Long-Term Impact of Trade Liberalization on Human Capital Formation

Jie Li, Yi Lu, Hong Song, and Huihua Xie*

Abstract

While a growing line of research has assessed the effect of trade liberalization on human capital formation, most of these studies focus on its short-term effect on individual's school attendance. Much less is known about its long-run effect, as well as the impact on other aspects of human capital formation such as labor market and noncognitive outcomes. This paper studies the impact of trade liberalization on individuals' long-term human capital accumulation, including school attendance, cognitive abilities, labor market performance, and noncognitive outcomes. We use data for China from 1990 to 2010, a period during which the country became increasingly involved in global trade. By constructing prefecture-year-level tariff barriers, our identification strategy exploits variations in different cohorts' exposure to a trade shock at age 16 for individuals within the same prefecture. Empirical results suggest that trade liberalization leads to decreased completed years of schooling, cognitive abilities, wage, and noncognitive outcomes. We provide suggestive evidence that this observed pattern is explained by the expansion of job opportunities in relatively low-skilled and labor-intensive sectors.

Keywords: Trade liberalization; Tariff reduction; Human capital; Long-term effect

JEL Classification: F14, F16, J24

*Li (lijiecueb@163.com): International School of Economics and Management, Capital University of Economics and Business; Lu (luyi@sem.tsinghua.edu.cn): School of Economics and Management, Tsinghua University, Beijing, 100084, China. Song (songhong@fudan.edu.cn): School of Economics, Fudan University, China; Shanghai Institute of International Finance and Economics, Shanghai, China; Xie: (huihuaxie@cuhk.edu.cn): School of Management and Economics, Chinese University of Hong Kong, Shenzhen, China. We thank Matilde Bombardini, Davin Chor, Bingjing Li, Hong Ma, Lin Ma and the audience at various seminars for their comments. We acknowledge the financial support from the Natural Science Foundation of China (71803027), Shanghai Pujiang Talent Program (18PJC012), and Ministry of Education (18YJC790139).

1 Introduction

In the past several decades, export-led growth policies have been considered to be an effective way to achieve industrialization for developing economies. It is therefore crucial to better understand the consequences of opening to trade, and whether and how trade liberalization might influence human capital accumulation. The effects of trade liberalization on human capital have long been studied by economists, and most of these studies focus on the individual's investment in education. The results are mixed: some studies find that increased exports lead to increased returns to skills (Schank, Schnabel and Wagner 2007; Munch and Skaksen 2008; Hanson and Harrison 1999; Goldberg and Pavcnik 2007), and thus motivate more youth to pursue higher education. Other studies find that in many developing countries, export sector expansion increases demand for low-skilled labor, and thus raises the opportunity cost of receiving higher education. In turn, this leads to higher dropout rates (Atkin 2016; Li 2016).

While much research has focused on the effect of trade liberalization on human capital formation, most of these studies examine the short-term effect on an individual's school attendance at a young age. Several questions remain to be answered. For example, what is the long-term effect of trade liberalization on human capital formation? In addition to school attendance, what is the effect on other dimensions of cognitive outcomes? More importantly, in addition to education, what is the effect on an individual's labor market performance and noncognitive measurements? Very little progress has been made in addressing these issues, largely because of a lack of longitudinal studies that trace exposure to tariff reduction on individual-level performance from a long-term perspective.

This study takes a novel step in that direction by linking exposure to exporting tariff reduction at a young age to the individual's comprehensive performance after entering adulthood, on average, 14 years after exposure. Following the strategies exploited by Atkin (2016), our identification strategy exploits variation in different birth cohorts' exposure to trade liberalization within the same district.[1] Specifically, we first follow Topalova (2010) to construct prefecture-level tariffs by weighting industry tariffs with the prefecture's em-

[1] Age 16 indicates the age cohort of 16, adjusted by school enrollment year and month. Details will be discussed in Section 3.3.

ployment share for each industry. As a consequence, the cross-prefecture variations in tariff levels originate from two sources: differences in industrial specialization by prefecture and tariff-level differences across industries. Then, we match the prefecture-year level tariff with the 2014 China Family Panel Survey (CFPS, 2014) dataset, which contains rich data on individual characteristics in 2014. To summarize, the identification strategy exploits variations in the prefecture-level industrial composition, which generates differential trade shocks across cities when the individual was 16 years old.

We find evidence that trade liberalization decreases long-term human capital accumulation. First, individuals exposed to a reduced district tariff at the key exposure age are more likely to drop out after middle school, and thus have fewer years of schooling. Second, trade liberalization reduces their cognitive abilities, measured by math and word test scores at the time of the survey (on average, 14 years after exposure). Third, while trade liberalization is found to have little effect on employment, it significantly reduces the worker's wage in labor market. Fourth, it also reduces individuals' noncognitive outcomes, including a lower level of general satisfaction, confidence and a higher level of mental stress.

How could the reduced tariff barriers that result from trade liberalization affect the level of human capital adjustments? One direct consequence of low tariffs is the expansion of employment in the export sector and other sectors connected by a production linkage. As Atkin (2016) points out, increased job opportunities would have two off-setting effects on schooling: the "opportunity cost channel" and the "returns to education channel." The opportunity cost channel suggests that the reduced tariff may generate an increased number of job opportunities. As a consequence, a student may drop out of school to take a factory job because of the increased opportunity cost of schooling. The return to schooling channel suggests that a student may choose to pursue further schooling if he/she expects that there will be job vacancies in the future and that a higher level of education attainment will be rewarded. How trade liberalization affects human capital investment depends on which channel dominates.

We present multiple pieces of additional evidence to support the claim that the pattern we find is driven by the increased opportunity cost to schooling. We use the Industry Survey Dataset to show an expansion of employment for labor-intensive and low-skill jobs with the

tariff reduction. Additionally, we provide evidence showing that education is one part of, but not the whole, channel that results in a reduced labor market and noncognitve performance.

