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How do households adjust to tariff liberalization? Evidence from China's WTO accession ☆

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ABSTRACT

This paper investigates how households adjust to local labor market shocks caused by import tariff liberalization in China. Exploiting regional variation in the exposure to tariff cuts resulting from the WTO accession, we find that regions that initially specialized in industries facing larger tariff cuts experienced relatively larger wage declines. Households responded to the shock in several ways, including more female and old household members working, more young adults co-residing with parents, and households saving less. These findings suggest an insurance role of households against trade-induced labor market shocks. JEL: F14, F16, J20, R23.

1. Introduction

Over the past four decades, many developing countries have implemented large-scale trade liberalization, substantially lowering the barriers on imports. A number of studies have documented that regions or industries exposed to import competition induced by tariff liberalization experienced relative declines in labor market conditions.[1] Although the extant literature has investigated how individual workers respond to such labor market shocks, less attention has been paid to the adjustments at the household level, such as family labor supply, living arrangement, and saving. Since these behaviors can serve as important insurance against the labor market risks besides formal social security system (Blundell et al., 2008, 2016; Kaplan, 2012; Gorbachev, 2016), investigating how households adjust to import tariff liberalization is important to both academic researchers and policy makers.

In this paper, we examine household responses in the context of China's WTO accession. China provides a suitable setting to conduct such a study. First, the arguably exogenous tariff changes following the WTO accession can serve as a quasi-experiment to identify the effects of import tariff liberalization. Second, targeted trade adjustment assistance programs as those in the United States do not exist in developing countries such as China. As such, mutual support among household members would play a more important role in protecting individuals from adverse trade shocks. Finally, the distributional effects of trade liberalization in developing countries is a topic of persistent attention in the literature, as surveyed by Goldberg and Pavcnik (2007) and Pavcnik (2017). Investigating China's tariff reform after WTO accession provides a valuable case study on this topic.

We use the Urban Household Surveys (UHS) that cover all prefecture-level cities in China during the period before and after the WTO entry. The UHS provides extensive information at both the individual and household levels, enabling us to investigate household responses in a variety of dimensions. Our methodology follows the "local labor market approach" that has recently been widely used in the literature.[2] We construct a tariff exposure variable at the prefecture city level. The identification is based on the variation in tariff changes across

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[1] Examples of industry-level studies include Revenga (1997); Attanasio et al. (2004); Goldberg and Pavcnik (2005). Examples of regional-level studies include Topalova (2010); Kovak (2013); Hakobyan and McLaren (2016); Dix-Carneiro and Kovak (2015, 2017, 2019).

[2] See Hasan et al. (2007); Edmonds et al. (2010); Topalova (2010); McCaig (2011); Autor et al. (2013); Kovak (2013); Dix-Carneiro and Kovak (2015, 2017, 2019); Costa et al. (2016); Hakobyan and McLaren (2016); McCaig and Pavcnik (2018).

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industries and the variation in pre-WTO industry employment composition across cities. In the individual level or household level regressions, we control for city fixed effects, year fixed effects, and demographic variables (including gender, age, and education) of the individual or the household head.

We first examine the effects of tariff reduction on individual wages. Consistent with the existing literature, we find strong evidence that workers in those regions that initially specialized in industries facing larger tariff cuts experienced relatively larger wage declines. A one-percentage-point reduction in the regional tariffs is associated with a relative wage decline of 1.8 percent.

Using the same methodology, we investigate a series of outcomes to show how households respond to the adverse labor markets shocks caused by tariff cuts. First of all, the labor supply of family members increased, especially for women and the elderly. This pattern supports the "added worker effect" noted in the labor economics literature, in which the labor supply of wives responds to the wage shocks of husbands (Lundberg, 1985; Hyslop, 2001; Stephens, 2002; Blundell et al., 2016). We also observe that labor supply decreased in the tradable sector but increased in the non-tradable sector, suggesting a reallocation of labor between these two sectors. Such sectoral reallocation pattern is consistent with Dix-Carneiro (2014) and Dix-Carneiro and Kovak (2019).[3]

In addition, we find that regional tariff reduction is associated with a relative increase in the probability of young adults to co-reside with their parents. This finding supports Kaplan (2012), who argues that the option of co-residing with parents provides adult children with a valuable insurance channel against labor market risks due to reduced living costs and shared public goods. On average, a one-percentage-point regional tariff cut increases the probability of parental co-residence by 0.5 percentage points. The parental co-residence incidence rate increased only among households whose heads are parents aged 50 years and above, suggesting that it is the children who move to live with their parents and not vice versa.

To examine the role of saving, we investigate household income and consumption, and find that a one-percentage-point regional tariff reduction decreases household income and consumption per capita by 1.2 percent and 1.0 percent, respectively. The smaller effects on consumption suggest that households lower their saving rate to buffer the adverse income shocks.

Meanwhile, we do not find evidence that households in regions with larger tariff cuts received more transfer payments from the government. As in many other developing countries, there was neither a complete welfare system nor a trade-adjustment assistance program in China during the sample period. In this case, the self-insurance provided by the aforementioned household behaviors – labor supply, coresidence and saving – may act as a substitute for the insufficient formal insurance provided by the government.

We present a back-of-envelope calculation to show to what extent the above-mentioned household behaviors buffer the impact of adverse labor market conditions caused by tariff declines. Specifically, the reduction of regional per capita wage income would be 15–30 percent larger had the labor supply not responded to the regional tariff cuts. Moreover, if saving rate was held constant, the reduction in consumption would be at least 15 percent larger. These suggest that the household behaviors serve as important insurance against trade-induced labor market shocks.

