing

	Manufacturing Index 2003=100		
Year	Production	Workers	Avg. Wage
1993	75.0		
2000	104.8		
2005	111.8	96.0	102.3
2007	114.3	97.2	102.8
2009	111.5	86.0	106.2

Production, employment and wages in manufacturing

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2009	111.5	86.0	106.2

- From 1993 to 2000 we observe a large increase in production in the manufacturing sector
- Since 2000, production in the manufacturing sector has been stagnant
- Manufacturing employment has contracted since 2003: 14 percent decline in employment in the manufacturing sector from 2003 to 2009
- Wages show an increase during the same period

Table: Composition of U.S. imports from Mexico and China

	Mexico			China		
NAICS	1992	2000	2009	1992	2000	2009
11	6.1%	2.8%	4.3%	2.1%	0.8%	0.6%
21	14.5%	8.4%	15.8%	2.1%	0.3%	0.1%
311	1.8%	0.9%	2.7%	0.8%	0.6%	1.1%
312	0.9%	1.0%	1.7%	0.0%	0.0%	0.0%
313	0.7%	1.1%	0.8%	4.3%	2.3%	3.3%
315	3.7%	7.0%	2.5%	20.4%	8.9%	11.2%
316	1.0%	1.1%	0.8%	18.3%	12.2%	6.6%
322	0.4%	0.3%	0.6%	0.5%	0.7%	1.0%
323	0.6%	0.2%	0.3%	1.3%	0.7%	0.9%
324	0.8%	0.9%	2.2%	0.2%	0.4%	0.1%
325	2.8%	2.0%	2.2%	1.9%	1.7%	3.2%
326	0.7%	0.9%	1.3%	1.8%	2.7%	3.1%
327	1.7%	1.3%	1.2%	1.6%	2.5%	1.6%
331	2.2%	1.9%	4.6%	0.7%	1.2%	1.4%
334	18.6%	27.0%	19.8%	11.6%	26.3%	35.4%
335	9.6%	8.1%	9.5%	6.8%	9.1%	7.4%
336	26.4%	28.8%	22.2%	0.9%	2.4%	1.9%
339	7.6%	6.1%	7.5%	24.7%	27.4%	21.0%

Composition of U.S. imports from Mexico and China

- **For Mexico:** Four industries account for more than 65% of its exports to the U.S.:
  Transportation equipment (336), Computers and electronics (334), Mining, oil, and gas (21), and Electrical products, appliances (335)
- **For China:** Exports to the U.S. in Computers and electronics (334) are by far the most important in recent years

Table: Shares of Mexico and China in total U.S. imports

	Mexico			China		
NAICS	1992	2000	2009	1992	2000	2009
11	12.0%	14.5%	18.2%	3.3%	3.0%	4.1%
21	10.1%	13.1%	11.7%	1.1%	0.3%	0.1%
311	4.6%	6.2%	10.3%	1.7%	2.7%	6.8%
312	6.5%	15.2%	16.6%	0.2%	0.2%	0.2%
313	3.0%	9.3%	5.8%	14.1%	15.0%	41.5%
315	3.8%	13.8%	5.2%	16.4%	13.2%	39.1%
316	2.4%	6.6%	5.2%	33.6%	53.3%	69.5%
322	1.1%	2.1%	4.2%	1.2%	3.2%	12.8%
323	5.9%	6.8%	7.5%	9.7%	16.2%	41.2%
324	2.4%	2.8%	4.0%	0.4%	0.9%	0.3%
325	3.2%	3.3%	2.0%	1.7%	2.1%	4.9%
326	2.9%	6.7%	7.3%	6.1%	14.5%	30.5%
327	8.9%	10.8%	13.6%	6.3%	15.9%	31.2%
331	3.2%	5.5%	12.1%	0.8%	2.6%	6.3%
334	6.5%	13.3%	12.7%	3.2%	9.8%	38.3%
335	18.4%	25.3%	26.1%	10.2%	21.5%	33.9%
336	8.4%	16.7%	19.3%	0.2%	1.0%	2.8%
339	4.7%	6.6%	7.8%	12.1%	22.2%	36.7%
Total	**6.7%**	**11.6%**	**10.8%**	**5.2%**	**8.8%**	**18.2%**

U.S. imports from Mexico and China

- Total share of each country in total U.S. imports:
  - Mexico's share rose to 11.6% by 2000, and then declined to 10.8% by 2009
  - Share of China grew dramatically between 2000 and 2009, rising from 8.8% to 18.2%
- China displaced Mexico as the second major trading partner of the U.S. since 2006
- At the industry level, 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%