This paper mainly builds on the growing literature that examines the effects of trade liberalization on human capital adjustment. Atkin (2016) focuses on a period of rapid trade liberalization in Mexico from 1986 to 2000, and finds that the expansion of export-sector job opportunities increases the high school drop-out rate during this period. Blanchard and Olney (2017) and Li (2016) use cross-country data and Chinese data, respectively, and find that export expansion in high-skilled/low-skilled sectors can encourage/discourage further educational attainment. Our study has two main features that differentiate it from these studies. First, while previous studies focus on education only, we extend the outcomes to various aspects of human capital formation, including education, cognitive ability, labor market performance, and noncognitive measures. Second, while most previous studies focus on the immediate or short-term effect, we extend the estimates from immediate impact to long-term impacts14 years, on average, after exposure.

More broadly, our paper is also related to the literature that examines long-term impact of macroeconomic or other external shocks at a young age. For example, Giuliano and Spilimbergo (2014) find that people who grow up in recessions are more likely to hold more left-leaning political views that support government redistribution. Liu and Hannum (2017) find that early exposure to poverty impedes educational attainment and leads to worse health outcomes. Oreopoulos, Von Wachter and Heisz (2012) study the impact of economic conditions at graduation from college on labor market outcomes, and identify negative and persistent wage effects if individuals graduated during a bad economy. Since many developing countries have experienced rapid trade liberalization and expansion of the manufacturing sector, whether and how trade shocks at a young age affect long-term human capital outcomes will carry profound policy implications.

The structure of the paper is as follows. Section 2 describes the background. Section 3 discusses the empirical strategy, dataset and variables. Section 4 presents empirical results, including the main results, robustness tests, and heterogeneity analysis. Section 5 discusses the mechanisms and Section 6 concludes.

2 Tariff Reductions Faced by China's Exports

China provides an ideal setting to study this issue. A dominant feature of China's economy over the past several decades is its rising role in global trade. Trade liberalization in China accelerated in two waves. The first occured in the late 1980s and early 1990s, when China made a concerted effort to join the World Trade Organization (WTO). In 1986, China became an observer in the General Agreement on Tariffs and Trade (GATT), the WTO's predecessor, and initiated the process of rejoining the organization after a hiatus of nearly 40 years. After 15 years prolonged negotiations, China finally entered the WTO on November 10, 2001. Meanwhile, in 1992, Deng Xiaoping proposed an open policy and economic reform during a tour to southern China. Since then, a great number of liberalization policies have been adopted, which boosted exports from 62 billion USD in 1990 to 248 billion USD in 2000. The second wave which followed China's accession into the WTO in 2001, was more dramatic and abrupt, with an increase in exports from 248 billion USD in 2000 to 1,577 billion USD in 2010. In 2014, China accounted for more than 12% of all world exports, with a nominal exports growth rate of about 17% during the last two decades.

To fulfill its commitment to the WTO, China reduced its tariffs significantly, from 35% in 1994 to 17% in 1997. After joining WTO, average tariff rates were further reduced to 15% for agricultural goods and 8.9% for manufacturing goods. At the same time, China benefited from the lower import tariff rates of their trading partners after joining the WTO. Since the formation of the GATT in 1947, eight rounds of trade negotiations have taken place, mainly to lower import tariffs. By the mid-1990s, import tariff rates on manufacturing goods fell to less than 4% for industrial countries.

The WTO stipulates that countries cannot discriminate between trading partners. If a special favor is given to one trading partner, it must be given to all WTO members, which is referred as Most Favored Nation (MFN) treatment.[2] In addition to MFN tariff rates, there are bound tariff rates, which are the maximum tariff levels a country can impose on another WTO member country. Prior to entering the WTO, many developed countries had

[2]Exceptions are made for free trade agreements within a group. For more information, see $https://www.wto.org/english/thewto_e/whatis_e/tif_e/fact2_e.htm$.

already granted China their MFN rate on an annual basis.[3] Joining the WTO made China's NTR status permanent, eliminating potential uncertainties in tariff rates (Pierce and Schott 2016). The weighted average of effectively applied tariff rates (AHS) imposed on Chinese manufacturing exports was 8.7% in 1990 and dropped to about 3.7% in 2010.[4] Previous studies have exploited the setting of China's WTO accession to examine the effect of trade liberalization on various socioeconomic outcomes (Lu, Tao and Zhang 2013; Fan, Li and Yeaple 2015; Lu and Yu 2015; Lu, Tao and Zhu 2017).

Figure 1 shows the relationship between tariff barriers faced by Chinese exports in 1990 and the tariff reduction level between 1990 and 2010. The horizontal axis is the initial tariff level in 1990, and the vertical axis shows the tariff reductions for the 20 years since then. The tariff is at the industry level, calculated by weighting each country's import tariff with Chinese exports value at year $t-1$ to that country. Figure 1 suggests that the tariff levels imposed on China's exports declined in most industries over the 20 years we study. Moreover, in general, the higher the initial tariff level, the larger the decline over this time period.

[Insert Figure 1 here]

3 Empirical Strategy, Data, and Variables

In this section, we introduce the empirical strategies, construction of the tariff barrier, data, and outcome variables.

3.1 Empirical strategy

As discussed above, we are interested in how the removal of tariff barriers affects an individual's human capital formation from a long-term perspective. Our specification framework is as follows:

$$Y_{ipb} = \alpha + \beta_1 Tariff_{pb} + W'_{ipb}\phi + \eta_p + \gamma_b + \eta_p \times t_b + \epsilon_{ipb} \quad (1)$$

[3]For instance, the US offers WTO members Normal Trade Relations (NTR) rates and other non-market economy countries non-NTR rates. The US started to give China NTR rates annually, subject to approval by the US Congress.

[4]Statistics are from the TRAINS database.

where i denotes individual, p denotes prefecture, and b denotes birth-cohort. Y_{ipb} is individual i's long-term outcomes, such as schooling years and earnings, and will be discussed in detail in Section 3.4. The regressor of interest is $Tariff_{pb}$, which is the tariff in prefecture p when the individual was in the age cohort of 16, and this measure captures the exposure of prefecture-birth-cohort level to trade liberalization. Construction of the tariff measurement will be described in Section 3.2. W'_{ipb} is a set of individual controls that include dummies for gender, siblings, belonging to a minority ethnic group, urban residence, and married status. η_p is the prefecture fixed effect that captures age-cohort invariant district characteristics, and γ_b is the birth-cohort fixed effect that captures the cohort effect common to all prefectures. t_b is the linear trend of the birth cohort; we include $\eta_p \times t_b$ to capture prefecture-specific birth-cohort linear trends. Finally, standard errors are clustered at the prefecture level to prevent misleading inferences due to serial correlation in the error term across birthcohort within a prefecture (Bertrand, Duflo and Mullainathan 2004).

