How does globalization affect educational attainment? Evidence from China*

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Abstract

This paper investigates how changes in trade policy, both by China and its trading partners, affect rates of high school completion in Chinese prefectures between 1990 and 2005. I separate the effects of trade policy changes into: (1) reductions in tariffs and trade policy uncertainty abroad; and (2) reductions in Chinese tariffs on intermediate, final, and capital goods. Exploiting spatial variation across 324 Chinese prefectures and temporal variation across 15 age cohorts, I employ a difference-in-difference empirical specification and verify the results with semi-parametric methods. Robust empirical findings suggest that increases in high school completion were more pronounced in prefectures with larger reductions in Chinese tariffs on unskilled-labor-intensive inputs, Chinese tariffs on foreign capital goods, and tariffs abroad on skilled-labor-intensive goods. At the same time, increases in high school completion were attenuated in prefectures facing larger reductions in trade policy uncertainty abroad regarding unskilled-labor-intensive goods. Overall, about half of the total increase in high school completion from 1990 to 2005 can be explained by the net effect of these trade policy changes.

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1 Introduction

As many developing countries phased out import-substitution and opened up to trade, their relative demand for skilled workers has changed.[1] The associated impact on educational attainment bears lasting influence on economic development and poverty reduction. What is the long-run impact of trade policy changes on the educational attainment of young people?

This question has been studied in a few recent empirical works that consider endogenous skill acquisition in response to trade shocks. Trade shocks can influence educational attainment through two main channels. First, trade shocks change returns to education, affecting the incentive to acquire education. Atkin (2016) finds the arrival of low-skill export jobs increased opportunity cost of schooling, and consequently increased school dropout rates in Mexico. Second, trade shocks change real income, affecting the affordability of education. Edmonds, Pavcnik, and Topalova (2010) associates unskilled workers' income loss due to trade liberalization with attenuation in schooling attendance trends in India. Mixed results from these studies indicate that the investigation is far from conclusive. More importantly, globalization in developing countries is often multi-faceted, yet existing studies each focus on a few limited aspects of globalization and thus paint incomplete pictures of the potential impact on educational attainment. A full understanding of the overall impact on education requires evaluating a comprehensive set of trade policy changes – China offers one such ideal context.

In this paper, I examine the educational impacts of globalization in China using an series of trade barrier reductions by China and its trading partners from 1990 to 2004 – China's trade liberalization since 1992, the conclusion of the Uruguay Round in 1995, US granting China permanent normal-trade-relations (NTR) in 2000, and China's accession to the World Trade Organization (WTO) in November 2001. Figure 1a offers a timeline of these events. The changes in trade policy during this time period affected sectors with various levels of skill-intensity, giving rise to offsetting impacts on skill acquisition.[2] The combined effect on educational attainment could mask the underlying competing forces resulted from different trade policy changes. Thus, the goal of this paper is to decompose

[1] See Goldberg and Pavcnik (2007) for survey.

[2] For example, *ceteris paribus*, export expansion in skilled sectors increases skill premium and skill acquisition, while export expansion in the unskilled sectors has the opposite effect.

the trade policy changes, empirically test their isolated impact on educational attainment, and identify the trade policy changes that encourage skill acquisition from the ones that suppress it.

To this end, I follow the "differential exposure approach" developed by Bartik (1991) and Topalova (2007), and examine, between 1990 and 2004, whether cohorts in prefectures exposed to bigger trade barrier reductions experienced more pronounced changes in high school completion rates than cohorts in prefectures less exposed.[3] I decompose the trade barrier reductions for both skilled and unskilled sectors into: 1) reduction in tariffs and trade policy uncertainty abroad; 2) lower Chinese tariffs on final and intermediate goods; and 3) lower Chinese tariffs on foreign capital goods.[4]

The identification strategy is straightforward. Different prefectures had different industrial composition, and trade barriers for different industries were reduced by varying levels at varying times, inducing variation in exposure to trade policy changes across Chinese prefectures. I measure each prefecture's local exposure to trade shocks as a weighted average of industry-level changes in tariff rates, with weights based on the initial prefecture industry mix. By using pre-existing industry mix as fixed weights, the changes in prefecture trade policy only reflect industry-level statutory changes overtime, eliminating confounding factors from production and employment composition shifts due to trade shocks.

The empirical analysis uses prefecture-level data that covers 324 of Chinese prefectures and 15 age cohorts. It is constructed by combining census data, firm-level custom and production data, and product-level trade policy data. The pseudo panel allows me to associate changes in educational attainment with local exposure to changes in trade policy. In a difference-in-differences specification, high school completion rate of an age cohort in a prefecture is regressed on prefecture-level time-varying measure of trade policies. The empirical design compares how changes in educational attainment across cohorts differ in prefectures with large changes in trade policy from prefectures with little changes in trade policy.

The causal interpretation of the estimated effect of local trade shocks on education relies on the exogeneity of trade policy changes. Several features of the trade policy changes, by

[3]Prefectures are the relevant labor market units because of low rates of permanent mobility between prefectures. See permanent migration rates in 2000 in Table 11 and more in Facchini, Mayda, Liu, and Zhou (2016).

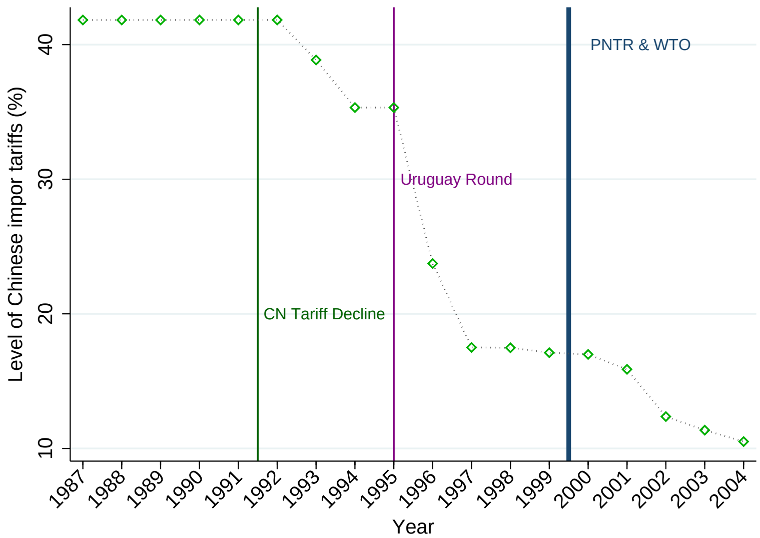
[4]I present more descriptive statistics on these policy changes in Section 2.

both China and its trading partners, mitigate the usual concern of endogeneity about trade openness (Grossman and Helpman 1994; 2002). First, the reduction in trade barriers by China's trading partners – first in 1995 due to the Uruguay Round, and in 2001 due to China's accession to the WTO – came from international multilateral negotiations that China was not a part of. These external trade policy changes were unlikely the outcome of a political process relevant to China. One exception remains where the U.S. granting China Normal-Trade-Relations in 2000 was the final result of bilateral negotiations between the U.S. and China. However, the size of the trade barrier reduction, measured by NTR Gap (Handley and Limao 2013; Pierce and Schott 2016), was not influenced by economic conditions in China. Second, since early 1990s, the Chinese government lowered the levels and dispersion of tariffs across industries to more uniform levels that aimed to match tariff levels in the GATT/WTO. In fact, China chose to unilaterally liberalize to gain credibility with its negotiating partners that it was seriously committed to opening up its economy (Branstetter and Lardy 2006). I present more evidence on the exogeneity of Chinese tariff rates in Section 2.3. Finally, the prefecture-specific local exposure to trade policy changes is constructed by interacting prefecture industrial composition and reductions in industry level trade barriers nationwide. As a result, it is unlikely that unobserved prefecture-specific time varying shocks that affect educational attainment are correlated with the local exposure to trade policy changes.

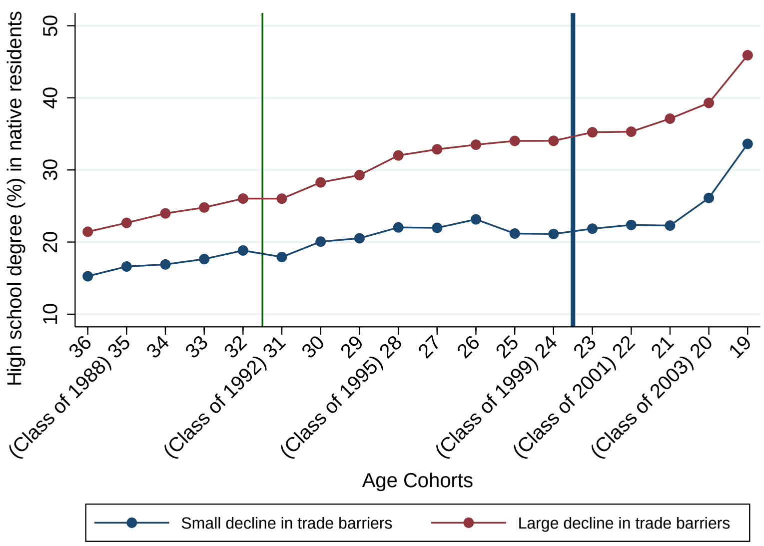
The source of identification comes from both spatial and time variations: different cohorts across Chinese prefectures differ in their timing and degree of exposure to local trade shocks. Figure 1 provides a simplified visual representation of the concurrent trade barriers reductions and increasing high school completion rates. In the upper panel, Figure 1a plots the decrease in Chinese import tariff rates against the timeline of three major globalization events. In the lower panel, Figure 1b plots school completion rate among the native population (non-migrants and out-migrants) across age cohorts. The deviation between prefectures facing bigger trade shocks and ones facing smaller trade shocks coincides with major globalization events. The pre-liberalization trends among the "treatment" and "control" prefectures track closely with each other, validating a DID empirical design. In Section 3, I further relax the common trend assumption with prefecture-specific time trends.

Robust empirical results show that, overall, trade policy changes are associated with the younger generations' increased high school completion rates. I find evidence of higher

Figure 1: Trade policy changes and educational attainment



(a) Average Level of Chinese Import Tariff Rates



(b) Share of High School Educated Workers

Notes: (a) plots the level of average import tariffs showing the degree of tariff declines against the timeline of major trade policy changes China experienced: China's beginning of lowering import tariff in 1992; conclusion of the Uruguay Round in 1995, and China's accession to the WTO in 2001. Age cohorts around these lines were most exposed to trade liberalizations. (b) plots from older cohorts to younger cohorts, the share of high school educated individuals among the native population (non-migrants and out-migrants). The blue line plots the average education level in cities "less-treated" (that is, experience smaller trade liberalization), and the red line plots the average education level in cities that were "more-treated". The vertical lines indicating major trade policy changes coincide with (a).

investment in human capital by cohorts in prefectures that were exposed to larger reductions of: a) Chinese tariffs on unskilled-labor-intensive inputs; b) Chinese tariffs on foreign capital goods, which embody skill-biased technology; and c) tariffs abroad of skilled-labor-intensive goods. At the same time, increases in high school completion were attenuated in prefectures facing larger reductions in trade policy uncertainty abroad regarding unskilled-labor-intensive goods.

From 1990 to 2004, in the average Chinese prefecture, high school completion rates among male 16-19 year-olds has increased 20 percentage points – from 26.3% to 46.5%. Positive changes related to Chinese tariff reduction increased the share of high school educated individuals among native labor force by about 10-13%, while PNTR and China's accession to WTO decreased high school educational attainment by 3.5% since 2001. The combined effects of globalization translates to about half of the total increase in high school completion since China's trade reform. Interestingly, I do not find evidence of globalization increases college completion in Chinese prefectures, possibly due to the limited number of seats in tertiary institutions and biased college admission policies during the time period examined. The contrast in results for high school and college completion suggests that provision of public education can be a binding effect in skill upgrading.

The paper proceeds as follows. I describe the data and context in Section 2, and present empirical specification in Section 3. Section 4 presents the main empirical results on the relationship between various trade policy changes and educational attainment, and Section 5 validates the main findings through a variety of robustness checks. Finally, in Section 6, I outline a simple model, and explore the mechanisms through which trade affected educational attainment. Section 7 concludes.

2 Data and Context

In this section I describe the data used in measuring education and trade policy changes, and provide the context for the relevant trade events as well as China's education system.

2.1 Data

To examine the effect of trade policy changes on educational attainment, I rely on China's considerable temporal and geographic variations in exposure to globalization, and link the school completion rate of each prefecture-cohort with the contemporaneous local trade barriers that cohorts faced in their schooling years.

The data used in the empirical analysis comes from several sources. The 2005 Chinese "Mini" Census provides information on age, educational attainment, and residence, thus allowing me to calculate the average educational attainment for each age cohort at various geographic locations. The prefecture level local industry mix comes from the 1997-1999 Chinese Custom Data (CCD), and 1998-2005 Chinese Annual Survey of Industrial Firms (CASIF). The Chinese Custom Data document firm-level import and export transactions at the product level, and the Chinese Annual Survey of Industrial Firms documents firm-level employment and production information. Using geo-referenced firm identification, I measure the aggregate industrial mix of each prefecture through detailed employment or trade information. To calculate the local exposure to trade barriers at the prefecture level, I aggregate industry-level trade barriers to the prefecture level using each prefectures pre-existing industrial composition in employment/trade as weights.

This location – year specific measures of trade barriers allow me to match cohorts' education outcomes with the trade environment they faced in their schooling years, at their hometown prefectures. The constructed panel covers 324 prefectures spanning 15 age cohorts – aged 18 to 32 – who represent graduating classes from 1990 to 2004. Each observation – an age cohort in a prefecture – links contemporaneous local exposure to trade barriers with educational outcomes.

I differentiate types of trade policy changes by distinguishing industries with different skill intensities, and dividing trade policy changes into import shocks and export shocks. I categorize industries into skilled– and unskilled – labor – intensive ones in the context of China. The skill intensity of each product can be calculated from the 2004 Chinese Annual Survey of Industrial Firms (CASIF), in which the number of skilled and unskilled workers used in producing various traded products are documented. The skill intensity is then calculated as the share of skilled workers used in the production of each product.[5]

The main trade policy changes considered are tariff changes and tariff uncertainty reductions. NTR gaps measuring China's export tariff uncertainty at the U.S market are from Pierce and Schott (2016). Tariff data at the product level (HS 6-digit) comes from the WITS-TRAINS database. The TRAINS database contains product-level (HS 6-digit)

[5] I thank Heiwai Tang for making this variable available for this study.

import tariff rates in China as well the tariffs in China's 10 major export destinations.[6] I use nominal ad valorem tariff rates imposed by China and China's main trading partners from 1990-2004 for about 6000 products.[7]

To aggregate trade policies to the prefecture level, I use the crosswalk from product classification to geographic units made possible by the 1997-1999 Chinese Custom Data (CCD). It is an annual HS-based transaction-level data compiled by the General Administration of Customs of China, and it records information on each import/export transaction, and the variables relevant for our analysis include commodity code (HS 6-digit), partner country, firm type, firm location at the prefecture level, import/export type, transaction value (in USD), and transaction types. In addition to trade basket weighted trade policies, I also construct alternative weights, using industrial employment information from 1998-2005 Chinese Annual Survey of Industrial Firms (CASIF), to aggregate trade policies from industrial level to prefecture level. Section 3.1 contains more details of the construction of trade policy changes.

I use the concordance between Broad Economic Categories (BEC) and Harmonized Commodity Description and Coding Systems (HS) at the 6-digit level to categorize traded products into consumption, intermediate and capital goods. This allows me to differentiate the effects of tariff changes between effects on final goods prices, on intermediate goods prices, and on access to foreign technology.