U.S. imports from Mexico and China

- For Mexico's most important exporting industry, Transportation equipment (336), share was about 19% by 2009
  Does not seem to be affected by China's rise (in 2009, China's share in this industry was only 1.9%)
- China's share in 9 (out of 18) of the industries was larger than 30% by 2009
- China's exports in sector 334, Computers and electronics, accounted for 38.3% of the U.S. imports in that industry in 2009 (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)

Outline

Trade Data

- For our measures of bilateral trade costs between Mexico and the U.S., we use U.S. import data from the United States International Trade Commission (USITC)
- Assume that trade cost rates are similar for Mexican and U.S. exporters
- We obtain the following series on U.S. imports from Mexico at the industry level: imports customs value (before duties or any other charges), import duties, and import charges (freight and insurance)
- From these series, we create the *tariff rate* (τ_{jt}), the *freight rate* (f_{jt}), and the *total cost rate* (c_{jt}) for industry j at time t
- We create similar variables for U.S. imports from China: τ^*_{jt}, f^*_{jt} and c^*_{jt}

Table: Trade costs for Mexico's exports to the U.S.

	Tariff rate (τ)		Freight rate (f)		Total cost (c)	
NAICS	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%
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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%
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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: Trade costs for China's exports to the U.S.

	Tariff rate (τ^*)		Freight rate (f^*)		Total cost (c^*)	
NAICS	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%
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323	4.9%	0.1%	8.3%	5.8%	13.2%	5.9%
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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%
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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%**

Trade costs for Mexico and China

- **For Mexico:** Weighted average for the total cost of exporting to the U.S. declined from 4.5% 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%

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- 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%
- **For China:** Weighted average for the total trade cost rate declined from 14.8% in 1992 to 8.3% 2009
- The average tariff rate declined from 7.9% to 3.7%, and the average freight rate declined from 6.9% to 4.6%

Occupations and skill levels

- Each worker is classified on one of 17 occupations
- We then use occupations to separate workers by skill level
- **Approach:** We sort occupations by skill level in a base year (1992) using an education or a wage variable, and keep that ranking constant for our entire period of study

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- Each worker is classified on one of 17 occupations
- We then use occupations to separate workers by skill level
- **Approach:** We sort occupations by skill level in a base year (1992) using an education or a wage variable, and keep that ranking constant for our entire period of study
- More appropriate approach than using changes in employment by education levels
- **Why?** Education levels in Mexico have increased over time for every type of worker
- **Then:** A trade and employment analysis that uses education level changes to approach for demand-for-skill changes would likely be biased in favor of a skill-biased technological change story

Table: 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 collar (supervisors, quality)	42%	52%	10%
52	Manufacturing: blue collar (repairs, maintenance)	12%	24%	12%
53	Manufacturing: blue collar (machine operators)	10%	21%	11%
54	Manufacturing: blue collar (helpers)	11%	21%	11%
55	Machinery and transportation workers (drivers)	6%	22%	15%
61	Management and services 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%

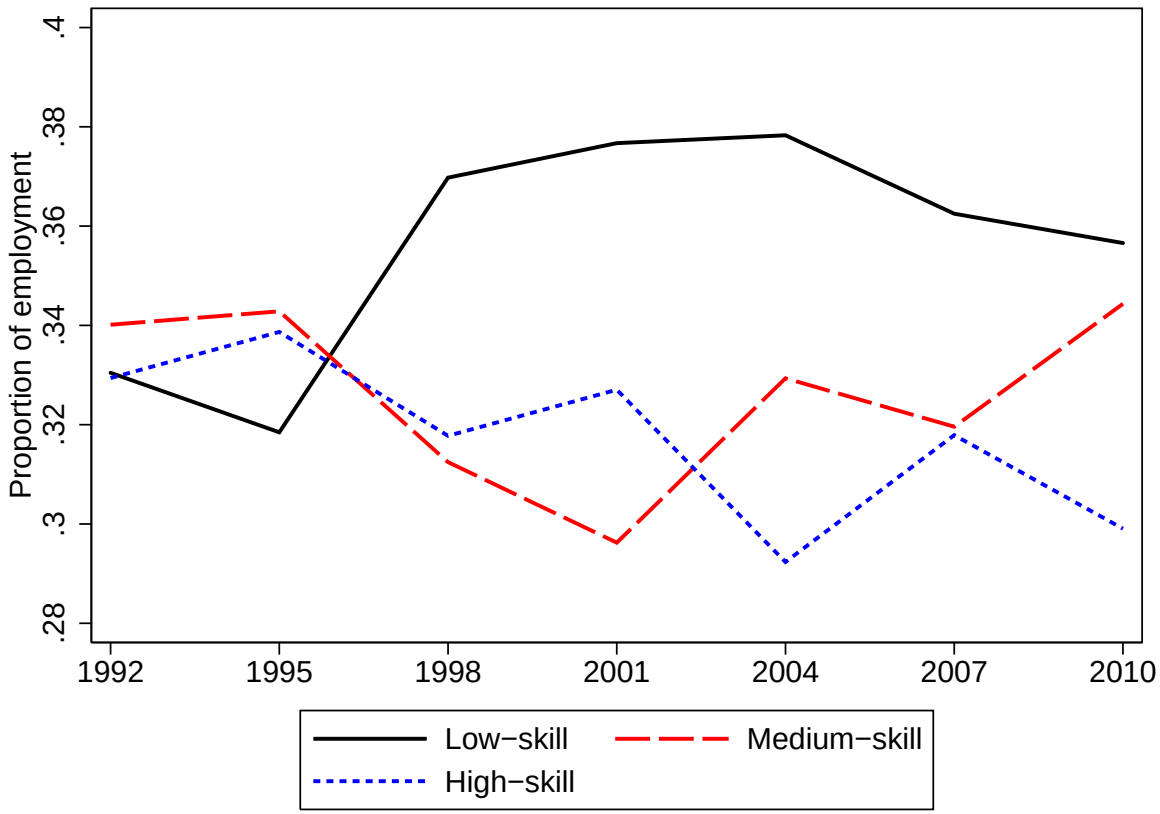
Table: Occupations and skill rankings (base year: 1992)