To further clarify this empirical setting, we start by assuming that there are two prefectures p_1 and p_2, with two birth cohorts b_1 and b_2. If we focus on prefecture p_1 only, and compare outcomes for individuals in b_1 and b_2, the estimate might be biased because of the birth cohort (age) effect. Similarly, if we focus on b_1 only, and compare outcomes for individuals in p_1 and p_2, the estimate may be biased because of prefecture-level omitted variables that are correlated with tariff change. To this end, in our setting, we use CFPS 2014 and control for both prefecture fixed effect and birth cohort fixed effect, so the estimate will not be contaminated by any time-invariant prefecture-level unobservables or any within-prefecture birth-cohort (age) level unobservables. In other words, the so called "birth-cohort (age) effects" or "prefecture effects" will be removed because of the two fixed effects we controlled for.

This empirical strategy is widely used in the literature; for example, by Atkin (2016) and Edmonds et al. (2010a). The coefficient β_1 on tariffs in specification (1) is identified under the assumption that conditional on covariates, the unobserved prefecture birth-cohort-level shocks that affect individual human capital investment are uncorrelated with the change in

prefecture tariffs across birth cohorts; that is:

$$E[\epsilon_{ipb}|Tariff_{pb}, \eta_p, \gamma_b, \eta_p \times t_b] = E[\epsilon_{ipb}|\eta_p, \gamma_b, \eta_p \times t_b] \tag{2}$$

Changes in prefecture tariffs capture the interaction of changes in industry tariffs at the national level and initial industrial composition in a prefecture. Consequently, only differential time trends in human capital that are correlated with both baseline industrial composition and national-level tariff changes could be a source of bias. To further investigate this possible endogeneity of trade liberalization, we follow the approach used by Edmonds et al. (2010a) and examine whether regional variations in tariff changes in the post-WTO period correlated with initial prefecture characteristics. Specifically, we regress the change in tariff from 2001 to 2010 on a set of prefecture-level characteristics in 2001, including total population, GDP per capital, average wage, amount of asset, amount of fixed asset investment, number of firms, number of colleges, and number of college students. As shown in Appendix Table 1, most of the estimates, as expected, are found to be small and statistically insignificant, suggesting that change in tariff is uncorrelated with pretreatment prefecture characteristics. Furthermore, in the robustness test part of Section 4.5, we will show that including linear and polynomial trends interacted with predetermined preference characteristics does not affect our estimation.

3.2 Measuring tariff barriers

Our regressor of interest is prefecture-year level tariff. In this section, we discuss construction of the tariff. The main idea for construction is to exploit each prefecture's industry employment information and overall industry's tariff level to obtain weighted average tariffs at prefecture level. In particular, we first obtain industry-level import tariffs each country imposed on China's exports from the WITS-TRAINS database.[5] Tariff data cover the years 1990 to 2010. Then we calculate the overall tariff barriers faced by each industry in China

[5]The WITS-TRAINS dataset also contains information on trade value, which we use as a weight in equation (3).

using the following equation:

$$weight\_tariff_{i,t} = \sum_m \frac{expv_{i,m,t-1}}{\sum_i expv_{i,m,t-1}} \times tariff_{i,m,t} \tag{3}$$

where i denotes industry, m denotes importing country, and t denotes year. The export value from China to importing country m at $t-1$ is used as a weight in the construction of industry-level tariffs.[6] Tariff and trade value data are obtained from WITS–TRAINS database, and are recorded at the 4-digit level, as classified by ISIC Rev 3. With a concordance table, we then map $weight\_tariff_{i,t}$ into the CSIC 4-digit level, which can be matched with population census data, from which we obtain employment data as weights when constructing prefecture tariffs.

Next, we construct prefecture-level export tariff barriers by weighting the industry-level tariff in each prefecture. We consider each prefecture as a local market and exploit the employment share in 2000, before joining the WTO, by industry as the weight to construct prefecture p's tariff barrier in year t as follows:

$$tariff\_barrier_{p,t} = \sum_i \frac{Emp_{i,p}}{\sum_i Emp_{i,p}} \times weight\_tariff_{i,t} \tag{4}$$

where $\frac{Emp_{i,p}}{\sum_i Emp_{i,p}}$ is the employment share of industry i in prefecture p, which is obtained from the 2000 population census;[7] and $weight\_tariff_{i,t}$ is the export value weighted average tariff imposed by trading partners for industry i in year t,[8], which is obtained from equation (3).

As suggested by the equation, the constructed variable varies across prefectures and over time. In particular, the cross-section variations come from differences in the initial industrial employment composition. Since the employment share used as weights remains constant for each prefecture year, within-prefecture over-time variations in tariff levels originate from

[6]Using imports in the previous year as weight can relieve potential endogeneity concerns since tariffs may have a negative impact on the current year's imports.

[7]We use the population census 2000 to obtain the employment share prior to WTO accession, to address the concern about endogenous industry structure change. This strategy is widely used in literature, for example, Kovak (2013) and Edmonds et al. (2010b).

[8]Given that we exploit the 2000 population census to obtain employment share, we ignore newborn industries during the period. This can help relieve the concern of endogenous industry structure change.

changes in industrial tariff levels over the years.[9]

Figure 2A presents prefecture-level export tariffs for different cities in 2010, and Figure 2B presents changes in prefecture-level tariffs from 1990 to 2010. These two figures have several implications: First, Figure 2A suggests substantial differences in tariff levels across prefectures in China. Second, Figure 2B suggests a substantial decrease in tariff barriers in most prefectures between 1990 and 2010. Most importantly, Figure 2B suggests a substantial variation in the reduction in tariffs across different prefectures during the estimation period, which is the source of variation in our identification. [10]

[Insert Figure 2 here]

3.3 Tariff shocks at the age of 16

Following Atkin (2016), our identification strategy exploits differences in exposure to a trade shock at age-cohort 16 across cohorts within the same prefecture. According to China's compulsory education law, students are required to enroll in primary school at age-cohort 7.[11] In other words, age-cohort 16 is when students complete the end of middle school (ninth grade) and must decide whether to continue to attend high school or not. For instance, age-cohort 16 in 2010 represents those born between September 1994 and August 1995.[12]