I draw prefecture-level educational attainment measures from China's 2005 "mini" population census, conducted by the National Bureau of Statistics (NBS). They covers 31 provincial regions, which include 27 provinces and 4 provincial municipalities, and 344 prefecture-level cities/municipalities.[8] The population census of China documents detailed individual-level information on age, education level, employment status, migration history, as well as other demographic and geographic information. I concord prefectures across census years, and aggregate the individual level data to prefecture-by-cohort cells using age and locality information. High school educational attainment level of age cohort t in prefecture j calculates the share of individuals with high school degrees or above. College educational

[6]HongKong, Japan, US, EU, Korea, Singapore, Taiwan, Russia, Canada and Australia. Chinese exports to these 10 destinations account for about 80% of total export before WTO accession.

[7]Goldberg and Pavcnik (2007) and Kovak (2013) both provide sound arguments as to why nominal tariff rates are the preferred measure to effective rates.

[8]The final sample used consists of 324 prefecture, because I exclude 20 prefectures due to missing data and extreme outliers.

attainment level is defined similarly.

I also collect time-varying prefecture characteristics from the Chinese City Statistical Yearbooks (1992-2004) for supporting analysis. These additional variables include Foreign Direct Investment (FDI) flows, number of teachers and number of schools.

2.2 Education in China

This paper focuses on schooling at the high school and college levels. In China, primary and secondary education take 12 years to complete, with 6 years for primary school, 3 years for junior high school, and 3 years for high school. China started implementing 9-year compulsory schooling across the country in 1986, which means all children at eligible school ages (7 to 15 years old) have the right to, and must complete primary education and junior secondary education.[9] Parents only have to pay basic tuition and fees that do not take up big shares in their income. Thus, I expect the poverty-schooling link (Edmonds, Pavcnik, and Topalova 2010), that is, the parents income suffer negative impact due to loss of protection after trade liberalization, will not likely play an important role in the context of China.

The trade policy changes this paper studies took place around early 1990s through early 2000s, which was a time with arguably universal and effective implementation of 9-year compulsory education. For the 1990 cohort and onwards, most schooling age children would have completed junior high school by requirement, and they can move onto high school by choice, the cost of which is publicly subsidized and low. Even though the gradual implementation of 9-year compulsory education has attributed to a larger base of junior high graduates who are eligible for high school education, high school education remained a personal choice, and the observed increase in high school completion rates since the 1990s cannot be fully driven by changes in education laws concerning lower grades.

Table 1 shows that from 1990 to 2004, there has been a steady increase in high school completion/enrollment rates among schooling age cohorts.[10] Internal migration presents another possible confounding factor; that is, trade policy shocks may trigger accumulation

[9] "Compulsory Education Law of the People's Republic of China" in 1986

[10] Due to wide variations in school starting age among different regions, some 18-21 year olds are still enrolled in high school when surveyed by the 2005 census. To address this concern, I include enrolled students across all cohorts to minimize this compositional shifts across cohorts. I also confirm this is not an isolated issue with the only 2005 Census, I do the same calculation with 1990 and 2000 census waves, and find that a substantial share of 18-21 year-olds are still enrolled in high school.

of skill (through education) *as well as* reallocation of skill (through migration) as seen in Facchini, Mayda, Liu, and Zhou (2016). To tease out the changes in local skill endowment from reallocation of skill, I limit the prefecture-level local samples to include only the non-migrants and out-migrants. On average, the nationwide high school completion (and enrollment) rate among natives increased from 24.9 percent in 1990 to 47.4 percent in 2004, and that of college education increased from 8.5 percent in 1990 to 14.1 percent in 2004. The summary statistics of the corresponding prefecture-level education levels are reported in Table 2. The pattern observed in Table 1 persists.

One can also see the regional variation in educational attainment increase form Figure 2a. I calculate prefecture-specific share of high school educated among 18-27 year-old natives (non-migrants and out-migrants) in 2000 and in 2005 separately, and then take the difference to see how educational attainment at the high school level has changed in each prefecture during this time period. In this figure, I geo-reference the the changes in school completion rates with the location of prefectures. Each polygon on the map stands for a prefecture, and the bold lines outline the provincial boundaries. Prefecture that saw increase in educational attainment among the young cohorts are marked by red and ones that saw decreased are marked by blue. The degree of decrease and increase are shaded gradually. Increase in human capital accumulated is concentrated in the economically advanced regions: Yangtze River Delta region (Shanghai included), Pearl River Delta region in the southeast (Shenzhen included), and Bohai Economic Rim (Beijing included). These regions also saw bigger changes in trade volumes and barrier reductions, as shown in Figure 2b and 2d. Certain regions even experienced decrease in educational attainment, suggesting opposing influence exerted by changes in different trade policies.

2.3 Trade Policy Changes

China experienced a few major trade policy changes, both internal and external, affecting both skilled and unskilled sectors. 1) from 1990 to 2005, average Chinese import tariff rates decreased from 38 percent to 8 percent for unskilled labor intensive goods, and from 27 percent to 7 percent for skilled labor intensive goods;[11] 2) tariffs rates Chinese exporters face with major trading partners also decreased from 7.6 percent to 4.3 percent for unskilled labor intensive goods, and from 4.9 percent to 3 percent for skilled labor intensive goods;

[11] These imports include consumption goods, intermediate goods and capital goods

Table 1: Summary Statistics of Education Levels

High School Class	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Age in 2005	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18
Natives (million)	9.266	8.704	7.947	7.402	6.436	6.730	6.708	6.080	6.251	6.816	5.801	5.640	5.996	7.170	9.422
High School Educated Natives (million)	2.304	2.109	2.109	1.994	1.858	1.954	1.979	1.765	1.872	2.093	1.815	1.860	2.192	3.116	4.462
Share of High School Educated in Natives (%)	24.87	24.23	26.54	26.95	28.87	29.04	29.50	29.03	29.94	30.71	31.30	32.98	36.55	43.45	47.36
Internal Migrants (million)	1.424	1.473	1.448	1.333	1.230	1.287	1.378	1.317	1.367	1.535	1.301	1.304	1.258	1.220	1.204
High School Educated Migrants (million)	0.420	0.449	0.460	0.477	0.472	0.521	0.577	0.560	0.579	0.652	0.540	0.522	0.430	0.361	0.343
Share of High School Educated (%) in Migrants	29.52	30.45	31.77	35.81	38.40	40.47	41.89	42.49	42.37	42.47	41.52	40.03	34.20	29.61	28.51
College Class	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Age in 2005	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22
Natives (million)	10.72	11.49	10.44	9.686	9.266	8.704	7.947	7.402	6.436	6.730	6.708	6.080	6.251	6.816	5.801
College Educated Natives (million)	0.911	1.047	1.015	0.967	0.985	0.926	0.907	0.857	0.780	0.804	0.776	0.718	0.780	0.918	0.817
Share of College Educated in Natives (%)	8.503	9.112	9.718	9.979	10.63	10.64	11.41	11.58	12.11	11.95	11.57	11.81	12.47	13.48	14.08
Internal Migrants (million)	1.187	1.410	1.376	1.428	1.424	1.473	1.448	1.333	1.230	1.287	1.378	1.317	1.367	1.535	1.301
College Educated Migrants (million)	0.107	0.138	0.148	0.171	0.165	0.172	0.180	0.185	0.196	0.218	0.248	0.234	0.265	0.302	0.238
Share of College Educated (%) in Migrants	9.015	9.777	10.72	11.97	11.59	11.66	12.45	13.90	15.95	16.98	18.00	17.75	19.37	19.69	18.26

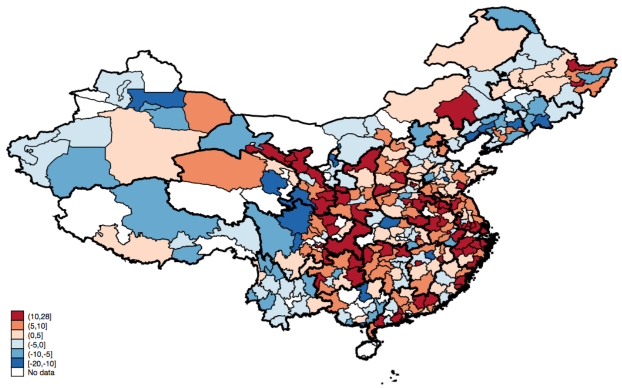
Notes: This table summarizes the nation-wide school completion (enrollment included) rates of the cohorts representing graduating classes from 1990 to 2004. Sample include males aged 18-36. "Natives" refers to non-migrants. Each cohorts' age in 2005 was listed below their class years for reference.

Table 2: Educational attainment of natives and migrants in 2005, by age cohorts

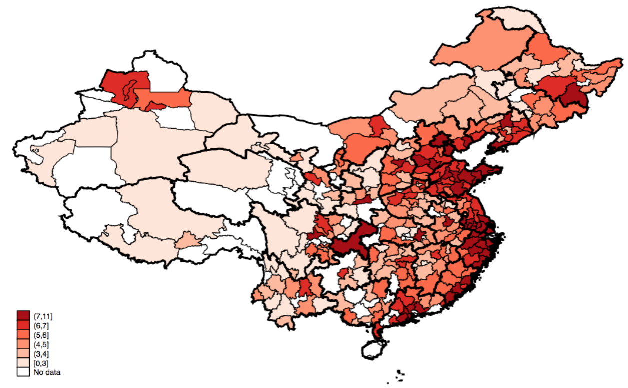
High School Class	1990-1994	1995-1999	2000-2004
Age in 2005	28-32	23-27	18-22
% in population	27.81	31.37	37.35
	(12.71)	(14.36)	(17.92)
% in non-migrants	28.72	31.79	39.84
	(15.46)	(17.12)	(21.26)
% in out-migrants	32.91	43.86	37.51
	(38.47)	(41.01)	(41.24)
% in in-migrants	31.34	40.86	36.86
	(30.13)	(33.88)	(34.69)
College Class	1990-1994	1995-1999	2000-2004
Age in 2005	32-36	27-31	22-26
% in population	11.03	11.67	13.04
	(7.390)	(7.638)	(10.45)
% in non-migrants	11.91	12.47	13.47
	(9.617)	(10.06)	(12.52)
% in out-migrants	12.44	14.84	21.51
	(26.40)	(28.84)	(33.43)
% in in-migrants	11.13	13.01	18.59
	(20.65)	(20.84)	(26.81)

Notes: This table summarizes the prefecture-level school completion (enrollment included) rates of the male cohorts representing graduating classes from 1990 to 2004. Sample include males aged 18-36 in 324 prefectures. Each cohorts' age in 2005 was listed below their class years for reference. Standard deviations are in parentheses. Each observation is a cohort in a prefecture. I consider 4 demographic groups: current residing population (non-migrants and in-migrants), non-migrants, out-migrants, and in-migrants.

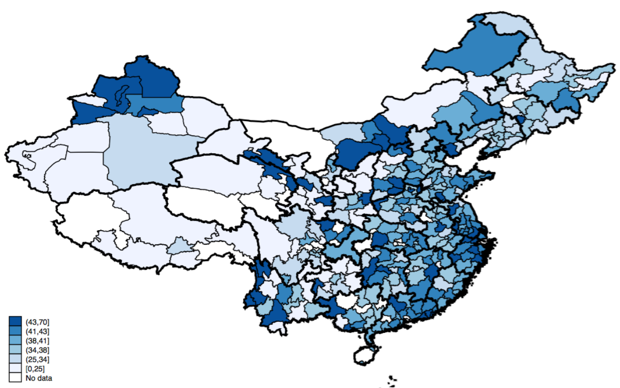
Figure 2: Geographic Variation Among Chinese Prefectures



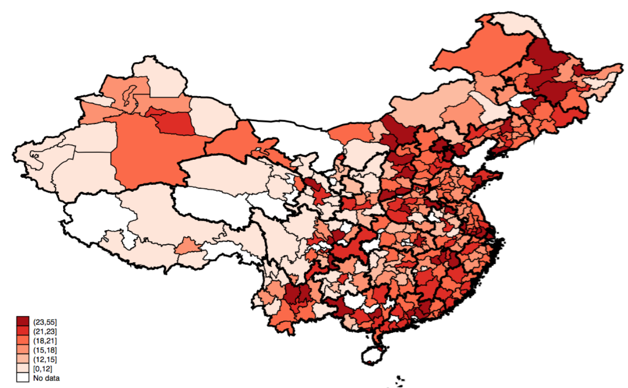
(a) Changes from 2000 to 2005 in High School Educated (%) among 18-27 Year-old Natives



(b) Log of Changes in Export Values from 2000 to 2005



(c) Trade Uncertainty Levels (NTR Gaps) in Low-skill Products



(d) Change in Tariff Rates on Capital Goods from 1992 to 2004

Notes: The geographic boundaries outline administrative division at the prefecture level. Bold lines mark provincial boundaries. (a) shows the increase in share of at least high school educated among the native 18-27 year-olds. (b) plots the geographic variation in prefecture-level increase in export values. (c) plots the geographic variation in prefecture-level NTR gaps of low-skilled exports. (d) plots the geographic variation in prefecture-level import tariff rates on capital goods.

3) foreign technology was adopted through foreign direct investment (FDI) and imports of capital goods, and the tariff rates on capital goods dropped from 24 percent to 7 percent; and 4) the reduction in trade policy uncertainty when US granted China permanent NTR status in 2000 improved market access to the U.S market. I present descriptive statistics on each of these trade policy changes below.

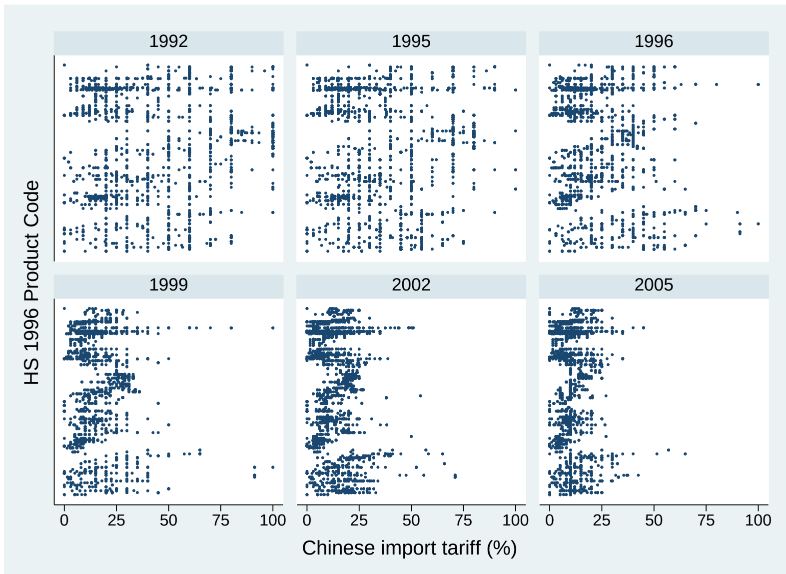
A: Import Tariff Change and Exogeneity

Import tariffs in China began to decrease beginning in 1992 as part of a broad set of reforms to facilitate the conditions for WTO accession. The average statutory tariff rates fell from an average of 43 percent in 1992 to 15 percent in 2001 and 8 percent in 2005. Figure 1a plots the simple average import tariffs on unskilled-labor-intensive goods across the globalization episodes. Each major event is associated with a dramatic decrease in import tariff rates. More evidence at the product level can be found at Figure 3a, which shows the scatterplot of HS 6-digit product level import tariff rates over time. Tariff rates in China were reduced to a uniformly low level over the years. This suggests that tariff changes are not strongly correlated with pre-liberalization protection patterns and dissuades the concern that baseline economic and political factors of industries played a role in the extent of tariff reductions.