Code	Description	Ranking by Education	Ranking by 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 collar (helpers)	4	1.5
41	Agriculture and forestry workers	5	1.5
52	Manufacturing: blue collar (repairs, maintenance)	6	7
83	Protective service workers	7	5
81	Personal service workers	8	3
71	Sales workers	9	8
51	Manufacturing: white collar (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 services supervisors	15	14
21	Managers in the government and private sector	16	17
11	Professionals	17	16

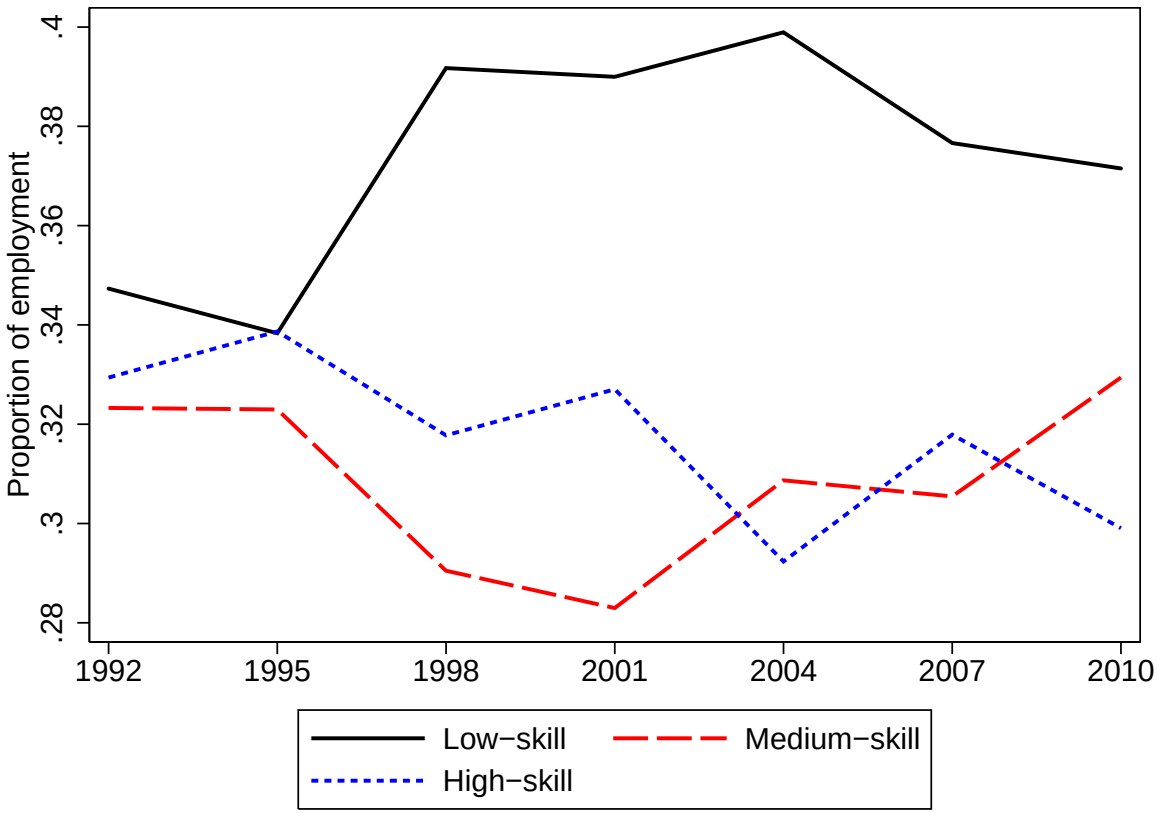
Correlation of 0.824 between the rankings