Why do trade shocks experienced at age 16 have the most pronounced effects on human capital investment? First, this is when students decide whether to attend high school, as education beyond this age is not compulsory. When making this decision, students and

[9] In Edmonds, Pavcnik and Topalova (2010a), both traded and non-traded industries are included in the construction of district tariffs, where non-traded industries are assigned zero tariffs. Our paper differs by calculating tariff measures using only industries with exports to reflect tariff barriers imposed by external trading partners. We focus on tradable sectors only when constructing tariff barriers, because we mainly focus on the direct impact from trade liberalization. In particular, the literature has shown the validity and advantage of using tradable sectors only and ignoring non-tradable sectors. Kovak (2013) uses a regional equilibrium model to show that a change in trade sector prices would proportionally affect price levels in non-trade sectors. If non-trade sector tariffs are considered to be zero through different years, then the general equilibrium effect of trade liberalization is ignored. This, in turn, could lead to understating the trade liberalization magnitude and bias the estimate.

[10] Since our identification relies on the variance of tariff at the prefecture-year level, the substantial change in tariff across prefecture-year level provides support for the source of identification.

[11] For example, students who were born between September 1990 and August 1991 were allowed to enroll in the first year of primary school in September 1997.

[12] For brevity, we use age 16 as an abbreviation for "age cohort 16" in the paper.

parents compare the forgone earnings from staying in school with the potential wage premium from being better educated. For instance, in districts in which there are abundant job opportunities in the low-skilled sector, students are more likely to drop out. Students are not allowed to leave school until age 16, and they are less likely to drop out after they have enrolled and paid tuition for the first year of high school at the age of 17. Second, 16 is the legal minimum working age in China, and thus factories are not allowed to hire employees who are younger. As a result, any shocks that occur when an individual is 16 will have a particularly pronounced effect on his/her schooling decisions. In Section 4.5, we provide empirical evidence showing that compared to other ages, 16 indeed has the most profound effect on an individual's outcomes.

3.4 Dataset and outcome variables

3.4.1 CFPS Dataset

Our analysis primarily relies on the 2014 China Family Panel Studies (CFPS), which is a nationally representative sample of Chinese communities, families, and individuals. It was launched in 2010 by the Institute of Social Science Survey of Peking University, and has are waves for 2010, 2012, and 2014. The survey was designed to exploit a stratified multi-stage sampling strategy. The CFPS sample represents 95% of the total population, and covers a wide range of domains for families and individuals from 124 counties in 25 provinces of China (Xie, 2012). Figure Appendix 1 plots the geographical distribution of the provinces covered by the CFPS dataset.

The CFPS dataset is ideal for our study for the following reasons. First, the survey is representative of the country. In particular, the survey team carefully compared important socioeconomic and demographic variables in the CFPS dataset with those in the Population Census data, and found that the mean values and distributions of important characteristics in both data sources are quite similar. Second, compared to the sample from the national census, the CFPS has fewer observations but more depth of information. The survey includes a variety of socioeconomic outcomes for adults, such as education level, cognitive ability, labor market performance, and noncognitive measures. In addition, the dataset provides

rich information on demographic characteristics, such as gender, race, number of siblings, birth year, and birth month.

We restrict the estimation sample using the following steps: First, we restrict the sample to individuals whose prefecture at birth and survey time are recorded; second, we further restrict the sample to non-migrant (non-migrant from birth to survey time) because we need information on the prefecture the individual was living in when he/she was 16 years old, and there is no direct information in the survey.[13] Third, we further restrict the sample to those who had reached 16 years old between 1990 and 2010, since 1990 is the earliest year from which tariff data are available. In other words, we restrict individuals to those aged between 20 and 40.[14] Our final estimation sample contains 5,781 individuals from 103 prefectures.

3.4.2 Outcome variables

The main purpose of this paper is to examine the long-term effects of trade liberalization on human capital accumulation. To fully capture various dimensions of human capital accumulation, we exploit rich information from the survey to measure human capital outcomes, including educational achievement, labor market performance, and noncognitive outcomes.

Education achievement. The first outcome we use is the years of completed education. In our estimation sample, the average years of schooling is 9.17 years. In China, compulsory education covers primary and middle schools and ends at ninth grade (compulsory education ends when a student is in age-cohort 16). A student can choose whether to continue to high school, and those who attend and complete high school are then eligible for college enrollment. Since the age of key exposure is before high school attendance, in addition to completed years of education, our analysis also includes whether an individual attends high school and whether the individual obtains a college degree.

[13] In the analysis, we restrict the sample to non-migrants, defined as someone who reports being born in the same prefecture they were living when the survey was conducted in 2014. We restrict the sample to non-migrants who lived in the same prefecture between being born and the survey year, because the survey contains no information for the prefecture in which the individual was living when he/she was 16 years old. Our estimation sample comprises 91.2 % of the full survey sample. We further show that migration status is not affected by tariff level, and results remain robust when we use all observations. Details are discussed in Section 4.5.3.

[14] More specifically, given that we focus on the period from 1990 to 2010, the age of individuals in our estimation sample ranges from 20 to 40. This is because the oldest individual in the estimation sample was born in 1974 (age 16 in 1990), and the youngest was born in 1994 (age 16 in 2010).

In addition to school attendance, we exploit math and word test scores in the CFPS to measure an individual's long-term cognitive abilities. Both of these tests are designed by the CFPS data center and administered in person at the time of the survey. In the math test, respondents were required to solve a set of math questions that include basic arithmetic operations, exponents, logarithms, permutations and combination questions. In the word test, respondents were required to read a set of Chinese characters. For ease of interpretation, we standardize scores to have a mean of zero and standard deviation of one.

Labor market performance. The first outcome variable we use to measure labor market performance is an individual's employment status, as defined by whether the individual is full-time employed, and the second outcome variable of interest is an individual's annual wage, which is self-reported by full-time employees in the survey. In our estimation sample, 44% of respondents are full-time employed and their average annual wage is 29,068 CNY (around 4,196 USD).