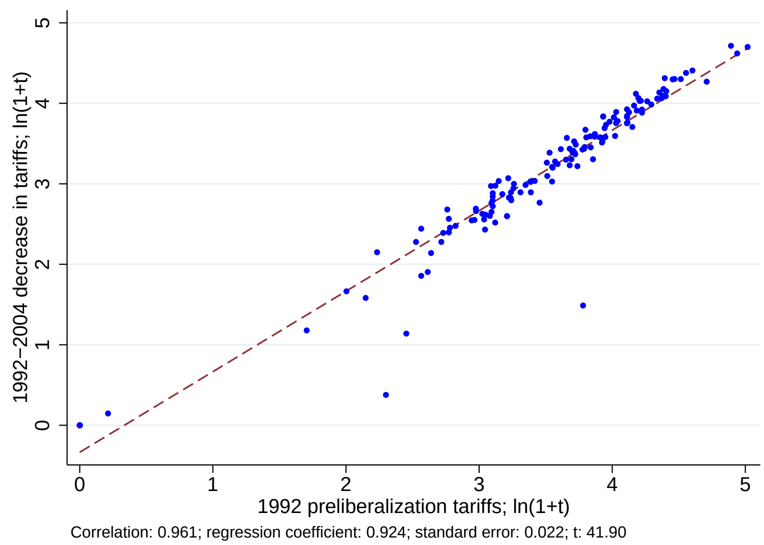
The exogeneity of industry-level tariff reduction is crucial for the causal inference of the following empirical analysis, which exploits on the pre-liberalization industrial structures of each prefecture. Previous studies have addressed this concern by showing almost perfect correlation between pre-liberalization tariff level and the ensued tariff declines, suggesting that policymakers reduced tariffs across the board to reduce cross-industry variation in tariffs; thus industries with high tariffs before liberalization experienced greater cuts. [12] Figure 3a shows the initially dispersed tariff rates across products were reduced to a uniform low level. Moreover, I plot the industry-level tariff cuts and the initial tariff rates in Figure 3b, which shows that industries with higher tariff before trade liberalization had bigger cuts (the correlation is 0.969). This reassures the exogeneity of Chinese tariff changes.

[12] Goldberg and Pavcnik (2005) shows the exogeneity of tariff changes in the context of Columbian trade reform by showing the industries with higher protection also experience larger tariff cuts. Topalova (2010) shows that industry tariff declines during India's 1991 trade reform are not correlated with baseline industry characteristics such as productivity, skill intensity, and capital intensity. In the case of Brazil, Kovak (2013) argues that the driving force for liberalization came from the government rather than from the private sectors, and he dissuades this concern following the approach by Goldberg and Pavcnik (2005).

Figure 3: Exogeneity of Chinese tariff reductions



(a) Chinese import tariff rates at product level



(b) Relationship between tariff reductions and pre-liberalization tariff levels at industry level

Notes: (a)This figures plots the distributions of Chinese import tariff rates at the HS 6-digit product level at various years. The leftward shift in the density over time shows gradual overall import tariff reductions. (b)Industry tariff rates are aggregated from HS 6-digit level to ISIC 4-digit level by taking unweighted averages.

B: Tariff Rates in ROW

Even though China was not part of the GATT, most of its major trading parters gave China the Most-Favored-Nation (MFN) status. China's top 10 export destinations during 1997-1999 were Hong Kong, Japan, US, EU, Korea, Singapore, Taiwan, Russia, Canada and Australia. Chinese exports to these 10 destinations account for about 80% of total export before WTO accession. EU granted China permanent MFN status in 1980; at the same time, US granted China MFN status subject to yearly renewal. As a result, when the agreements of Uruguay Round came into effect in 1995, the tariff rates Chinese exports faced in foreign markets also decreased.

C: Trade Policy Uncertainty in the U.S.

In November 1995, China formally requested to accede to the World Trade Organization (WTO). After several years of arduous and lengthy negotiations, China became a member of the WTO in December 2001. A concurrent event closely leading up to China's WTO accession was the U.S. granting China permanent normal trade relations at the end of 2000. Prior to that, U.S. gave China conditional MFN status, which was subject to appeal every year. It was a contentious political process which created substantial uncertainty in the tariff rates Chinese exporters faced in the US market. In fact, in the 1990s, a bill was put before Congress every year to revoke MFN status to China. If enacted, these bills would have led to the application of the Smoot Hawley tariff.[13] In 2000, the average MFN tariff was 4%, whereas if China had lost MFN status, it would have faced a 31% average tariff. While China's normal trade relations with the US had never been revoked, and Chinese imports had enjoyed MFN tariff rates in the US between 1980 and 2000, the uncertainty imposed by China's conditional MFN status with the US was not trivial. The reduction of this uncertainty at the end of 2000, as US granted China permanent MFN status, created sizable impacts to the US, according to recent works (Autor, Dorn, and Hanson 2013, Handley and Limao 2013, Pierce and Schott (2016)). The U.S. trade policy uncertainty reduction is likely to have had sizable impacts on the Chinese labor market as well, causing long-term changes such as educational attainment.

To capture this effect, I measure the size of US-China trade liberalization, specifically the reduction of uncertainty due to the US conferral of permanent MFN status to China,

[13] See more detailed description in Handley and Limao (2013) and Pierce and Schott (2016).

using the product-specific normal-trade-relations (NTR) gap measure developed by Handley and Limao (2013) and Pierce and Schott (2016). This measure calculates the gap between pre–WTO Most Favorite Nation (MFN) tariffs applied by the United States to Chinese imports and the threat tariffs that would have been implemented if MFN status was not renewed by Congress on a yearly basis (the so called column 2 tariffs of the Smooth-Hawley Trade Act). NTR gap is defined as the difference between non-NTR tariff rate and the NTR rate. It measures the uncertainty faced by the Chinese exporters to the US. The NTR gap for product i is defined as: NTR $\text{gap}_i = \text{non NTR rate}_i - \text{NTR rate}_i$. Summary statistics of NTR gaps of skilled- and unskilled-labor-intensive goods are presented in Table 3. The trade policy uncertainty faced by Chinese exporters prior to the 2001 WTO accession are non-trivial. Consequently, the removal of trade policy uncertainty by the U.S. could also have non-trivial impacts on skill prices.

To determine local exposure to uncertainty, I use a weighted average of the NTR gap values for each Chinese prefecture, using information on the prefecture's export basket in 1999 to determine the corresponding weights. Furthermore, the trade policy uncertainty across Chinese regions varies significantly. As an example, the prefecture-specific NTR gaps on unskilled products, weighted by trade baskets of unskilled goods in each prefecture (more details in Section 3.1) are also presented in Figure 2c.

Table 3: Product Level NTR gaps by skill group, 1999

	Unskilled	Skilled	Total
Non-NTR rate	41.0	29.8	34.9
	(25.9)	(20.4)	(23.7)
NTR rate	5.40	2.99	4.11
	(6.88)	(5.33)	(6.21)
NTR gap	35.6	26.8	30.8
	(22.7)	(18.7)	(21.1)

Notes: This table shows the summary statistics of product level NTR gaps. The first two columns are unskilled and skilled products, respectively. Skill groups are determined by skill intensity information drawn from the 2004 Industrial Census. Non-NTR rates are Smoot-Hawley rates, NTR rates are MFN rates, and NTR gaps are the difference between non-NTR rates and NTR rates.

D: Non-Tariff Barriers (NTB)

Non-tariff barriers were also dramatically cut in the 1990s. The share of imports regulated by quotas and import licenses also fell from nearly 50 percent in 1980s to 18 percent in 1992 and 8.45 percent by 2001 (Branstetter and Lardy 2006).

For lack of available measures of NTB at detailed industry level over the time period examined in this paper, I control for two aspects of NTBs: Investment Barriers and MFA Quota. China is a major destination of foreign direct investment, and several studies have emphasized the role that FDI has had in promoting local development (Chen, Chang, and Zhang 1995). I proxy barriers to investment using the *Contract Intensity* measure proposed by Nunn (2007). The latter describes the share of intermediate inputs used by a firm that require relationship-specific investments by the supplier. The higher is the contract intensity of a firm, the more pervasive is the effect of the presence of investment barriers in a prefecture. Upon China's accession to WTO, barriers to investment were eliminated, and as a result prefectures characterized by firms with higher contract intensity disproportionately benefited from trade liberalization. My measure of contract intensity is constructed in a similar way as NTR gaps and captures the reduction in investment barriers due to China's WTO accession.

An additional sectoral driver that played an important role in this period is represented by the *MFA Quota Bound*, measuring U.S. apparel and textile quotas under the Multi Fibre Agreement (MFA) and the Agreement on Textiles and Clothing (ATC). This information is taken from Brambilla, Khandelwal, and Schott (2010). MFA Quota Bound measures the relaxation of MFA quotas; specifically, I calculate the share of export that faced binding MFA quota.[14] Constructed similarly as a treatment of trade liberalization, MFA Quota Bound measures the share of textile export that would have faced binding MFA quota, were not for China's WTO-accession.

3 Empirical Analysis

3.1 Measuring trade liberalization

To quantify local exposure to trade policy changes, I follow the literature that evaluates trade policy changes at subnational levels (Topalova 2007. See Kovak 2013 for literature

[14] I consider products with fill rate (share of actual import in allowed import) higher than 85% as products with binding quota.

review). They commonly uses a weighted average of changes in trade policy, with weights based on the industrial or factor distributions in each (subnational) region, and explore the spatial variation in trade policy changes. Kovak (2013) builds a theoretical foundation for this empirical approach and shows that the appropriate measures of liberalization uses *only* the traded sectors in the weights. I follow this approach throughout the empirical analysis.

To quantify time-varying trade policies for each of Chinese prefectures, I correlate industry trade policy with prefecture-specific local trade/employment compositions, constructing a weighted regional exposure of trade policy changes. I carry out this construction with two approaches: with import and export trade baskets, and with industrial employment concentrations. In Section 5, I show the main findings persist through alternative methods of aggregating.

A: Weighting Trade Barriers with Trade Baskets

I first measure a prefecture's exposure to trade barriers with its import and export baskets. Using trade baskets alone and omitting non-traded sectors are justified according to Kovak (2013), which shows that using only information on traded goods is an appropriate measure as non-traded priced move with traded prices, thus including the non-traded sectors while assuming non-traded prices are unaffected by trade policy changes will yield upward biased estimates. Another benefit of using transaction level trade data is the richness in details regarding traded goods type, trade regime, trading partners, etc..

Each transaction in the data is tagged with the location of importer/export in China, which is what I use to aggregate total import and export baskets to the prefecture level. The rich information the Chinese Custom Data allows me to differentiate imports and export for various purposes. Each transaction was categorized to a trade regime, according to which I can differentiate ordinary trade from processing trade. I exclude imports for processing trade following Fan, Li, and Yeaple (2015), because they are not subject to import tariffs. In addition, with the concordance between BEC and HS, I can further organize imports into consumption goods, imports of intermediate goods, and imports of capital goods. I also treat imports of equipments and capital goods as a separate category to measure the degree of technology adoption by Chinese firms.

B: Weighting Trade Barriers with Industrial Employment Concentration

Alternatively, I follow Autor, Dorn, and Hanson (2013) and (Kovak 2013), and use the prefecture-specific sectoral employment distribution as weights to calculate local exposure to trade policy changes. To do so, I use the 1998-2000 Chinese Annual Survey of Industrial Firms (CASIF), where each firm falls into an industry according to its main products.[15] CASIF also reports the number of workers employed by each firm, which allows me to calculate the local employment distribution across industries. With the crosswalk between the sectors (Chinese Industry Code 2002 or ISIC- Rev3) and products (HS6), I calculate the prefecture-level trade barriers as an interaction of employment distribution across various industries and industry-level trade policy changes.

C: Prefectures-specific trade barriers

With the trade and employed based weights, the average trade policy each prefecture j faces at year t is aggregated as

$$\text{Trade Policy}_{jt} = \sum_i w_{ij} \cdot \text{Trade Policy}_{it}$$

where c is the time-invariant weight that measures the importance of industry i at prefecture j prior to trade policy changes, and Trade Policy_{it} measures the industry level time-varying trade policy. When using employment weights, $w_{ij} = \text{Emp}_{ij} / \sum_i \text{Emp}_{ij}$; and when using trade basket weights, $w_{ij} = \text{XM}_{ij} / \sum_i \text{XM}_{ij}$ where XM is the value of product imported/exported at prefecture j.

Note that the weights used in constructing prefecture level tariff rates come from employment or trade structures that are determined before China's WTO accession. This approach follows the tradition in the literature to eliminate endogeneity concerns from the production and employment composition shifts due to tariff changes. As a result, the variation in the weighted average prefecture level trade policy only reflects the variation in industry-level statutory changes overtime. The unlikely correlation between pre-treatment local industry mix and industry-level tariff changes makes the prefecture weighted average an exogenous measure of local exposure to trade policy changes (see Section 2.3).

[15] The ideal employment information should come from pre-treatment time periods, but due to data limitation, 1998-2000 is the earliest data on industrial employment I have access to. I normalize various variables in the production data following Brandt, Van Biesebroeck, and Zhang (2014) and Yu (2015).

Moreover, products are either skilled labor intensive or unskilled labor intensive, depending on the share of skilled labor used in the production process. Aggregating to the prefecture level using trade basket, the skilled sector produces goods that are skilled-labor intensive, and vice versa. I use L and H to denote unskilled- and skilled-labor intensive products, respectively. Using the approach described above, I calculate both import tariff rates and tariffs abroad faced by prefecture j at time t:

- Import tariff rates for unskilled (L) and skilled (H) goods: tariff^L_{CHN}; tariff^H_{CHN}
- Import tariff rates on capital goods: $\text{tariff}_{CHN-Tech}$
- Tariff rates abroad for unskilled (L) and skilled (H) goods:tariff^L_{ROW}; tariff^H_{ROW}

Table 4 shows the summary statistics of the prefecture level tariff rates for each cohort. The first 5 rows report the calculation based on trade basket weights, and the bottom 4 rows are based on employment weights. Figure 4 plots the skill-specific tariff rates faced by each cohort at their schooling age, which shows that both import tariff and tariff abroad that Chinese prefectures face dropped, and the decline in unskilled sectors is more drastic. Since each cohort spends three years in high school, I take a simple average of the tariffs rates in three consecutive years to construct the average trade policy change each cohort faced while studying in high school. For example, Class of 1994's average tariffs are averages of 1992, 1993, and 1994's tariff rates. Figure 4a and 4b plots the prefecture-level tariff rates across time/cohorts.

In addition to tariff barriers, I also control for non-tariff barriers that likely affect the overall trade environment in Chinese prefectures. These measures include U.S. tariff uncertainty measured by NTR gaps, investment barriers measure by *contract intensity*, and *MFA quota bound*. Table 5 gives a summary statistics of these measures.