Occupational shares on total employment

- Aggregating the occupations in three skill levels: low-skill, medium-skill, and high-skill
- Based on the education ranking:



Based on the wage ranking:



Changes in occupational shares

- 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
- 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

Changes in occupational shares

- 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
- 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
- Not a story of skill-biased technological change
- 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

Outline

At the end we have:

- Occupation-industry combinations as our units of analysis: panel with 306 occupation-industry units (17 occupations and 18 industries) followed over 18 years (from 1992 to 2009)
- **Objective of the empirical approach:** Identify shifts in the type of occupations embodied in trade

Equation to estimate

$$\triangle e_{ijt} = \alpha_{ij} + \alpha_t + \beta \triangle \tau_{jt} + \gamma \triangle \tau_{jt} \times r_i + \delta X_{jt} + \rho Z_{ijt} + \varepsilon_{ijt}$$

- 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
- $r_i \in (0, 2)$ is the ranking of occupation i: the occupation ranked 1 (lowest-skilled) has a value r_1 close to zero, the occupation at the median has a value r_9 of 1, and the occupation ranked 17 (highest-skilled) has a value r_{17} close to 2
- 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

Benchmark regression

- We use the ranking based on education (percent of workers with high school or more)
- X_{jt}: the change in the total trade cost rate for U.S. imports from China ($\triangle c^*_{jt}$), the interaction of $\triangle c^*_{jt}$ with r_i, and the log difference in the U.S. import price index ($\triangle p^M_{jt}$)
- Z_{ijt}: log hourly wage, the share of informal workers, the share of self-employed workers, the average age, and the share of females

Table: Benchmark regression results

Dependent variable: $\triangle e_{ijt}$	
$\triangle \tau_{jt}$	-10.712**
	(4.426)
$\triangle \tau_{jt} \times r_i$	5.651*
	(3.300)
Trade controls (X_{jt})	
$\triangle c^*_{jt}$	-0.434
	(0.542)
$\triangle c^*_{jt} \times r_i$	0.895*
	(0.529)
$\triangle p^M_{jt}$	-0.158
	(0.104)
Occupation-industry controls (Z_{ijt})	
$\log(\text{Hourly wage})_{ijt}$	0.028
	(0.053)
$\text{Informal-workers share}_{ijt}$	0.194
	(0.123)
$\text{Self-employed share}_{ijt}$	-0.412*
	(0.215)
Age_{ijt}	-0.007*
	(0.004)
$\text{Female share}_{ijt}$	-0.186
	(0.116)

Benchmark regression results

- Coefficients of interest: $\hat{\beta} = -10.712$ and $\hat{\gamma} = 5.651$,
- 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%

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- 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%
- **After a decrease in the tariff rate, low-skill occupations have larger employment expansions**

Benchmark regression results

- Trade controls: Only significant variable is the total trade cost rate for U.S. imports from China interacted with our occupations' ranking variable $(\triangle c_{jt}^{*} \times r_i)$
- The coefficient is positive and close to 0.90
- 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

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- **Then, a decrease in trade costs between the U.S. and China has a negative impact on occupations in Mexico, with a stronger negative effect on high-skill occupations**
- China is competing with—and affecting more—Mexico in more sophisticated occupations

Robustness

These results are robust to several specifications:

- In other regressions, we also include as trade controls the freight rate for Mexican exports, the trade costs for China split in tariff and freight rates, and an import penetration measure
- These variables were highly insignificant and did not have any effects in the magnitude and statistical significance of our coefficients of interest
- If we use the occupation ranking based on the median wage, results barely change
- Results are similar if we use a weighted regression
- Results are robust to the use of different base years for our rankings of occupations

Outline

Bottlenecks in the Mexican economy

- The quality of education in Mexico is relatively poor
- Among 15-year-old individuals, Mexico ranks 47th in science among 56 countries (OECD)
- Labor market rigidity: In the index of employment rigidity 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 (China's employment index 31)
- Limited access to credit: Hanson (2010) shows that domestic credit to the private sector declined for the years 2001-2008
- Mexican exports are facing strong competition from China