Noncognitive outcomes. To measure noncognitive outcomes, we follow the literature (Lavy and Schlosser 2011; Lavy et al. 2016) to elicit mostly commonly used noncognitive measurements from CFPS. In particular, two questions in the survey measure general satisfaction: (1). What is your level of happiness? (2) What is your level of your confidence in the future? One question measures social acclimation: (1) How well you are dealing with others? Three questions measure mental stress—how frequently the individual feels (1) worried, (2) depressed, and (3) that life is meaningless. We follow Autor et al. (2003)'s aggregation method to obtain the overall effect of trade liberalization on noncognitive outcomes. Specifically, we first conduct principal component analysis (PCA) to classify these six survey questions into two categories: (1) level of social acclimation and satisfaction, and (2) the level of mental stress. We then follow Kling, Liebman and Katz (2007) to calculate the average effect size (AES), which is a weighted average of the z-scores of its component. This aggregation improves statistical power to detect effects that are consistent across specific outcomes when the outcomes have idiosyncratic variation. We report results for both AES and each item.

Table 1 provides summary statistics. Specifically, it provides statistics for all outcome variables: education, cognitive abilities, labor market performance, and a set of noncognitive

measures and the regressor of interest – prefecture-level tariff when the individual was 16 years old – as well as a set of individual controls, such as gender, ethnic group, and residence status. As described above, the table contains rich information: It suggests that, for instance, average years of schooling are 9.17 years; among full-time employees, the average annual wage is 29,068 CNY (around 4,196 USD); and the average tariff was 4.63, with a standard deviation of 1.28. It implies that both outcome variables and the regressor of interest have reasonable variations.

[Insert Table 1 here]

4 Empirical Results

In this section, we present the estimated effect of trade liberalization on human capital accumulation, as measured by a variety of long-term outcomes.

4.1 Academic achievement

Table 2A presents the effect of trade liberalization on school attendance. We begin by looking at the effect of trade liberalization on students' completed schooling years. Columns 1-2 present the results, which suggest that exposure to higher tariffs at the age of 16 significantly increases the individual's schooling years. In particular, a 1 percentage-point decrease in the tariff barrier is associated with a 0.246-year decrease in schooling years. Given that the average tariff decreased from 8.7% in 1990 to 3.7% in 2010 – a reduction of 5 percentage points – everything being equal, trade liberalization decreases completed years of schooling by 1.23 years (0.246 * 5 = 1.23). As emphasized in Section 3, if new job arrivals at age 16 raised the opportunity cost of schooling, we would expect the bulk of the reduction in school attainment to come from students' decisions whether attend high school. We next examine whether trade liberalization reduces high school attendance. Columns 3-4 present the results, which suggest that exposure to higher tariffs at the age of 16 significantly increases an individual's attendance in high school: Everything being equal, a 1-percentage-point reduction in the export tariff that resulted from trade liberalization is associated with

a 2.5% decrease in high school attendance. Columns 5 and 6 present the effect on college enrollment and display similar patterns.

In addition to school attendance, the CFPS contains math and word test scores, which allow us to measure changes in cognitive skills at the time of the survey 14 years, on average, after the largest exposure to tariff reductions at 16 years old. Table 2B suggests that students who experienced a reduction in the tariff have a lower performance on math and word tests (statistically significant on math test only). In particular, focusing on the estimate on math test, a 1-percentage-point reduction in the tariff rate is associated with a 0.283 standard deviation reduction in math test scores. In other words, trade liberalization from 1990 to 2010, in total, resulted in a 1.415 (0.283 *5=1.415) standard deviation reduction in cognitive abilities.

[Insert Table 2 here]

4.2 Labor market performance: Employment status and wage

Table 3 presents the effects of trade liberalization on an individual's long-run labor market performance. In our estimation sample, the average age for survey respondents is 30 years old, so the result for labor market outcomes reflects the effect of exposure to tariffs at a young age on an individual's performance in the labor market after 14 years. Columns 1 and 2 present the effects on employment status. The estimates are small and statistically insignificant, indicating little evidence of the impact on an individual's long-term employment status. Columns 3 and 4 present the effects on logged annual wage. The estimates show that a 1-percentage-point increase in the prefecture tariff is associated with a 9.8% increase in long-term earnings.[15]

Regarding the magnitude, the annual average wage in China was 2,140 CNY in 1990 and 20,759 CNY in 2010, with roughly ten times increase. The tariff reduction resulted from the trade liberalization from 1990 to 2010 can account for 4.9% of the total changes.[16]

[15] The number of observations drop from 5,811 to 2,528 from the first two columns to the last two columns due to missing values on the measurement of wage.

[16] 9.8%*5/10=0.049.

This impact is consistent with our expectation. As indicated in Table 2A, tariff barrier reductions depress educational attainment, which in turn would depress income level and the possibility of entering a high-skill occupation over one's lifetime. Furthermore, since most of the increased work opportunities that resulted from trade liberalization are low-skill jobs, such as manufacturing and/or textile industries, salaries are low and there are few opportunities to be promoted or move to other careers. In addition, competitiveness is expected to be reduced because of unsatisfactory working conditions and low-qualified peers in the early career stage.[17]

[Insert Table 3 here]

4.3 Noncognitive outcomes

In this section, we analyze the effects of trade liberalization on an individual's noncognitive outcomes; that is, the index for general satisfaction and confidence and the index for mental stress. As shown in Table 4, regarding general satisfaction and confidence, panel A suggests that the estimates are consistently positive and statistically significant across all measures and AES. Regarding the index for mental stress, panel B suggests that the estimates are consistently negative across all measures and statistically significant for "meaningless." To summarize, a higher district tariff is associated with higher levels of noncognitive measures. Focusing on the AES measurement for magnitude interpretation, trade liberalization significantly reduces general satisfaction measures by 0.475 of a standard deviation (0.095*5=0.475), and increases the level of mental stress by 0.13 of a standard deviation (0.026*5=0.13).

[Insert Table 4 here]

[17]It is worth noting that the estimates on tariff are still significant with the inclusion of education as a control, but with smaller magnitude, indicating that education is one part of, but not the whole channel affect long term labor market performance. The results are further discussed in Section 5 and reported in Appendix Table 2.