3.2 Empirical Specification

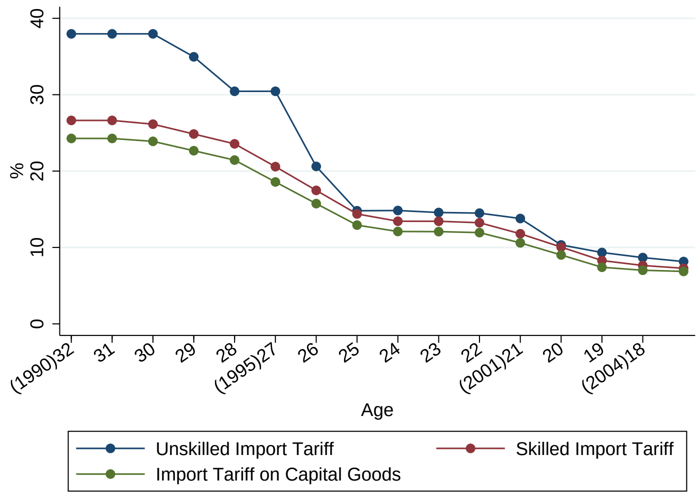
Different prefectures in China had different industrial composition prior to the series trade policy changes starting in 1992. Tariffs and non-tariff barriers were reduced by varying degrees at varying times, inducing differential exposure to trade policy changes across Chinese prefectures. Using prefecture-level data described in Section 2, I link each cohort's education outcomes with the local trade policy environment they faced at the home prefecture

Table 4: Summary Statistics of Trade Barriers (3 year average matched to each cohort)

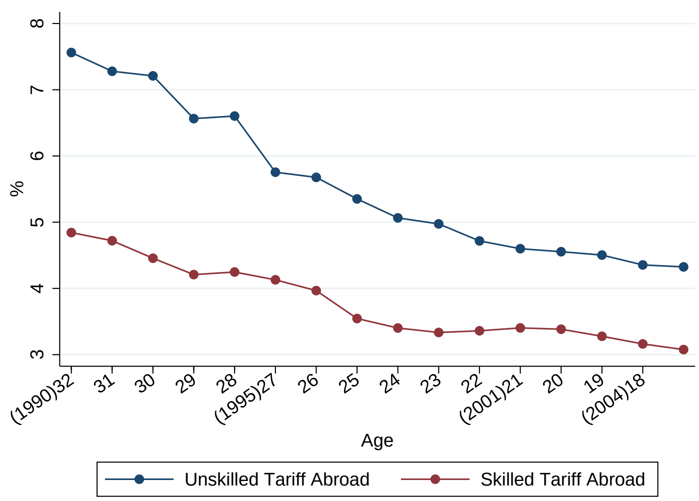
Trade Basket Weighted	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
$\text{tariff}^{L}_{CHN-O}$	37.97	37.97	37.97	34.96	30.45	30.45	20.61	14.80	14.84	14.58	14.50	13.79	10.33	9.339	8.672	8.153
	(14.46)	(14.46)	(14.46)	(13.20)	(12.06)	(12.06)	(7.881)	(5.299)	(5.298)	(5.213)	(5.202)	(4.935)	(3.752)	(3.384)	(3.141)	(2.669)
$\text{tariff}^{H}_{CHN-O}$	26.63	26.63	26.63	25.17	22.76	22.76	16.21	13.44	13.51	13.35	13.42	12.95	9.019	8.180	7.656	7.082
	(9.161)	(9.161)	(9.161)	(8.904)	(8.904)	(8.904)	(5.408)	(4.563)	(4.585)	(4.577)	(4.594)	(4.359)	(4.228)	(4.040)	(3.891)	(2.700)
$\text{tariff}_{CHN-Tech}$	24.27	24.27	24.27	23.13	20.59	20.59	14.53	12.09	12.15	12.03	12.04	11.77	7.994	7.282	6.940	6.825
	(10.49)	(10.49)	(10.49)	(9.923)	(8.981)	(8.981)	(5.999)	(4.921)	(4.939)	(4.901)	(4.901)	(4.745)	(3.282)	(3.019)	(2.883)	(2.820)
tariff^{L}_{ROW}	7.562	7.279	7.209	6.564	6.602	5.754	5.677	5.351	5.065	4.974	4.717	4.599	4.554	4.503	4.355	4.325
	(5.232)	(5.306)	(5.865)	(5.085)	(5.412)	(2.790)	(3.246)	(2.809)	(2.660)	(3.024)	(2.654)	(2.635)	(2.536)	(2.638)	(2.483)	(2.492)
tariff^{H}_{ROW}	4.859	4.811	4.491	4.065	4.069	4.608	3.712	3.580	3.344	3.281	3.379	3.420	3.412	3.320	3.100	3.065
	(4.784)	(4.773)	(4.765)	(2.525)	(2.527)	(6.218)	(3.139)	(3.006)	(2.891)	(3.790)	(5.543)	(5.417)	(5.091)	(3.473)	(3.097)	(3.562)
Employment Weighted	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
tariff^{L}_{CHN}	49.84	49.81	48.25	45.60	42.73	36.73	29.49	22.34	19.69	19.71	19.43	18.02	15.85	13.61	12.16	11.44
	(11.57)	(11.58)	(11.14)	(10.31)	(9.423)	(7.867)	(6.136)	(4.592)	(3.916)	(3.989)	(4.401)	(4.686)	(4.067)	(3.457)	(2.894)	(2.764)
tariff^{H}_{CHN}	36.72	36.82	36.20	35.06	33.73	29.60	24.67	19.82	18.39	18.39	17.83	15.68	12.99	10.47	9.341	8.614
	(15.22)	(15.35)	(15.28)	(15.24)	(15.04)	(12.57)	(9.922)	(7.529)	(7.235)	(7.228)	(6.902)	(5.815)	(4.488)	(3.293)	(2.643)	(2.306)
tariff^{L}_{ROW}	9.355	9.370	8.967	8.609	8.003	7.580	7.040	6.602	6.382	6.261	6.226	6.306	6.435	6.501	6.208	4.016
	(4.745)	(4.734)	(3.628)	(2.690)	(1.997)	(1.911)	(1.849)	(1.626)	(1.592)	(1.605)	(1.737)	(2.065)	(2.316)	(2.450)	(2.045)	(1.276)
tariff^{H}_{ROW}	24.51	24.38	20.04	15.73	10.58	9.436	8.330	7.889	9.234	9.238	8.199	5.404	4.092	3.803	4.443	3.001
	(27.45)	(27.42)	(21.62)	(15.85)	(8.548)	(7.008)	(5.853)	(5.545)	(7.387)	(7.495)	(6.501)	(3.318)	(2.341)	(2.274)	(2.821)	(2.072)

Notes: This table summarizes the prefecture-level tariff rates across time/cohorts. HS 6-digit product level tariff rates from the WTIS-TRAINS database are aggregated to prefecture level tariff rates by using trade basket weights (first 5 rows) and industrial employment weights (last 4 rows). Each yeah corresponds to an age cohort.

Figure 4: Tariff rates across years and cohorts



(a) Import Tariff



(b) Tariff Abroad

Notes: This figure plots the progression of prefecture-level tariff rates across time/cohorts. HS 6-digit product level tariff rates from the WTIS-TRAINS database are aggregated to prefecture level tariff rates by taking simple averages using import and export baskets of each prefecture. The Chinese import tariff rates use are MFN rates, not including VAT or general duty. Prefecture-level tariff rates are aggregated by taking simple averages of the tariff rates associated with the local trade basket.

Table 5: Summary tatistics of non-tariff barriers

%	mean	sd	min	max
NTR_L	32.66	14.846	0	70
NTR_H	24.95	14.089	0	80.97
Contract Intensity	41.74	10.518	0	85.62
MFA Quota Bound	9.845	11.920	0	100

Notes: This table summarized the prefecture-level non-tariff trade barriers, including unskilled and skilled U.S. tariff uncertainty measured by NTR gaps, investment barriers measure by contract intensity, and MFA quota. See Facchini, Mayda, Liu, and Zhou (2016) for a detailed description of these measures

in their school attending years.The resulting panel data consists of trade conditions and education outcomes of 15 age cohorts in 324 Chines prefectures.

I estimate the effect of trade barrier reductions on educational attainment using an OLS difference-in-difference (DID) specification. The specification exploits the spatial variation across prefectures and the temporal variation across cohorts in exposure to trade policy changes. The DID specification allows me to focus on difference across prefectures in terms of their exposure to reductions in trade barrier, and establish whether cohorts in prefectures exposed to bigger trade barrier reductions experiences more pronounced changes in educational attainment then cohorts in prefectures less exposed.

This empirical design is a variation of the standard DID design (see Autor 2003; Bertrand, Duflo, and Mullainathan 2004). Instead of having a treatment and control groups, prefectures with bigger changes in trade policies are more treated than prefectures with smaller trade policy changes (control groups). Correspondingly, age-cohorts mimic the counterfactuals of pre- and post- treatment. Since China went through stages of trade liberalization at different time periods, some age cohorts were exposed to the trade liberalization which overlaps with their schooling age, while other age cohorts were eligible to school enrollment in years when there was no change trade barriers. Thus, for any given prefecture, the variation among younger and older cohorts in their timing of exposure to trade policy changes is analogous to the pre- and post- treatment periods of the said prefecture.[16]

[16]To interpret the cohort-prefecture DID specification in light of the standard DID design, one can think of each prefecture as the decision maker, choosing the skill composition of the schooling age cohort at each time period, and the choice of how many kids will grow up to be skilled labor is intrinsically a supply of skill response to the concurrent factor prices. As reduced trade barriers change the skill premium, prefectures change the share of skilled labor to supply. uction depends on the composition of their imports and export.

The DID specification can be summarized in the following equation:

$$\begin{aligned}\overline{E_{jt}} =&\beta_0 + \beta_1 \mathbf{tariff}_{jt}^{CHN} + \beta_2 \text{tariff}_{jt}^{Tech} + \beta_3 \mathbf{tariff}_{jt}^{ROW} \\ &+ \beta_4 \mathbf{NTR}_j \cdot \mathbf{1}\{\text{Post WTO}_t\} + \gamma X_{jt} + \delta(D_j \cdot t) + \lambda_t + \lambda_j + \epsilon_{jt}\end{aligned} \tag{1}$$

$\overline{E_{jt}}$ is the share of individuals completed or enrolled in high school, for age cohort t in prefecture j. $\mathbf{tariff}_{jt}^{CHN}$ is a vector of Chinese tariff rates on unskilled- and skilled-labor intensive products that prefecture j faced in year $t-1$, t, $t+1$, averaged to reflect what cohort t would have responded to during their three high school years. Similarly, $\mathbf{tariff}_{jt}^{ROW}$ is a vector of prefecture-specific average tariff rates Chinese exporters face abroad (MFN rates). $\text{tariff}_{jt}^{Tech}$ measures the Chinese import tariff rates on capital goods that can bring skilled-biased foreign technology. $\mathbf{NTR}_j$ is a vector of time-invariant measures of the reduction in tariff uncertainty on unskilled- and skilled-labor intensive products. Trade policy uncertainty was eliminated as China acceded the WTO, thus I interact $\mathbf{NTR}_j$ with a time dummy, $\mathbf{1}\{\text{Post WTO}_t\}$, to indicate whether cohorts' schooling years overlapped with China's WTO accession, to capture the discrete changes in these non-tariff trade barriers. X_{jt} is a vector of cohort-specific prefecture characteristics, such as the skill composition of migration and other non-tariff barriers. Cohort and prefecture fixed effects are captured by λ_t and λ_j. I also include prefecture-specific time trends $D_j * t$ to account for pre-existing trends in education in each prefecture.

The causal impacts of trade trade policy changes on educational attainment are embodied in β's. A negative sign of β_1, β_2, and β_3 tells us, compared to the national trend, a decrease in tariff rates are associated with increase in education completion rates of affected cohorts in exposed prefectures. The interpretation of β_4 is the opposite. A higher NTR gap means a bigger reduction in trade policy uncertainty overtime, and the interaction term, $\mathbf{1}\{\text{Post WTO}_t\} \cdot \mathbf{NTR}_j$, measures the size of uncertainty reduction (treatment). Thus a negative sign in β_4 means reduction in trade policy uncertainty decrease education, and vice versa.

To summarize the likely impact of trade liberalizations that theory predicts, Table 6 lays out how average educational attainment would respond to reduction in various trade barriers, assuming no income effects.[17] For example, when the import tariff on unskilled-

[17] Section 6.1 has more details on income effects.

labor intensive goods (tariff^L_{CHN}) decreases, the relative price of unskilled-labor-intensive goods decreases, and the skill premium increases as a result of Stolper Samuelson Theorem. In other words, reduction in import tariff on unskilled-labor intensive goods has attributed to rising returns to education, which should turn into higher average educational attainment in the long run.[18] The opposite holds true for import tariff on skilled-labor intensive goods (tariff^H_{CHN}). Similarly, when the tariff abroad on skilled-labor intensive goods (tariff^H_{ROW}) decreases, the demand for Chinese skilled labor increases despite some offsetting impact from term of trade effects, and also create increased demand for education. NTR gaps have similar impacts as tariff abroad, as uncertainty in tariff rates that US imposes on Chinese exported goods can be interpreted as higher tariff rates abroad.

Table 6: Stolper-Samuelson Theorem Predictions: Impact of Trade Barrier Reductions on Education

	Import tariffs			Tariffs abroad		NTR gaps	
	tariff_{Tech}	tariff^H_{CHN}	tariff^L_{CHN}	tariff^H_{ROW}	tariff^L_{ROW}	ΔNTR^H	ΔNTR^L
$\partial(w^s - w^0)/\partial\tau$	< 0	> 0	< 0	< 0	> 0	> 0	< 0
Skill Premium	↑	↓	↑	↑	↓	↑	↓
Education	$E\uparrow$	$E\downarrow$	$E\uparrow$	$E\uparrow$	$E\downarrow$	$E\uparrow$	$E\downarrow$

Notes: For brevity, I do not differentiate import tariffs on consumption goods from intermediate goods. The economic intuition for the tariff changes are the same, i.e. they change the demand for the domestic factor used, thus the theoretical prediction in educational outcomes are the same. I ignore the income effect from trade policy changes on education for now.

4 Results

4.1 Estimation Results of High School Completion

A: Baseline results

During 1990-2004, high school completion increased by more in prefectures that experienced larger import tariff declines in unskilled-labor-intensive goods, the reverse is true for prefectures that saw larger declines in tariffs abroad and U.S. tariff uncertainty on unskilled-labor-intensive exports. Table 7 presents the baseline findings on average high

[18] In this example, term of trade effect increases the relative return to the unskilled labor intensive sectors, causing the skill premium in China to increase. But the term of trade effect will never offset the tariff reduction.

school completion among native male labor force. The outcome variable is the share (%) of high school educated workers in the native male labor force, where the native labor force consists of non-migrants and out-migrants. Unit of observation is by prefecture and age cohort, where 324 prefecture and 15 cohorts (18 to 32 years old) are included in the 2005 Census. Column (1) shows the coefficients on prefecture-specific tariff rates on goods imported by Chinese prefectures (CHN), and tariff rates abroad on exported goods from Chinese prefectures (ROW), where L and H denotes low-skill and high-skill labor intensive industries respectively. Column (2) shows coefficients on prefecture-specific reduction in trade policy uncertainty, measured by NTR gaps. Column (3) reports all coefficients, and column (4) adds additional control variables, including the skill composition of in-migrants, relaxations in investment barriers measured by *Contract Intensity* and *MFA Quota bounds*. In columns (5) and (6), I restrict the sample to prefectures that have nonzero in-migrants. These prefectures are arguably those who are more impacted by globalization since they sought to adjust to the increase in labor demand by bringing migrant labors.[19] In all specifications, standard errors are clustered by prefecture, and prefecture-specific time trend are included.

All estimates show that larger declines in China's import tariff on unskilled goods are associated with higher high school completion rates of the natives relative to the national trends, suggesting that increased access to import competition in the unskilled sectors decreased the demand for Chinese unskilled labor. For each percentage point decrease in tariff^L_{CHN}, about 0.27% more high-school aged children finish high school.

On the other hand, two other trade policy changes related to expansion in unskilled labor intensive manufacturing sectors have attenuated increase high school education completion. Reduction in tariff uncertainty of the unskilled goods (measured by NTR^L) and decrease in tariff rates on exported unskilled goods (measured by tariff^L_{ROW}) are both associated with sizable negative impact on schooling. Everything else equal, the one percentage point decrease in tariff^L_{ROW} is associated with a 0.17 percentage point decrease in high school completion relative to the national trend, and one percentage point decrease in NTR^L is associated with a 0.11 percentage point decrease in high school completion relative to the national trend. This suggests that as the unskilled sectors enjoyed improved market access

[19]Facchini, Mayda, Liu, and Zhou (2016) offer a detailed analysis of the impact of trade policy changes on internal migration.

to the rest of the world, the expanded employment opportunity for unskilled workers reduced the incentive of schooling. These findings are stronger in prefectures with in-migration flows, as seen in columns (4) – (7).

B: Disaggregated import tariff rates

The proceeding results presented in Table 7 treat all imports the same, and do not differentiate between imported inputs for ordinary trade, processing trade, or imported capital goods such as equipments or machineries.[20] In Table 8, I disaggregate the import basket into imports of intermediate goods used for ordinary trade and imports of capital goods, and measure the tariff declines separately using $\text{tariff}^{L}_{CHN-o}$ and $\text{tariff}_{CHN-Tech}$.

The structure of the table follows Table 7, and similar results hold. Among various reductions in trade barriers, declines in the Chinese import tariff on unskilled-labor-intensive intermediate goods are associated with higher high school completion rate of the natives relative to the national trend. For each percentage point decrease in tariff^{L}_{CHN}, about 0.17% more high-school aged children finish high school. When adoption of foreign technology is controlled for, the effect of import tariff rates on education goes down (comparing Column (1) and (2)). Importing foreign technology has an even bigger positive impact on education – one percentage point decrease in $\text{tariff}_{CHN-Tech}$ leads to 0.48 percentage point increase in high school completion rate. This suggests that the imported foreign technology complements skill and increases the skill premium. This finding is consistent with the increased relative demand for skill in Mexico and other Latin America countries, as documented in relevant studies (Pavcnik 2003, Bustos 2011).

Similar to results in Table 7, two other trade policy changes related to expansion in unskilled labor intensive manufacturing sectors suppressed high school education completion: reduction in tariff uncertainty of the unskilled goods, measured by NTR^{L}, and decrease in tariff rates on exported unskilled goods, measured by tariff^{L}_{ROW}. Everything else equal, the one percentage point decrease in tariff^{L}_{ROW} is associated with a 0.15 percentage point decrease in high school completion relative to the national trend, and one percentage point

[20]Processing trade is not subject to tariffs on inputs. Foreign firms and joint ventures are exempt from import tariffs on these capital goods, as a result $\text{tariff}_{CHN-Tech}$ may correlate with FDI activities, which also demanded relatively more skilled labor. On the other hand, domestic firms are subject to paying import tariffs on capital goods, and the decline in these tariff rates may provide domestic firms an improved access to foreign technology. Not accounting for various types of imports may bias the results.

decrease in NTR^L is associated with a 0.11 percentage point decrease in high school completion relative to the national trend. Once again, These effects are stronger for prefectures with non-zero in-migrant flows.

4.2 Estimation Results of College Education

I then turn to college completion rates, and examine whether trade policy changes have had similar effects at the college level. Table 9 shows the estimates. Even though college completion (and enrollment) rates have increased from 8.5 % in 1990 to 14 % in 2004, these increases seem to be unrelated to trade policy changes. A few possible reasons may explain this finding. First, tertiary institutions all have limited number of seats. Each year a "National College Entrance Examination" (*gaokao*) is held in early June, when high school seniors were ranked by their test performance which determines their eligibility to move on to college. Second, most tertiary institutions rely on federal funding, and adopt an "affirmative action" style college admission policies that aim to even out the education inequality among regions. As a result, college education, a highly competitive product mostly funded at the federal level, has a highly limited supply, and the share of college education of each cohort reflects the equilibrium outcome of demand and supply of college education. More specifically, trade policy changes may have affected the demand for college education, but this increased incentive may not translate perfectly in the presence of inelastic supply of college education and distortive admission policies.

5 Robustness Checks

5.1 Industrial employment weights

Most studies that evaluate the impact of trade shocks on labor market outcomes focus on the impact through employment. To quantify the local trade shocks, they interact industry-level measures of trade policy with the geographic concentration of industries (Topalova 2007, Autor, Dorn, and Hanson 2013, and Kovak 2013). This approach emphasizes the impact of trade policy changes that work through employment. The empirical analysis presented in Section 4 instead uses trade baskets as the local industry mix. To check if my main findings are robust to using employment weighting approach, I weight the local exposure to trade policy changes using prefecture-level employment distribution, and present the regression

Table 7: High School Completion of Native (non-migrant plus out-migrants) Male Labor Force

	All prefectures				Prefectures with in-migrants	
	(1)	(2)	(3)	(4)	(5)	(6)
tariff^L_{CHN}	-0.305		-0.271	-0.271	-0.461	-0.473
	(0.108)***		(0.103)***	(0.103)***	(0.144)***	(0.140)***
tariff^H_{CHN}	-0.127		-0.089	-0.108	-0.059	-0.081
	(0.146)		(0.129)	(0.127)	(0.156)	(0.144)
tariff^L_{ROW}	0.169		0.178	0.174	0.190	0.186
	(0.085)**		(0.085)**	(0.085)**	(0.088)**	(0.086)**
tariff^H_{ROW}	-0.108		-0.115	-0.105	-0.018	-0.010
	(0.073)		(0.075)	(0.074)	(0.059)	(0.063)
Post WTO $*$ NTR^L		-0.120	-0.116	-0.114	-0.150	-0.141
		(0.046)**	(0.046)**	(0.047)**	(0.059)**	(0.060)**
Post WTO $*$ NTR^H		-0.033	-0.017	-0.015	0.011	0.014
		(0.055)	(0.055)	(0.056)	(0.064)	(0.061)
R^2	0.81	0.81	0.81	0.81	0.84	0.84
N	4,860	4,860	4,860	4,860	3,390	3,390
Other Controls	No	No	No	Yes	No	Yes
Pref FE; Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Pref x cohort trend	Yes	Yes	Yes	Yes	Yes	Yes

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Notes: The table shows the regression DD results of the baseline specification. Outcome is the share (in percentage points) of high school educated workers in the native male labor force. Unit of observation is by prefecture and age cohort, where 324 prefecture and 15 cohorts (18 to 32 years old) are included in the 2005 Census. The native labor force consists of non-migrants and out-migrants of a prefecture. Columns (1)-(4) covers all 324 prefectures, while columns (5)-(6) include only 226 prefectures with non-zero in-migrants. Huber-White robust SEs in parentheses are clustered at the prefecture level to correct for serial correlation. Prefecture-specific cohort trends are added to all specification. Trade policies are weighted with skill-specific trade baskets (during 1997-1999) of each prefecture, where L and H denotes below-high-school and high-school-educated labor intensive industries respectively. tariff^L_{CHN} and tariff^H_{CHN} are aggregated tariff rates on imported goods by a prefecture at each cohort's schooling years, and these include inputs for both ordinary and processing trade, and capital goods such as equipments and machineries. tariff^L_{ROW} and tariff^H_{ROW} are levels of tariff rates charged by Rest of the World on exported goods from a prefecture during the each cohort's schooling years. Trade policy uncertainty is measure by NTR gaps, Post WTO $*$ NTR^L and Post WTO $*$ NTR^H, which are interactions of time-invariant NTR gaps with a time dummy indicating cohorts' schooling years were after China's WTO accession. Other controls include skill composition of in-migrants, relaxations in investment barriers measured by *Contract Intensity* and *MFA Quota bound*.

Table 8: High School Completion of Native (non-migrant plus out-migrants) Male Labor Force

	All prefectures				Prefectures with in-migrants		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
tariff^L_{CHN-O}	-0.233	-0.185		-0.170	-0.235		-0.237
	(0.084)***	(0.078)**		(0.075)**	(0.107)**		(0.094)**
tariff^H_{CHN-O}	-0.218	-0.163		-0.148	-0.118		-0.095
	(0.152)	(0.133)		(0.120)	(0.194)		(0.177)
tariff^L_{ROW}	0.153	0.144		0.151	0.159		0.161
	(0.088)*	(0.092)		(0.091)*	(0.100)		(0.097)*
tariff^H_{ROW}	-0.113	-0.092		-0.093	0.003		0.004
	(0.074)	(0.070)		(0.073)	(0.060)		(0.069)
$\text{tariff}_{CHN-Tech}$		-0.548		-0.478	-0.676		-0.620
		(0.211)***		(0.202)**	(0.295)**		(0.281)**
Post WTO $*$ NTR^L			-0.120	-0.109		-0.152	-0.131
			(0.046)**	(0.046)**		(0.061)**	(0.058)**
Post WTO $*$ NTR^H			-0.033	-0.001		-0.022	0.025
			(0.055)	(0.056)		(0.066)	(0.061)
R^2	0.81	0.81	0.81	0.81	0.84	0.84	0.84
N	4,860	4,860	4,860	4,860	3,390	3,390	3,390
Other Controls	No	No	No	Yes	No	No	Yes
Pref FE; Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pref x cohort trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Notes: The table shows the regression results of the main specification with disaggregated import tariffs. Outcome is the share (in percentage points) of high school educated workers in the native male labor force. Unit of observation is by prefecture and age cohort, where 324 prefecture and 15 cohorts (18 to 32 years old) are included in the 2005 Census. The native labor force consists of non-migrants and out-migrants of a prefecture. Columns (1)-(4) covers all 324 prefectures, while columns (5)-(7) include only 226 prefectures with non-zero in-migrants. Huber-White robust SEs in parentheses are clustered at the prefecture level to correct for serial correlation. Prefecture-specific cohort trends are added to all specification. Trade policies are weighted with skill-specific trade baskets (during 1997-1999) of each prefecture, where L and H denotes below-high-school and high-school-educated labor intensive industries respectively. tariff^L_{CHN-O} and tariff^H_{CHN-O} are aggregated tariff rates on imported inputs for ordinary trade by a prefecture at each cohort's schooling years. $\text{tariff}_{CHN-Tech}$ is the average tariff rates on the machinery and equipments imported by manufacturing firms in a prefecture. tariff^L_{ROW} and tariff^H_{ROW} are levels of tariff rates charged by Rest of the World on exported goods from a prefecture during the each cohort's schooling years. Trade policy uncertainty is measure by NTR gaps, Post WTO $*$ NTR^L and Post WTO $*$ NTR^H, which are interactions of time-invariant NTR gaps with a time dummy indicating cohorts' schooling years were after China's WTO accession. Other controls include skill composition of in-migrants, relaxations in investment barriers measured by *Contract Intensity* and *MFA Quota bound*.

Table 9: College Completion of Native Male Labor Force

	NM+EM (1)	NM+EM (2)	NM+EM (3)	NM (4)	NM+IM (5)	ALL NM+IM (isic) (6)	ALL NM+IM (cic) (7)
tariff^L_{CHN}	-0.082		-0.091	-0.091	-0.098	-0.048	-0.034
	(0.067)		(0.068)	(0.068)	(0.064)	(0.053)	(0.043)
tariff^H_{CHN}	-0.113		-0.112	-0.113	-0.112	0.093	0.010
	(0.091)		(0.092)	(0.092)	(0.079)	(0.049)*	(0.046)
tariff^L_{ROW}	-0.006		-0.006	-0.006	-0.005	-0.006	0.006
	(0.058)		(0.059)	(0.059)	(0.050)	(0.023)	(0.018)
tariff^H_{ROW}	0.063		0.061	0.062	0.090	0.004	-0.013
	(0.074)		(0.076)	(0.076)	(0.073)	(0.027)	(0.028)
Post WTO $*$ NTR^L		0.020	0.021	0.021	0.029	-0.037	-0.044
		(0.023)	(0.022)	(0.022)	(0.022)	(0.044)	(0.039)
Post WTO $*$ NTR^H		-0.013	-0.011	-0.010	0.001	0.091	0.106
		(0.029)	(0.028)	(0.028)	(0.029)	(0.071)	(0.060)*
R^2	0.73	0.73	0.73	0.73	0.73	0.85	0.85
N	4,860	4,860	4,860	4,860	4,860	4,860	4,860
Other Controls	No	No	Yes	Yes	Yes	No	No
Pref FE; Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pref x cohort trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Notes: Outcome is the share (in percentage points) of college educated workers in the native male labor force. Unit of observation is by prefecture and age cohort, where 324 prefecture and 15 cohorts (22 to 36 years old) are included in the 2005 Census. Samples include, in columns (1)-(3): male non-migrants and out-migrants in a prefecture; in column (4): male non-migrants; in (5): male non-migrants and in-migrants; and in columns (6)-(7): male plus female non-migrants and in-migrants. Huber-White robust SEs in parentheses are clustered at the prefecture level to correct for serial correlation. Prefecture-specific cohort trends are added to all specification. Trade policies are weighted with skill-specific trade baskets (during 1997-1999) in columns (1)-(5), and with skill-specific industrial employment (during 1998-2000) in columns (6)-(7), where L and H denotes non-college-education and college-education labor intensive industries respectively. tariff^L_{CHN} and tariff^H_{CHN} are aggregated tariff rates on imported goods by a prefecture at each cohort's schooling years, and these include inputs for both ordinary and processing trade, and capital goods such as equipments and machineries. tariff^L_{ROW} and tariff^H_{ROW} are levels of tariff rates charged by Rest of the World on exported goods from a prefecture during the each cohort's schooling years. Trade policy uncertainty is measure by NTR gaps, Post WTO $*$ NTR^L and Post WTO $*$ NTR^H, which are interactions of time-invariant NTR gaps with a time dummy indicating cohorts' schooling years were after China's WTO accession. Other controls include skill composition of in-migrants, relaxations in investment barriers measured by *Contract Intensity* and *MFA Quota bound*.

results in Table 10.

Specifically, I rely on the 1998-2000 Chinese Annual Survey of Industrial Firms (CASIF), an annual firm-level census that reports the location, main products, and employment information of all firms with more than 5 million RMB in annual revenue. The detailed production information allows me to identify the low-skill (L) and high-skill (H) labor intensive industries in each prefecture, and distribution of workers employed in these industries. Industry level trade barriers are then aggregated to the prefecture level, following the approach described in Section 3.1.

Columns (1)-(2) in Table 10 report results using prefecture tariffs weighted at the ISIC-Rev3 level, and columns (3)-(4) report results using prefecture tariffs weighted at the CIC 2002 level. Results in Table 10 – column (4) and Table 7– column (4) are of similar magnitude. Under the employment-weighted specification, reduction in Chinese import tariffs on unskilled goods, measured by tariff^L_{CHN}, has positive impacts on schooling, while expanded export market of unskilled labor intensive goods (tariff^L_{ROW}, NTR^L) has negative impacts on schooling. Surprisingly, decrease in tariff rates on exported skilled goods, measured by tariff^H_{ROW}, seem to discourage schooling, which contradicts the Stolper-Samuelson prediction. One possible explanation is the processing trade exports.

5.2 Migration

The local labor market adjustments to skill price changes may take place through relocation of skills, i.e., internal migration, in the short-run, and acquisition of skill, i.e., educational attainment, in the medium-to-long run. In this section, I address the confounding effects of internal migration by providing institutional background and robustness checks.

Internal migration can contaminate the empirical analysis in two important ways. First, internal migration attenuates the local exposure to trade shocks through movement of skills (Borjas 2006). Facchini, Mayda, Liu, and Zhou (2016) show that, when the trade policy uncertainty with the U.S. was eliminated as China joined the WTO, skilled labor responded to increased demand of labor by migrating towards the job opportunities while the unskilled labor responded by working longer hours. The dampening effect of internal migration, however, does not completely mitigate the trade-induced changes in skill prices, as China's *Hukou* system remains fairly restrictive and protective of local residents until today.[21] The

[21] Internal migration in China has been tightly controlled by the *hukou* (Household Registration) System.

remaining labor mobility friction preserves the geographic difference between prefectures in terms of local exposure to trade shocks, and sustains the effectiveness of a difference-in-differences strategy.