4.4 Discussion

It is valuable to compare these results with those found in the literature. Several studies have examined the effect of trade liberalization on students' educational attainment. Most studies that focus on developing countries have found a negative effect. For example, Atkin (2016) finds that the growth of export manufacturing in Mexico during a period of major trade reforms increases students' drop-out rate from school. Specifically, with every 25 jobs created, one student dropped out of school at ninth grade rather than continuing with their studies. Most prior studies, however, only focus on school attendance immediately after exposure to tariff reduction. To this end, more research is needed on whether the effect of trade liberalization compounds or is diminished over time, and more importantly, whether and how trade liberalization affects other aspects of human capital. Our results provide answers to these questions: they show that the effect of trade liberalization lasts for more than 10 years after exposure to liberalization, and the effect is not restricted to school attendance; it also affects cognitive abilities, earnings, and noncognitive outcomes. The results suggest that the potential cost of trade liberalization might be underestimated if we focus on short-term school attendance only, and ignore other long-term measurements.

4.5 Robustness checks

4.5.1 The age-16 exposure window and effects at other ages

Our identification strategy is built on the assumption that individuals are disproportionately affected by tariff shocks when they are 16 years old. A similar strategy is used by Atkin (2016). Following Atkin, we first justify this assumption based on the fact that 16 is both the legal factory employment age and the time at which students decide whether to attend high school. Second, we repeat the main specification, but replace the tariffs the individual faced at age 16 with rates faces at other ages. We estimate 11 separate regressions, one each for age of exposure to tariff shocks is at age 11 to 21. Figure 3 plots the coefficients for each of the 11 regressions, for schooling years and wage, respectively. We notice that there are also some significant effects for exposure at other ages, and especially at age 15, but with

smaller magnitudes relative to age 16.

[Insert Figure 3 here]

4.5.2 Trends correlated with pretreatment difference

In the main specifications, we included prefecture-specific linear trends to control for cross-prefecture birth-cohort-varying changes in the outcomes. Here, we follow the approach used in Edmonds, Pavcnik and Topalova (2010a) and estimate an alternative specification with linear and quadratic trends interacted with pre-WTO prefecture characteristics. The augmented specification is:

$$Y_{ipb} = \alpha + \beta_1 Tariff_{pb} + W_{ipb}^{'}\phi + \eta_p + \gamma_b + \eta_p \times t_b + \varphi Z_p^{'} \times f(b) + \epsilon_{ipb} \tag{5}$$

where $Z_p^{'} \times f(b)$ is a vector of prefecture-level pre-WTO characteristics, as those in Appendix Table 1, interacted with a quadratic form of birth cohort. The regression results are presented in Table 5, columns 1 and 2. We find that the inclusion of these trends doesn't change the baseline estimates, indicating that pre-treatment differences across prefectures do not contaminate our estimates.

4.5.3 Migration across districts

In the main analysis, we restrict the sample to non-migrants, or those who reported being born in their prefecture of residence during the 2014 survey period. They comprise 91.2% of the full survey sample. In other words, our analysis is only representative for the 91.2% who were not migrants. Our estimations may be biased if there are unobservable factors that are correlated with district tariffs and migration decisions. For example, if the reduced district tariffs due to trade liberalization prevented the out-migration of low-skilled workers but not of high-skilled workers, then the estimated coefficients for tariffs will have a downward bias. To deal with this concern, we use the main specification to regress the migrant dummy on tariff. As shown in column 3 of Table 5, the estimates are small and statistically insignificant, indicating that the migration decision is not correlated with district tariffs. In addition, we

use the full sample, which includes both non-migrants and migrants, to replicate the results and find similar patterns.[18]

4.5.4 Exposure to import competition

So far, we have focused exclusively on lowered tariff barriers faced by China's exports. However, another side of trade liberalization is the lowered import tariff on imports into Chinese markets. Significant reductions in import tariff could expose certain industries and prefectures that specialize in those industries to fierce competition. Therefore, in columns 4 and 5 of Table 5, we further controlled for import tariff barriers faced by each prefecture. The results again present a positive and significant estimate for export tariff levels, and small estimates for the import tariff level, indicating that the estimates are not sensitive to the inclusion of import competition.

4.5.5 Other reform controls

During the 1990s and early 2000s, China implemented several other reforms concurrent with WTO accession, such as the state-owned enterprises reform (SOE) from 1998 and the expansion of college enrollment from 1999. College enrollment expansion would alter the distribution of education attainment for each prefecture, so we include college student share over prefecture population to control for the effect of this reform. We also include GDP contributed by SOE firms. We include these controls in the specification by interacting those variables with the birth-cohort linear trend. As shown in Table 5 columns 6 and 7, we find estimates similar to those in baseline regressions, indicating that the estimates are not biased by other reforms.

4.5.6 Concern about child labor

Another concern is about the child labor in China. Given that our regressor of interest is the prefecture-year level tariff barrier when the individual was 16 years old, one assumption with the identification setting is that the student was in the final year of middle school when he/she was 16 years old. While students are not allowed to leave school and work before

[18] For brevity, the results that use the full sample are available upon request.

16 years old, as required by the Compulsory Education Law in China, it will be a concern, however, if some children was illegally employed by factories before reaching 16 years old. To test whether our results are driven by the possible existence of child labor, we further restrict the estimation sample to individuals those had graduated from middle school and have at least 9 years of schooling, in other words, we restrict the sample to those who were unlikely of being child labor, and replicates the regressions. The results are reported in Table 5 columns 8 and 9, and the estimates are robust and similar to those in baseline results, indicating that our estimates are not driven by the existence of child labor.

[Insert Table 5 here]

4.6 Heterogeneity analysis

In addition to showing the average treatment impacts of trade liberalization on human capital, we explored heterogeneous effects that vary across individuals' background characteristics, including their gender and their *hukou* status.[19] We include the interaction term between tariff and the corresponding variable and report results in Table 6.

Table 6 columns 1 and 2 present the heterogeneous analysis by gender. It suggests that compared with females, the effect of trade liberalization on schooling is larger for males. In particular, while the estimate of tariff on schooling years is 0.141 (statistically insignificant), the estimate on the interaction term is 0.198, which is statistically significant. We find similar patterns for wage. These results suggest an overall pattern whereby trade liberalization has a more profound effect on males than on females.

Columns 3 and 4 present results by students' residence (rural or urban), and suggest a larger trade liberalization effect on individuals from urban areas. An interpretation of this finding is that compared to those in rural areas, students in urban areas are more likely to find expanded job opportunities resulting from export expansion. As a result, they are more likely to be affected by export expansion.