Second, relocation of skills changes prefectures' skill endowment through compositional shifts. Thus, merely observing the changes in skill endowment of all observed residents overestimates the impacts of trade policy changes on skill acquisition. I tease out the skill relocation response from the skill acquisition response by considering the educational outcomes of only prefecture *natives*. Specifically, I focus on residents of a prefecture who are either non-migrants (born, educated and live there) or out-migrants (born, educated and moved away). This approach is justified by the fact that most schooling age children in China receive their primary and secondary education in their hometowns, as entitlement to public education is predicated by the *hukou* system. Assuming schooling age children do not make migration and schooling decisions simultaneously, the hometown exposure to trade policy changes is what affects their education outcomes.

To fully address possible confounding effects from increased internal migration, I carry out robustness checks with alternative samples in Table 12. Column (2) replicates the results in the main specification where the native sample of each prefecture includes non-migrants and out-migrants. Column (1) uses the entire population observed at prefectures, i.e., non-migrants and in-migrants. Column (3) restricts to only non-migrants. Results are similar across these three alternative samples. Interestingly, all the significant coefficients have larger magnitude in the regression in column (1) than in column (3), which suggests that trade policy changes had altered the relative demand for skill, and part of the adjustment took place through internal migration. Columns (4) and (5) show results for the female samples, and the results suggest that trade policy changes had different impacts on females than males.

Hukou is a resident permit issued by a prefecture on a family basis, and one of the most important features of the system is that *hukou* entitles its holder to local social welfare programs, such as public education and public health. For this reason, it limits internal migration since it precludes access to public services to those migrants who cannot acquire a local *hukou*. Since the late 1990s, *hukou* policy has been relaxed to facilitate temporary labor mobility as well as to help address urban prefectures' increased demand for labor. Nevertheless, restrictions on long-term migration remain, and permanent migration between prefectures remain very low, as shown in Table 11.

5.3 Placebo Tests

In Table 13, I run a Granger test on older cohorts to make sure the results were not driven by reverse causality. Reverse causality arises if, before China experienced any trade policy changes, prefectures' initial skill endowment predicated future trade shocks, that is, the pre-liberalization education disparity determined the subsequent size of trade policy changes in each region. To rule out reverse causality, I test the effects of trade policy changes during 1990 - 2004 on cohorts who finished high school prior to the trade policy changes. They are Classes of 1980 to 1994, and their high school years were not overlapped with the upcoming trade events in China. All specifications report insignificant results on all coefficients, confirming that individuals between 28 years old (Class of 1994) and 42 years old (Class of 1980) didn't exhibit anticipatory response to the later trade liberalizations that took place after these older cohorts finished high school education.

By construction, the skill-specific trade policy changes should only affect the skill-premia at the high school and college levels, and leave the schooling incentive at lower grades unchanged. However, the observed educational response to trade shocks could come from a increased pool of high-school eligible students, if the primary and junior school quality and supply are vastly improved by trade-related factors. The Placebo test in Table 13 show that this is not the case.

5.4 Semiparametric Evidence

The results presented in Section 4 only focuses on how trade policy changes affect the *mean* of the educational attainment. The linear regression approach overlooks the nuanced changes along the entire distribution of educational outcomes. In this section, I use a semi-parametric approach to compare the education distribution of more exposed prefectures to that of less exposed ones.

DiNardo, Fortin, and Lemieux (1996) devise a semi-parametric procedure to analyze changes in the distribution of wages. Pavcnik (2003) applied this methodology and observed difference in density of wagebill share of skilled workers between plant that adopted technology and plants that did not. Chiquiar and Hanson (2005) applied this method to test the negative selection hypothesis of Mexican migrants in the U.S.. By comparing the wage distribution of Mexican natives and of emigrants, they show that Mexican immigrants

Table 10: Robustness Checks: High School Completion of local labor force (male plus female), with sectoral employment weights

	ISIC Rev3		CIC 2002	
	(1)	(2)	(3)	(4)
tariff^L_{CHN}	-0.316	-0.331	-0.241	-0.247
	(0.125)**	(0.121)***	(0.098)**	(0.095)**
tariff^H_{CHN}	0.181	0.204	-0.011	-0.000
	(0.098)*	(0.093)**	(0.073)	(0.073)
tariff^L_{ROW}	0.519	0.458	0.145	0.120
	(0.307)*	(0.305)	(0.068)**	(0.065)*
tariff^H_{ROW}	0.173	0.169	0.116	0.115
	(0.033)***	(0.033)***	(0.025)***	(0.026)***
Post WTO $*$ NTR^L	-0.433	-0.414	-0.265	-0.252
	(0.091)***	(0.089)***	(0.077)***	(0.077)***
Post WTO $*$ NTR^H	-0.111	-0.123	-0.166	-0.175
	(0.152)	(0.153)	(0.119)	(0.119)
R^2	0.87	0.88	0.87	0.88
N	5,085	5,085	5,085	5,085
Other Controls	No	Yes	No	Yes
Pref FE; Cohort FE	Yes	Yes	Yes	Yes
Pref x cohort trend	Yes	Yes	Yes	Yes

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Notes: This table shows the robustness check of using sectoral employments as weights. Outcome is the share (in percentage points) of high school educated workers in the observed labor force (non-migrants and in-migrants). Unit of observation is by prefecture and age cohort, where 339 prefecture and 15 cohorts (18 to 32 years old) are included in the 2005 Census. Huber-White robust SEs in parentheses are clustered at the prefecture level to correct for serial correlation. Prefecture-specific cohort trends are added to all specification. Columns (1)-(2) in Table 10 report results using prefecture tariffs weighted at the ISIC-Rev3 level, and columns (3)-(4) report results using prefecture tariffs weighted at the CIC 2002 level. Definitions of trade policy follows Table 7. See text for more description of the construction of trade policy changes.

Table 11: Internal migration in China (employed workers), 2000

	Temporary Migration		Permanent Migration	
Males	Skilled	Unskilled	Skilled	Unskilled
Flow (in millions)	6.07	21.46	3.08	2.18
Share (%)	8.6	7.6	4.4	0.7
Females	Skilled	Unskilled	Skilled	Unskilled
Flow (in millions)	5.02	24.24	3.59	5.36
Share (%)	8.6	7.6	7.8	2.0

Notes: Based on author's calculation using Chinese Census 2000. The sample use is 16-65 year-old employed workers in China during 2000.

Table 12: Robustness Checks: High School Completion of Labor Force

	NM + IM	NM + EM	NM	female NM + IM	female NM + EM
	(1)	(2)	(3)	(4)	(5)
tariff^L_{CHN-O}	-0.195	-0.176	-0.183	-0.115	-0.077
	(0.068)***	(0.074)**	(0.073)**	(0.079)	(0.075)
tariff^H_{CHN-O}	-0.239	-0.151	-0.185	-0.172	-0.120
	(0.124)*	(0.122)	(0.115)	(0.123)	(0.113)
tariff^L_{ROW}	0.117	0.154	0.158	-0.209	-0.157
	(0.097)	(0.091)*	(0.092)*	(0.065)***	(0.061)**
tariff^H_{ROW}	-0.106	-0.096	-0.095	0.047	0.053
	(0.080)	(0.072)	(0.072)	(0.114)	(0.097)
$\text{tariff}_{CHN-Tech}$	-0.789	-0.467	-0.460	-0.526	-0.337
	(0.267)***	(0.200)**	(0.202)**	(0.226)**	(0.201)*
Post WTO $*$ NTR^L	-0.125	-0.110	-0.109	-0.060	-0.015
	(0.051)**	(0.045)**	(0.047)**	(0.045)	(0.044)
Post WTO $*$ NTR^H	-0.047	-0.003	-0.032	-0.060	-0.046
	(0.056)	(0.056)	(0.056)	(0.055)	(0.054)
R^2	0.80	0.81	0.81	0.78	0.82
N	4,856	4,856	4,856	4,855	4,855
Other Controls	Yes	Yes	Yes	Yes	Yes
Pref FE; Cohort FE	Yes	Yes	Yes	Yes	Yes
Pref x cohort trend	Yes	Yes	Yes	Yes	Yes

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Notes: The table shows the robustness check of the main specification by using alternative samples of "natives". Outcome is the share (in percentage points) of high school educated workers in the male labor force. Unit of observation is by prefecture and age cohort, where 324 prefecture and 15 cohorts (18 to 32 years old) are included in the 2005 Census. Samples include, in column (1): non-migrants and in-migrants in a prefecture; in column (2): non-migrants and out-migrants; in column (3): only non-migrants; in (4): female non-migrants and in-migrants; and in (5): female non-migrants and out-migrants. Huber-White robust SEs in parentheses are clustered at the prefecture level to correct for serial correlation. Prefecture-specific cohort trends are added to all specification. The right-hand-side trade policy variables are the same as in Table 8.

Table 13: Granger Test: High School completion of older cohorts (Class of 1980 - Class of 1994)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
tariff^L_{CHN-O}	0.014	0.025		0.020	0.042		0.038
	(0.048)	(0.050)		(0.051)	(0.064)		(0.063)
tariff^H_{CHN-O}	0.038	0.052		0.041	-0.005		-0.021
	(0.095)	(0.092)		(0.090)	(0.116)		(0.115)
tariff^L_{ROW}	0.039	0.037		0.038	0.029		0.031
	(0.089)	(0.089)		(0.089)	(0.092)		(0.094)
tariff^H_{ROW}	-0.093	-0.090		-0.083	-0.120		-0.114
	(0.084)	(0.085)		(0.088)	(0.086)		(0.088)
$\text{tariff}_{CHN-Tech}$		-0.118		-0.130	0.030		0.031
		(0.147)		(0.146)	(0.184)		(0.182)
Post WTO $*$ NTR^L			0.049	0.052		0.039	0.037
			(0.041)	(0.043)		(0.054)	(0.056)
Post WTO $*$ NTR^H			-0.019	-0.014		-0.010	-0.006
			(0.045)	(0.046)		(0.062)	(0.063)
R^2	0.79	0.79	0.79	0.79	0.82	0.81	0.82
N	4,212	4,212	4,212	4,212	3,352	3,352	3,352
Other Controls	No	No	No	Yes	No	No	Yes
Pref FE; Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pref x cohort trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Notes: This table shows the granger test of the main specification by using older cohorts that shouldn't have anticipated the trade policy changes. The cohorts used in this regression are 28 to 42 years old when surveyed in 2005, and they are Classes of 1980 to 1994, whose high school years were not overlapped with China's trade liberalization. Outcome is the share (in percentage points) of high school educated workers in the male labor force. Unit of observation is by prefecture and age cohort. Samples include, in columns (1)-(4): all prefecture, and in columns (5)-(7): prefectures with nonzero in-migrants in 2005. Huber-White robust SEs in parentheses are clustered at the prefecture level to correct for serial correlation. Prefecture-specific cohort trends are added to all specification. The right-hand-side trade policy variables are the same as in Table 8.

Table 14: Placebo Test: Junior High School completion

	All prefectures				Prefectures with in-migrants		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\text{tariff}^{L}_{CHN-O}$	0.007	0.008		0.017	-0.034		-0.012
	(0.070)	(0.076)		(0.076)	(0.103)		(0.106)
$\text{tariff}^{H}_{CHN-O}$	-0.131	-0.131		-0.129	-0.107		-0.094
	(0.149)	(0.143)		(0.141)	(0.278)		(0.283)
tariff^{L}_{ROW}	0.051	0.051		0.057	0.015		0.020
	(0.110)	(0.110)		(0.110)	(0.155)		(0.156)
tariff^{H}_{ROW}	-0.247	-0.247		-0.242	-0.263		-0.261
	(0.145)*	(0.144)*		(0.146)*	(0.159)*		(0.154)*
$\text{tariff}_{CHN-Tech}$		-0.002		0.012	-0.001		-0.008
		(0.205)		(0.207)	(0.268)		(0.273)
Post WTO $*$ NTR^{L}			0.026	0.019		0.024	0.013
			(0.042)	(0.042)		(0.058)	(0.058)
Post WTO $*$ NTR^{H}			-0.056	-0.054		-0.071	-0.056
			(0.053)	(0.052)		(0.080)	(0.081)
R^2	0.87	0.87	0.87	0.87	0.90	0.89	0.90
N	4,799	4,799	4,799	4,799	3,116	3,116	3,116
Other Controls	No	No	No	Yes	No	No	Yes
Pref FE; Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pref x cohort trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

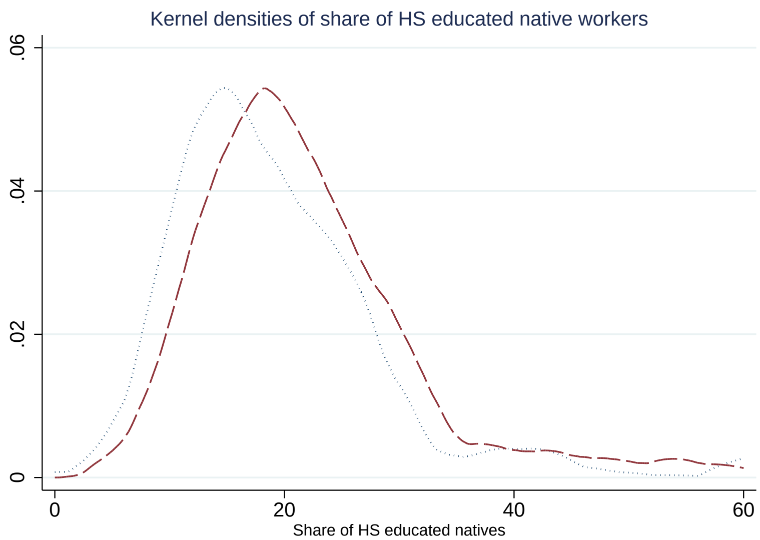
Notes: The table shows the placebo test of the main specification using junior high school completion rates. The cohorts used in this regression are 15 to 29 years old in 2005 – Classes of 1990 to 2004 of junior high school. Outcome is the share (in percentage points) of junior high school educated workers in the native male labor force. Unit of observation is by prefecture and age cohort. Samples include, in columns (1)-(4): all prefecture, and in columns (5)-(7): prefectures with nonzero in-migrants in 2005. Huber-White robust SEs in parentheses are clustered at the prefecture level to correct for serial correlation. Prefecture-specific cohort trends are added to all specification. The right-hand-side trade policy variables are the same as in Table 8.

in the U.S are more educated than non-migrants in Mexico.

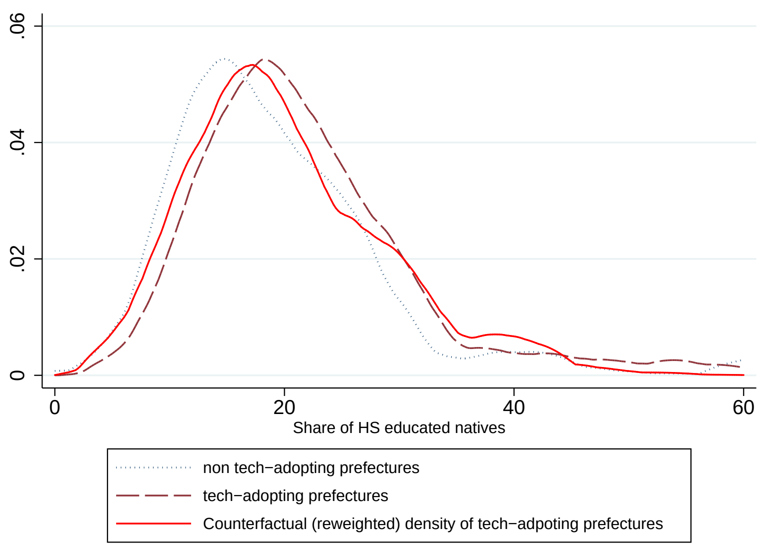
I apply this semi-parametric method to test whether the impact of technology adoption (or imported intermediate goods) on educational attainment differ for prefectures with different skill endowment. Figure 5 plot the actual densities of education for prefectures that did not adopt technology (in dashed green line) and prefectures that did (in maroon line). The difference in education distributions could be due to technology adoption or other underlying prefecture characteristics that could also influence skill endowment. To isolate the causal effect of foreign technology on schooling, I match prefectures that did adopt foreign technology to ones that did not based on their characteristics , and plot the *counterfactual* skill density of the tech-adopting prefectures if they did not adopt foreign technology (red solid line). The remaining difference between the actual and counterfactual skill densities are not driven by sample selection, and thus can be attributed to the adoption of foreign technology. For the tech-adopting prefectures, they would have ended up with a lower skill endowment if they had not adopted foreign technology. I repeat the same exercise for use of imported low-skill intermediate goods in Figure 6. There is a visible difference between the actual and counterfactual education densities of prefectures with large decrease in unskilled intermediate goods, suggesting decrease in import tariffs on unskilled products has lead to higher average schooling.

One should be cautious to make causal inference with the results shown above. Acemoglu (2003) argues that, as the supply of skill increased in the 1970, the speed of SBTC increased to exploit and increased amount of skill on the labor market, thus raised the skill premium in the 1980's and 1990's. What I find in this section can be a version of endogenous foreign technology adoption, that is, prefectures better endowed with skilled workers had stronger incentives to import foreign technology.

Figure 5: Kernel densities of share of HS educated native workers



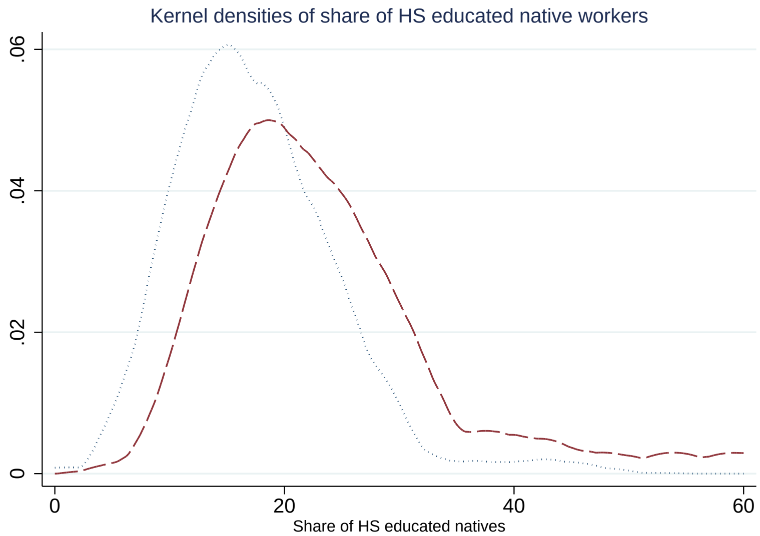
(a)



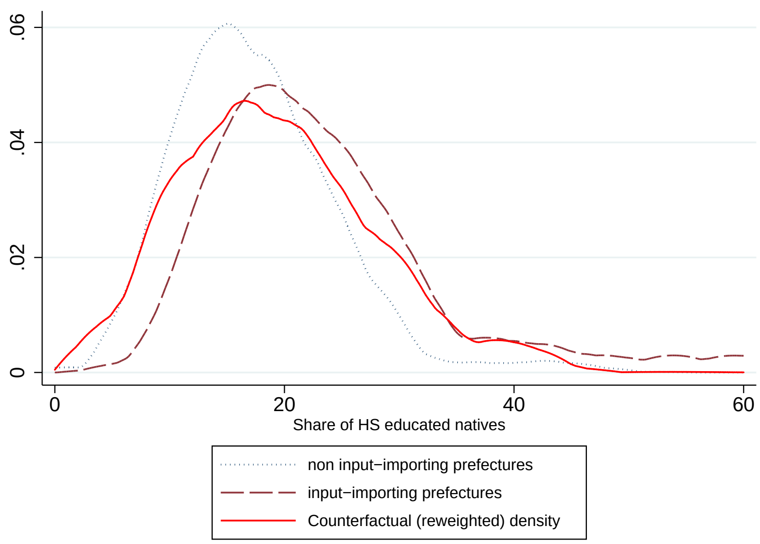
(b)

Notes: (a) plots the actual densities of education for prefectures that did not adopt technology (in dashed green line) and prefectures that did (in maroon line). In (b), I match prefectures that did adopt foreign technology to ones that did not by their characteristics such as labor market condition, geographic location, age composition etc, and plot the counterfactual skill density if they did not adopt foreign technology (red solid line).

Figure 6: Kernel densities of share of HS educated native workers



(a)



(b)

Notes: (a) plots the actual densities of education for prefectures that did not import low-skill intermediate goods (in dashed green line) and prefectures that did (in maroon line). In (b), I match prefectures that did import low-skill intermediate goods to ones that did not by their characteristics such as labor market condition, geographic location, age composition etc, and plot the counterfactual skill density if they did not import low-skill intermediate goods (red solid line).

6 Mechanisms

There are two main channels through which the above-mentioned trade policy changes can influence educational attainment. First, changes in return to education affect the incentive to acquire education. Second, changes in real income affect the affordability of education. The simple education decision outlined in Section 6.1 provides intuition on these channels.

In the first channel, trade of both final and intermediate goods changes the skill premium through Stolper-Samuelson effects (Findlay and Kierzkowski 1983, Blanchard and Olney 2017).[22] China's increasing economic involvement with the rest of the world has come from reductions in tariff and non-tariff barriers, as well as the elimination of trade policy uncertainty with the U.S.. Freer trade influences the relative demand for factors of production, and consequently shifts the payouts to skilled and unskilled workers. Increases (decreases) in skilled wages translate directly into increases (decreases) in return to education, while increases in unskilled wages have an additional effect on the opportunity cost of education. The latter mechanism, often ignored, is confirmed by Atkin (2016), which showed that, in the case of Mexico, the arrival of low-skill export-manufacturing jobs raised the opportunity cost of schooling and increased drop-out rates. Moreover, trade-induced technology upgrading also affects returns to education.[23] Globalization has fastened the speed at which developing countries acquired access to skill-biased technologies (Pavcnik 2003; Bustos 2011). As a result, the increased wage gap across skill levels in developing countries has also been attributed to skill-biased technological change.

In the second channel, trade changes the affordability of education through income effects. Trade policy changes can decrease (increase) household real income for import-competing (export-oriented) workers, and hence decrease (increase) the ability to pay for education. In many developing countries, unskilled-labor-intensive sectors were more protected prior to liberalization, contrary to the trade protection patterns assumed in classical trade models (Attanasio, Goldberg, and Pavcnik 2004, Topalova 2004, Goldberg and Pavcnik 2005, Goldberg and Pavcnik 2007). As a result, the costs of globalization were often borne by unskilled workers in developing countries. Edmonds et al. (2010) finds that,

[22] Blanchard and Willmann (2016) shows that, in a many-sector economy in which a country can have comparative advantage in multiple distinct skill-intensity sectors, freer trade can induce simultaneous incentives for skill upgrading and skill downgrading.

[23] It is widely agreed that technological advancement since the 1970's has been skill-biased and complements skill (Acemoglu 1998, Acemoglu 2003).

Indian districts with concentrated employment in industries losing tariff protection saw a relative rise in poverty, and families facing this negative income effect demanded more child labor and reduced schooling of their children.

The combined effect of the skill premium and income channels could mask the underlying competing forces resulted from different trade policy changes. For example, *ceteris paribus*, a decrease in import tariffs on unskilled labor intensive goods lowers unskilled wages. This could lead to an increase in the returns to education (skill premium), a decrease in the opportunity cost of education, and thus an increase the incentive for schooling. At the same time, lower unskilled wages make education less affordable for households who become too budget constrained to pay for education. In this case, the combined effect of trade policy changes on education depends on whether the substitution effect or the income effect dominates. This explains why existing studies that examine aggregate educational outcomes have found mixed results despite overwhelming evidence of increases of skill premium in developing countries.[24] For example, both facing increased skill premium brought by globalization, unskilled workers in the U.S. responded by upgrading their skills (Hickman and Olney 2011), while unskilled workers in India responded by downgrading their children's education to cope with trade-induced poverty (Edmonds, Pavcnik, and Topalova 2010).

6.1 Conceptual Framework

Consider an individual making schooling decision at the beginning of entering the labor market. Schooling takes 1 period of time, and tuition costs c. Denote w^0 and w^s as the real income of unskilled and skilled workers, respectively.

Value Functions for unskilled workers:

$$V^0 = \sum_{t=0}^{\infty} \beta^t w^0 = \frac{w^0}{1-\beta}$$

Value Functions for skilled workers:

$$V^s = -c + \sum_{t=1}^{\infty} \beta^t w^s = -c + \frac{\beta}{1-\beta} w^s$$

[24]Increased wage inequality across skill types has been consistently documented for many countries. For Mexico, see Feenstra and Hanson (1996), Feenstra and Hanson (1997), Revenga (1997), and Harrison and Hanson (1999). See Attanasio, Goldberg, and Pavcnik (2004) for Colombia, Pavcnik (2003) for Chile, Bustos (2005) for Argentina, Bustos (2011) for Brazil, and Topalova (2007) for India.

Individuals acquires education if the utility value from going to school is higher:

$$V^s + e^s > V^0 + e^0$$

The probability that we observe an individual as a skilled worker is:

$$Pr(s = 1) = Pr(e^0 - e^s < \frac{\beta}{1-\beta}[w^s - w^0] - w^0 - c) \quad (2)$$

The first term embodies skill premium channel, ask skill premium increases, either due to rising w^s or falling w^0, educational attainment increase. The second term represents the opportunity cost of going to school, and the third term for the tuition cost.

Define $u = e^0 - e^s$, which is mean zero with *cdf* $F(u)$ and strictly positive density $f(u)$. To analyze the determinants of changes in schooling, I differentiate Equation 2 with respect to tariff changes, $d\tau$.

$$dPr(s = 1) = f(u) \cdot [\frac{\beta}{1-\beta} \cdot \frac{\partial w^s}{\partial \tau} d\tau - \frac{1}{1-\beta} \cdot \frac{\partial w^0}{\partial \tau} d\tau - \frac{\partial c}{\partial \tau} d\tau] \quad (3)$$

From Equation 3, trade policy changes ($d\tau$) can affect individual's education decision through 1) changing the skill premium, i.e. the substitution effect, and 2) changing the relative cost of education, i.e. the income effect. The interaction between the type of trade policy change and the skill-intensity of the sector it affects determines how skill acquisition is impacted.[25]

In some cases, these two channels can counteract with each other. For example, when import tariffs on unskilled-labor intensive goods decline, whether these goods are used for final consumption by households or as inputs by industries, they replace domestic unskilled labor and increase the relative demand for skilled labor. As a result, higher return to education will increase the incentive for skill upgrading. However, unskilled workers may suffer income declines due to the loss of tariff protection, and may not be able to afford to invest in education. The converse holds true for decreases in tariffs abroad on unskilled-

[25]None of these three terms explain the income effects directly. In an individual decision's problem, without specifying parents' income, the income channel can only be indirectly channeled through the real cost of education, c. For example, let the local economy as a whole be the provider of credit for education expense, and the nominal tuition expense is set at the national level. Depending on the industry mix of this local economy, a trade shock could increase or decrease its overall GDP relative to the national standard. This affects the local economy's ability to provide education credit to its resident students, regardless of how skill premium changes.

labor intensive goods. The rise in relative demand for domestic unskilled labor not only decreases the skill premium, but also increases the opportunity cost of schooling. But education becomes more affordable as unskilled workers' income rises. As a result, some individuals may respond more to the skill-premium channel, while other budget-constrained ones may respond more to the income effects.

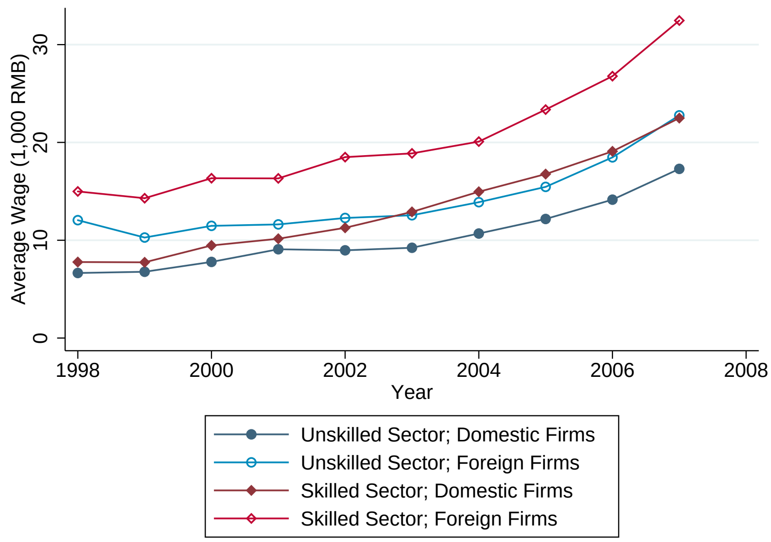
The conceptual motivation outlined above offers three possible explanations: 1) return to education increased in response to trade policy changes; 2) arrival of low-skill jobs increased the opportunity cost of education; 3) cost of education decreased in high school but not in college. I explore each of these channels in the following subsections and present evidence supporting the main finings.

6.2 Return to Education

The main results imply that trade policy changes increase the relative demand for skill. Given that the unemployment rate in China stayed at a very low level for both skill types (Facchini, Mayda, Liu, and Zhou 2016), shifts in demand for labor should exhibit more through wage changes. In other words, the positive effects on education from foreign technology adoption and imports of unskilled-labor-intensive products should also have positive impacts on skill premium. Consequently, the higher return to education prompts stronger incentives to acquire schooling. For this mechanism to be valid, skill premium and education should both increase.

Ge and Yang (2014) documents that, between 1992 and 2007, significant increase in average wage as well as schooling premia. They find that capital accumulation and SBTC among the main explanations for higher returns to education. I replicate the schooling premium trend in Ge and Yang (2014) with firm-level manufacturing census data from 1998-2007. According to the skill intensity of industries and firm ownership types, I consider four average wage points: the average wage in 1) domestic and 2) foreign firms in the unskilled-labor-intensive industries; 3)domestic and 4) foreign firms in the skilled-labor-intensive industries. I plot the annual average wages of these 4 types between 1998 and 2007 in Figure 7. The skilled sectors are in diamonds, and the unskilled sectors are in circles. I denote domestic firms with red and solid markers, and foreign firms with blue hollow markers. Several patterns emerge from Figure 7. First, foreign firms pay higher wages than domestic firms. Second, skilled sectors pay higher wages than unskilled sectors, and the gap between them increases overtime, for both domestic and foreign firms. This confirms the increasing trend in skill premium.

Figure 7: Average wage in skilled and unskilled sectors



Notes: Average wages are calcualted from 1998–2007 Chinese Annual Survey Industrial Firms, which is an annual survey conducted by the Chinese National Bureau of Statistics to collect information on all large-scale firms (annual sales over 5 million RMB). By skill intensity of industries and firm ownership types, 4 types of average wages are calculated for each year in the sample. I denote domestic firms with red and solid markers, and foreign firms with blue hollow markers. The skilled sectors are in diamonds, and the unskilled sectors are in circles.