[Insert Table 6 here]

[19] Hukou status is defined as whether the individual was a rural or urban resident.

5 Mechanisms

Our results thus far suggest that a decline in export tariffs at age 16 depresses long-term human capital accumulation, including decreased years of schooling, cognitive abilities, income levels, and noncognitive outcomes. In this section, we examine the channels through which trade liberalization plays a role. We first provide evidence in support of the "opportunity cost channel", then discuss how the impact persists and affects long-term outcomes.

5.1 Expansion of employment in labor-intensive sectors

Over the trade liberalization period, China mainly specialized in relatively low-skill and labor-intensive industries. If lowered export tariff levels lead to more exports in labor-intensive/low-skill sectors, firms in those sectors would see an expansion in employment and output. This could, in turn, provide more job opportunities for young people finishing middle school, and thereby increase the probability that they will stop pursuing higher education.

To test whether this is the case, we use firms' employment and output data to test whether tariff reductions have heterogeneous effects on firms with different skill levels. This is done by interacting prefecture tariff levels at the current year with the labor intensity of each industry. We use the Annual Survey of Industrial Firms from 1997 to 2008 (ASIF), conducted by China's National Bureau of Statistics (NBS), and interact district tariffs with the labor intensity of the industry to which the firm belongs.

We construct two measurements to proxy the firm's labor intensity. The first is the number of employees in an industry over fixed assets, and the second is the industry's total wage bill over fixed assets. Both measures are constructed using data from year 2004's Industry Survey. Results are presented in Table 7. Columns 1, 3, and 5 report estimates using the first measurement, and columns 2, 4, and 6 report estimates using the second measurement. Columns 1 and 2 present the effect of tariff on firm employment, controlling for prefecture-industry, industry-year, and prefecture-year fixed effects and firm-level controls, including the firm's age, capital stock, fixed assets, export status, and ownership status. We find negative and significant estimates for the interaction between prefecture tariff, indicating that a lower prefecture tariff (resulting from trade liberalization) increases employment more

for firms in labor-intensive industries.

Columns 3 and 4 use the firm's output value as a dependent variable and find similar patterns–namely, a lower tariff increases production more for firms in labor-intensive industries. Another dimension we examine is the number of newly established firms at the prefecture-industry level. Using data for the year in which firms were established, we aggregate and calculate the number of firms that were established in each prefecture-industry-year unit between 1998 and 2007. As presented in columns 5 and 6, we find negative estimates on the interaction terms, indicating that in prefectures with lower tariff levels, there are more newly established firms in labor-intensive industries. Since the estimates for production value and new firms established are statistically insignificant, we should interpret them with caution. To summarize, the above firm-level analysis provides suggestive evidence that trade liberalization results in an expansion in labor-intensive industries.

[Insert Table 7 here]

5.2 Education, first job quality, and long-term outcomes

We have shown the pattern of expansion in labor-intensive/low-skill firms that resulted from China's trade liberalization. This could, in turn, provide more job opportunities for young people finishing middle school, and thereby increase the probability that they will not pursue more education. To this end, absence from high school and choice of first job could in turn have an impact on long-run human capital formation. In addition to wage differences, highly educated individuals can obtain more social support, which helps reduce stress, depression, and anxiety (Ross and Willigen 1997; Edgerton, Roberts and von Below 2011).

In addition to the channel through education, exposure to a certain kind of macroeconomic environment at the beginning of an individual's career may also have a long-term impact. In particular, according to the impressionable years hypothesis, experiences at a young age have a profound impact on people's views and values over their entire lifetime (Krosnick and Alwin 1989).[20] In addition, early work experience has an impact on labor

[20]Relatedly, Loughlin and Barling (2001) point out that work experience at a young age can shape future work-related attitudes. These values and attitudes can, in turn, have an impact on later-life outcomes.

market consequences later in life (Neumark 2002).[21]

Given the extensive evidence in the literature that school attendance and first job choice have a profound impact on the individual's long-term human capital adjustment, we infer that the expansion in labor-intensive/low-skill firms negatively affects young people's education decisions and first-job quality, which then affect one's long-term human capital outcomes in multiple respects. Indeed, to test whether education is the only channel that affect other long term outcomes, we include education (measured by schooling year) in the regression for labor market performance and non-cognitive measures and replicate the regressions. As shown in Appendix Table 2, for both labor market performance and noncognitive outcomes, we find that after controlling for education, the estimates are still statistically significant and robust, but the magnitude of the coefficients dropped. This provides suggestive evidence that education is one part of, but not the whole, channel that affect those outcomes.

6 Conclusion

In this paper, we study how trade liberalization affects an individual's long-term human capital accumulation of different kinds. We find that during the period between 1990 and 2010, rapid trade liberalization in China negatively affects human capital adjustment. We summarize our main findings as follows. First, trade liberalization reduces young people's educational achievement, including a reduction in total years of completed schooling, a reduction in likelihood to attend high school and college, and a decrease in long-term cognitive abilities, measured by math and word test scores. Second, while trade liberalization has little effect on employment status, it substantially decreases wages 14 years, on average, after exposure. Third, trade liberalization also affects noncognitive outcomes, including a decreased level of general satisfaction and a higher level of mental stress. We next exploit firm-level annual industry data and provide evidence that the lower prefecture tariff levels that resulted from trade liberalization increase employment more for firms in labor-intensive

[21]For example, Oyer (2006a) and Oyer (2006b) find that macroeconomic factors might sort individuals into different careers and have a long-lasting impact. In terms of wage growth, Topel and Ward (1992) point out that about 66% of wage growth is accounted for by the first 10 years of an individual's career, and that most job changes also occur in this time period.

industries, which supports the "increased opportunity cost of schooling" channel.

While the literature has extensively documented the effects of trade on human capital accumulation, most have focused on short-run educational outcomes. Given findings from the literature that trade liberalization may reduce school attendance in developing economies, an important question is whether this negative impact will be eliminated, persist, or even be exacerbated in the long term, and what is the effect on other aspects of human capital formation. The potential cost of trade liberalization will be incorrectly estimated if we ignore the long-term impact and focus on the immediate impact only. This paper contributes to the literature by investigating long run and multiple effects of trade liberalization.

The findings in this paper are relevant and important for designing industrial and trade policies. Many developing countries, including China, are experiencing rapid trade liberalization along with improvements in education and working regulations and conditions. Given the tradeoffs between reduced human capital accumulation and increased exposure to trade liberalization, it is vital that policy makers develop strategies to remediate the negative effects. For example, policy designers could increase on-the-job training for young workers in low-skilled manufacturing jobs, or develop adult education programs to encourage low-skilled workers to continue their education, and thus render them more competitive in the job market.

References

Atkin, David, "Endogenous Skill Acquisition and Export Manufacturing in Mexico," *American Economic Review*, 2016, *106* (8), 2046–2085.

Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan, "How Much Should We Trust Differences-In-Differences Estimates?," *The Quarterly Journal of Economics*, February 2004, *119* (1), 249–275.

Blanchard, Emily J. and William W. Olney, "Globalization and Human Capital Investment: Export Composition Drives Educational Attainment," *Journal of International Economics*, 2017, *106*, 165–183.

Edgerton, Jason D., Lance W. Roberts, and Susanne von Below, "Education and Quality of Life," *Handbook of Social Indicators and Quality of Life Research*, 2011, pp. 265–296.

Edmonds, Eric V., Nina Pavcnik, and Petia Topalova, "Trade Adjustment and Human Capital Investments: Evidence from Indian Tariff Reform," *American Economic Journal: Applied Economics*, October 2010, *2* (4).

Edmonds, Eric V, Nina Pavcnik, and Petia Topalova, "Trade adjustment and human capital investments: Evidence from Indian tariff reform," *American Economic Journal: Applied Economics*, 2010, *2* (4), 42–75.

Fan, Haichao, Yao Amber Li, and Stephen R Yeaple, "Trade liberalization, quality, and export prices," *Review of Economics and Statistics*, 2015, *97* (5), 1033–1051.

Giuliano, Paola and Antonio Spilimbergo, "Growing up in a Recession," *Review of Economic Studies*, 2014, *81* (2), 787–817.

Goldberg, Pinelopi Koujianou and Nina Pavcnik, "Distributional Effects of Globalization in Developing Countries," *Journal of Economic Literature*, March 2007, *45* (1), 39–82.

Hanson, Gordon H. and Ann E. Harrison, "Trade Liberalization and Wage Inequality in Mexico," *Industrial and Labor Relations Review*, 1999, *52* (2), 271–288.

Kling, Jeffrey R, Jeffrey B Liebman, and Lawrence F Katz, "Experimental Analysis of Neighborhood Effects," *Econometrica*, 2007, *75* (1), 83–119.

Kovak, Brian K, "Regional effects of trade reform: What is the correct measure of liberalization?," *American Economic Review*, 2013, *103* (5), 1960–76.

Krosnick, Jon A and Duane F. Alwin, "Aging and Susceptibility to Attitude Change," *Journal of Personality and Social Psychology*, 1989, *57* (3), 416–425.

Lavy, Victor and Analia Schlosser, "Mechanisms and impacts of gender peer effects at school," *American Economic Journal: Applied Economics*, 2011, *3* (2), 1–33.

_ , Giulia Lotti, and Zizhong Yan, "Empowering Mothers and Enhancing Early Childhood Investment: Effect on Adults Outcomes and Children Cognitive and Non-cognitive Skills," Technical Report, National Bureau of Economic Research 2016.

Li, Bingjing, "Export Expansion, Skill Acquisition and Industry Specialization: Evidence from China," *Working paper*, March 2016.

Liu, Xiaoying and Emily Hannum, "Early Poverty Exposure Predicts Young Adult Educational Outcomes in China," *China Economic Review*, 2017, *44*, 79–97.

Loughlin, Catherine and Julian Barling, "Young Workers' Work Values, Attitudes, and Behaviours," *Journal of Occupational and Organizational Psychology*, 2001, *74*, 543–558.

Lu, Yi and Linhui Yu, "Trade Liberalization and Markup Dispersion: Evidence from China's WTO Accession," *American Economic Journal: Applied Economics*, 2015, *7* (4), 221–253.

_ , Zhigang Tao, and Lianming Zhu, "Identifying FDI Spillovers," *Journal of International Economics*, 2017, *107*, 75–90.

_ , _ , and Yan Zhang, "How do Exporters Respond to Antidumping Investigations?," *Journal of International Economics*, 2013, *91* (2), 290–300.

Munch, Jakob Roland and Jan Rose Skaksen, "Human Capital and Wages in Exporting Firms," *Journal of International Economics*, 2008, *75*, 363–372.

Neumark, David, "Youth Labor Markets in the United States: Shopping around vs. Staying Put," *The Review of Economics and Statistics*, Aug 2002, *84* (3), 462–482.

Oreopoulos, Philip, Till Von Wachter, and Andrew Heisz, "The Short- and Long-term Career Effects of Graduating in a Recession," *American Economic Journal: Applied Economics*, 2012, *4* (1), 1–29.

Oyer, Paul, "Initial Labor Market Conditions and Long-Term Outcomes for Economists," *Journal of Economic Perspectives*, 2006, *20* (3), 143–160.

_ , "The Making of an Investment Banker: Macroeconomic Shocks, Career Choice and Lifetime Income," *NBER Working Paper No. 12059*, 2006.

Pierce, Justin R. and Peter K. Schott, "The Surprisingly Swift Decline of US Manufacturing Employment," *American Economic Review*, 2016, *106* (7), 1632–1662.

Ross, Catherine E. and Marieke Van Willigen, "Education and the Subjective Quality of Life," *Journal of Health and Social Behavior*, September 1997, *38* (3), 275–297.

Schank, Thorsten, Claus Schnabel, and Joachim Wagner, "Do Exporters Really Pay Higher Wages? First Evidence from German Linked Employer–Employee Data," *Journal of International Economics*, 2007, *72*, 52–74.

Topalova, Petia, "Factor Immobility and Regional Impacts of Trade Liberalization: Evidence on Poverty from India," *American Economic Journal: Applied Economics*, 2010, *2* (4), 1–41.

Topel, Robert H. and Michael P. Ward, "Job Mobility and the Careers of Young Men," *The Quarterly Journal of Economics*, May 1992, *107* (2), 439–479.