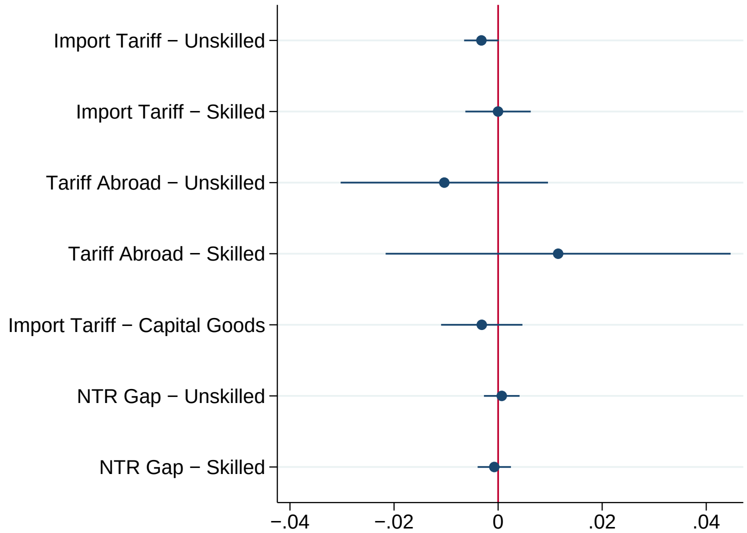
I next check whether the increases in demand for skill are caused by trade policy changes. I relate the share of skilled employees to the local trade policies at the prefecture level, and carry out a standard DID regression using firm-level employment data in 1995 and 2004.[26] The regression results are presented in the coefficient plot below. Consistent with the changes in educational attainment, the average wages increase relatively more in prefectures with more imports of unskilled products. The effect from imports of capital goods are not significant.

6.3 Arrival of Low-skill Manufacturing Jobs

In Figure 9, I first document the increase in low-skill manufacturing employment using firm-level data form 1998 to 2007. Overall number of jobs in the unskilled sectors increased

[26]Due to data limitation, I cannot measure skill premium form the firm-level data. Thus, I use the average wage in a prefecture.

Figure 8: Estimated Effects of Tariff Rates on Mean Log Wages



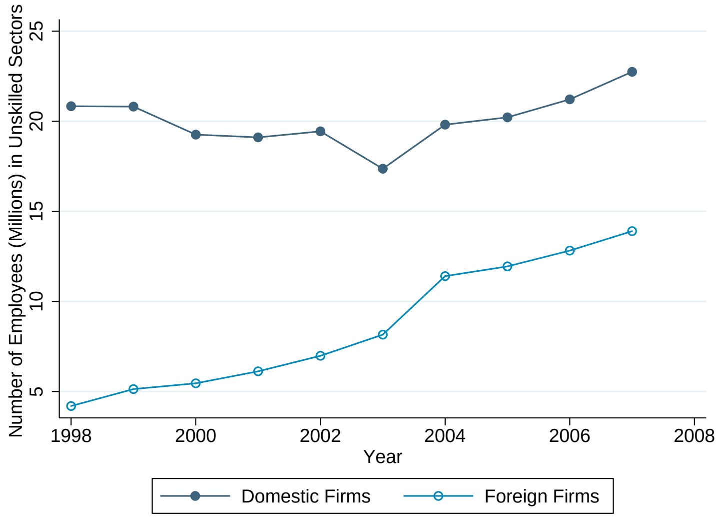
Notes: This figure plots the DID regression coefficients of trade policy changes. The dependent variable is mean log wage in a prefecture during a year. Measures of trade policy changes follow the main empirical analysis in Section 3. 95% confidence internal is plotted around the point estimates using robust standard errors. Prefecture and year fixed effects are included in the regression.

overtime, but the job growth in foreign firms is much faster, suggesting job creations associated with better integration with foreign markets as China acceded to WTO.

I then relate NTR gaps to the increase of unskilled jobs using an industry panel data constructed from CASIF 1998-2007, and estimate the impact of trade policy uncertainty reduction on unskilled job growth. The results are reported in Table 15. U.S. granting China Permanent Normal Trade Relations is positively associated with job growth in the unskilled sectors. Both domestic and foreign firms expanded and hired unskilled workers. However, if these new jobs are taken by internal migrants, then internal migration will attenuate the increased demand for unskilled labor, leaving little change in opportunity cost of schooling for local youth. I address this concern in Table 16, which shows that, increased internal migration (Table 11) was not sufficient to satiate the increased demand for unskilled labor, leaving native unskilled workers working longer hours.

The negative impact on educational attainment from reduction of trade policy uncertainty in unskilled sectors came from increased availability of jobs that do not acquire skills. In other words, the unskilled job expansion since 2000 likely created opportunities outside school, and increased the opportunity cost of acquiring education.

Figure 9: Level of Employment in Unskilled Sectors



Notes: This figure plots the total number of jobs in the unskilled sectors from 1998 to 2007. Two lines each indicate domestic and foreign forms.

Table 15: Estimated effect of PNTR on low-skill job growth

	Unskilled Industries			Skilled Industries
	All firms	Chinese Firms	Foreign Firms	All Firms
Post x NTR Gap	0.872	0.584	0.303	-0.023
	(0.312)***	(0.239)**	(0.141)**	(0.331)
R^2	0.85	0.83	0.86	0.68
N	2,081	2,018	1,960	2,128
Other Controls	Yes	Yes	Yes	Yes
Industry FE; Year FE	Yes	Yes	Yes	Yes

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Notes: The table shows the estimated effect of reduction in trade policy uncertainty on the job growth. The first heading indicates unskilled and skilled sectors, and the second heading indicates firm types. Trade policy uncertainty is measured by NTR gaps, Post WTO $*$ NTR, which is the interaction of time-invariant NTR gaps with a time dummy indicating years after China's WTO accession. Other controls include tariff changes, relaxations in investment barriers measured by *Contract Intensity* and *MFA Quota bounds*. See text for more details. Huber-White robust SEs in parentheses are clustered at the prefecture level to correct for serial correlation. Prefecture-specific cohort trends are added to all specification.

Table 16: Increase in Labor Demand in Chinese Prefectures, 2000–2005

	Migration		Native Working Hours	
	Unskilled	Skilled	Unskilled	Skilled
Post x NTR Gap	0.032	0.093	0.56	-0.000
	(0.019)*	(0.032)**	(0.015)***	(0.012)
R^2	0.96	0.88	0.72	0.73
N	666	666	666	666
Other Controls	Yes	Yes	Yes	Yes
Prefecture FE; Year FE	Yes	Yes	Yes	Yes

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

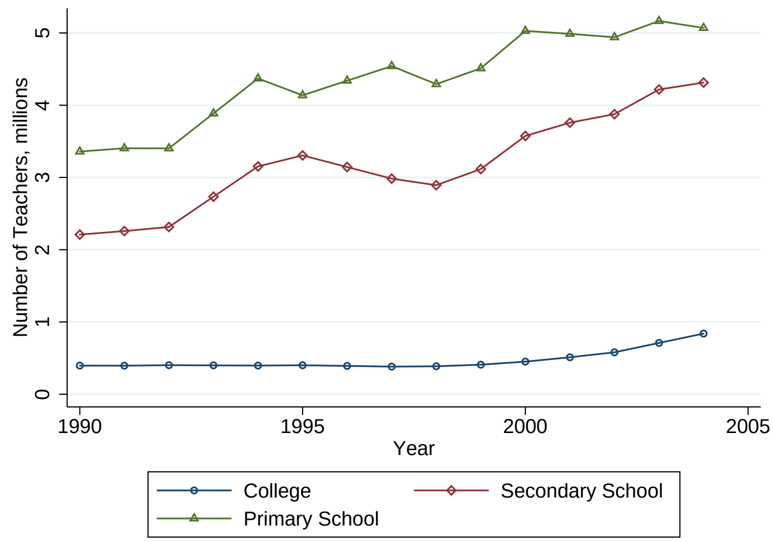
Notes: The table shows the estimated effect of reduction in trade policy uncertainty on demand for skill, through internal migration flows and working hours. The first heading indicates measure of labor supply, and the second heading indicates skill types. Trade policy uncertainty is measured by NTR gaps, Post WTO $*$ NTR, which is the interaction of time-invariant NTR gaps with a time dummy indicating years after China's WTO accession. Other controls include tariff changes, relaxations in investment barriers measured by *Contract Intensity* and *MFA Quota bounds*. See text for more details. Huber-White robust SEs in parentheses are clustered at the prefecture level to correct for serial correlation. Prefecture-specific cohort trends are added to all specification.

6.4 Provision of Public Education

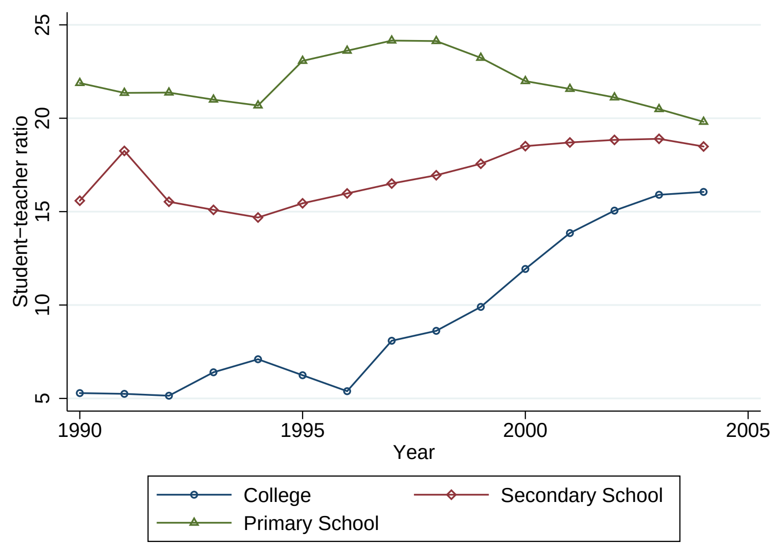
The increase in schooling among younger Chinese cohorts would not have been possible without the increase in education facilities. To confirm the increase availability of education resources during the time period examined, I plot the total number of teachers and student-teacher ratios in Figure 10. Overall, number of teachers in all education levels increase since 1990, however, the increase in primary and secondary schools are much more rapid than in colleges. In fact, the increase in number of teachers in primary and secondary schools kept the student-teacher ratio about steady, while the sharp increase in college student-teacher ratio suggest insufficient education resources at the tertiary education institutions. This may help explain the contrasting result I find for high school and college education.

To test whether the local governments at prefectures that experience more skill-increasing trade shocks also expanded education facilities accordingly, I run the DID regression for number of teachers and number of teachers per school in Table 17. Local education resources did respond to trade policy changes, responding in the same direction as children's incentive for schooling. For high school education, which is funded by local government, imports of capital goods and unskilled products increased the number of teachers.

Figure 10: Education Resources, 1990-2004



(a) Total number of teachers



(b) Average student teacher rations

Notes: For three education levels, primary school (grade 1 to 6), secondary school (grade 7 to 12), and tertiary education, (a) plots the national total number of full-time teachers in China from 1990 to 2004, and (b) plots the student teacher ratios.

Table 17: Trade and Education Resources at Secondary School and Colleges

	Secondary Schools		Colleges	
	No. teacher	teachers per school	No. teacher	teachers per school
tariff^L_{CHN-O}	-0.018	-0.016	-0.073	-0.069
	(0.006)***	(0.009)*	(0.028)***	(0.029)**
tariff^H_{CHN-O}	0.002	-0.001	-0.021	-0.027
	(0.007)	(0.007)	(0.040)	(0.041)
tariff^L_{ROW}	-0.012	-0.017	0.021	0.012
	(0.007)*	(0.010)*	(0.024)	(0.021)
tariff^H_{ROW}	-0.002	0.002	0.011	0.012
	(0.009)	(0.022)	(0.020)	(0.023)
$\text{tariff}_{CHN-Tech}$	-0.034	-0.067	-0.090	-0.120
	(0.013)**	(0.023)***	(0.070)	(0.075)
Post WTO $*$ NTR^L	-0.002	-0.021	-0.010	-0.017
	(0.004)	(0.007)***	(0.019)	(0.018)
Post WTO $*$ NTR^H	-0.005	-0.014	-0.046	-0.047
	(0.004)	(0.007)**	(0.017)***	(0.017)***
R^2	0.97	0.97	0.87	0.81
N	4,045	4,045	3,175	3,175
Other Controls	No	No	No	No
Pref FE; Cohort FE	Yes	Yes	Yes	Yes
Pref x cohort trend	Yes	Yes	Yes	Yes

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Notes: The table shows the estimated results of trade policy changes on education resources at both the secondary and college levels. I use two measures of teaching resources: 1) number of teachers, and 2) number of teachers per school. Unit of observation is by prefecture and year, with 324 prefecture and 15 years covering 1990 to 2004. Huber-White robust SEs in parentheses are clustered at the prefecture level to correct for serial correlation. Prefecture-specific cohort trends are added to all specification. Trade policies are weighted with skill-specific trade baskets (during 1997-1999) of each prefecture, where L and H denotes low-skill and high-skill labor intensive industries respectively. tariff^L_{CHN-O} and tariff^H_{CHN-O} are aggregated tariff rates on imported inputs for ordinary trade by a prefecture at each year. $\text{tariff}_{CHN-Tech}$ is the average tariff rates on the machinery and equipments imported by manufacturing firms in a prefecture. tariff^L_{ROW} and tariff^H_{ROW} are levels of tariff rates charged by Rest of the World on exported goods from a prefecture during each year. Trade policy uncertainty is measure by NTR gaps, Post WTO $*$ NTR^L and Post WTO $*$ NTR^H, which are interactions of time-invariant NTR gaps with a time dummy indicating post WTO accession years.

7 Conclusion

Recent empirical research has emphasized the distributional impacts of globalization, as many developing countries have forgone the import-substitution policy and opened up to trade in the past few decades (Goldberg and Pavcnik, 2004; 2007). Whether the inequality in *income* will translate to inequality in *education* in the long run requires careful and comprehensive assessment of the possible channels through which trade can affect educational attainment. I examine this question in the context of China's trade liberalization since early 1990 which culminated in the WTO accession in 2001. I assess a wide range of trade policy changes, and decompose the differential impact of each component. My findings can be summarized to three parts. 1) Despite the fact that internal migration also responded to shifting demand for labor due to trade shocks (Facchini, Mayda, Liu, and Zhou 2016), it was not sufficient to arbitrage away the skill price changes, and the overall low endowment of skill left remaining incentive for skill upgrading. 2) I find that completion of high school education has increased in China since early 1990s, these trends are more pronounced in prefectures where industries benefitted more from falling tariff on foreign technology, and in prefectures where industries substituted imported intermediate goods for domestic unskilled labor due to falling tariff protection on these inputs. On the other hand, expansion of export opportunities in unskilled sectors, due to reduction in trade policy uncertainty (i.e., US granting China Permanent normal trade relations) has increased the opportunity cost of schooling and decreased high school education completion. Overall, trade-related factors help explain half of the increase in high school completion rate from cohorts in 1990 to cohorts in 2004. Furthermore, these findings are robust to a variety of alternative methods to account for potential endogeneity of the baseline specification. 3) Interestingly, trade policy changes seem to have no effect on college education, possibly due to the limited seats tertiary institutions, as well as distortive college admission policies that aim to even out the education inequality among regions. Lastly, I provide evidence for three channels through which changes in trade policy affected educational attainment: return to education, opportunity cost of schooling, and supply of education resources. More detailed examinations suggest that increased schooling premium and local government's increased provision of public education may have facilitated increased schooling. At the same time, export expansion of manufacturing goods due to better access to foreign markets has increased the demand for unskilled labor and reduced schooling.

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