China's WTO accession is followed by a dramatic export expansion, which could be a confounding factor in our analysis. To deal with this problem, we explicitly control for the export in the regressions, using several popular measures of local export shock in the literature (Autor et al., 2013; Pierce and Schott, 2016; Aghion et al., 2018). In all these specifications, we find that our results are not affected by the inclusion of the export variables.

We conduct several additional robustness checks. First, to address the endogeneity issue of the tariff cuts, we use the maximum allowable tariff rates as an instrument for actual tariffs and find fairly consistent results. Second, to alleviate the concern about the potentially differential time trends across different regions, we plot the differences in the outcome variables between regions with larger and smaller tariff cuts over time and find that they present parallel trends before WTO entry. Further placebo tests suggest a rather weak correlation of pre-WTO changes in outcomes with the post-WTO tariff cuts in the local regions. Third, our estimates are also robust to including a wide range of control variables such as input tariffs, non-tariff barriers, FDI restrictions, consumption prices, minimum wages, housing prices, and privatization of the state-owned-enterprises (SOEs). Finally, to address the cross-region migration issue, we show that regional migration is not significantly driven by regional tariff cuts, and that our results are robust to restricting the sample to the households living in their current city since 2001.

This paper is related to the emerging literature on the regional impact of trade liberalization (Dix-Carneiro and Kovak, 2015, 2017, 2019; Edmonds et al., 2010; Hakobyan and McLaren, 2016; Kovak, 2013; Topalova, 2010). The negative wage effects of the tariff reduction are well documented for other developing countries such as India and Brazil. We present the similar evidence for the case of China, the largest trading nation in the world. More importantly, we extend the focus of interest to a wide range of household-level behaviors and outcomes. The results provide a systematic portrait of how households adjust to tariff liberalization and emphasizes the insurance role of households against the labor market shocks triggered by tariff liberalization. Such evidence complements the recent empirical studies on the impact of import competition on households, family, and risk sharing (Huber and Winkler, 2019; Keller and Utar, 2018; Autor et al., 2019).

We also contribute to the literature on the economic impact of China's trade liberalization in terms of the WTO accession. On the one hand, different from previous studies examining the effects on labor markets in other countries (Autor et al., 2013; Pierce and Schott, 2016; Utar, 2014), we investigate China's own labor market adjustments to this event and show that the adjustment costs of trade liberalization through tariff reduction are also pervasive. On the other hand, complementing to the literature on the impact of WTO entry on China itself (Brandt et al., 2017; Yu, 2015; Fan et al., 2015), which mostly focuses on firm-level outcomes, we explore household behavioral responses and outcomes.

Our findings are related to the established labor economics literature on how households respond to income shocks (Lundberg, 1985; Blundell et al., 2008, 2016; Kaplan, 2012; Gorbachev, 2016). We explore the adverse labor market conditions caused by tariff cuts as exogenous shocks and consistently find that household behaviors play an important role in insuring against trade risks.

The rest of the paper is organized as follows. Section 2 describes the data and provides graphical evidence. Section 3 introduces the empirical strategy and presents the main estimation results. Section 4 conducts several robustness checks. The final section concludes.

2. Data and descriptive evidence

2.1. Urban Household Surveys

Our analyses rely primarily on the Urban Household Surveys (UHS) conducted by China's National Bureau of Statistics. The data are collected over the course of the year. Households are asked to keep a record of their detailed income and expenditures every day, and that record is collected every quarter by a surveyor (NBS, 2006). For each household, the final data are aggregated at the year level. The UHS is the official source of the basic living indicators for urban households in

[3] However, sector switching is costly for workers. Dix-Carneiro (2014) estimates that the cost of switching sector is 1.4–2.7 times the annual wages.

China. The aggregated data of the UHS are published in the China Statistical Yearbook. The UHS chooses the sample cities using a stratified sampling method.[4] Moreover, the number of households across cities is proportional to each city's urban population (NBS, 2006). In Appendix Fig. A1, we can see a positive correlation between the number of observations in the UHS and the city's urban population size reported in the City Statistical Yearbook in 2008.

The UHS contains detailed individual-level information, including demographic characteristics such as gender, age, and education level, as well as employment information such as working status, occupation, sector, and wages.[5] It also provides information about household characteristics, household income, and consumption expenditure. Furthermore, the UHS reports the information on who is the head of the household and the relationship of each household member with the household head. Because the head of the household is defined as the person who plays the major role in financial decisions and household issues, this information enables us to investigate the household structure and to identify whether the household head lives with their children or parents. In the analyses, we only include household members aged 20 years and above. Unfortunately, the structure of the UHS does not allow us to track households over time. Consequently, we can only estimate the regional tariff effect with repeated cross-sectional data.

We have access to the UHS data of 18 provinces that cover 179 prefecture-level cities.[6] The selection of prefectures in the UHS is unlikely to be related to regional tariff exposure. To show this, we compare the tariff changes during 1998–2007 for the 179 prefectures in the UHS with other prefectures that are not. Tariffs fell by 7.2 percentage point for the UHS prefectures and 6.8 for the other prefectures. Regressing the tariff change against a dummy variable of UHS sample yields a coefficient of −0.004 which is not statistically different from 0.

Since China entered the WTO in December 2001, we use the data collected from 1999 to 2008. In total, our sample includes over 590,000 individuals and 210,000 households. The number of observations is not equally distributed between 1999 and 2008. There was a major reform of UHS in 2002. As a result, the total number of households jumped from 11,037 in 2001 to 25,812 in 2002. Our sample size is relatively stable during the pre-reform and post-reform years.

The UHS only covers urban residents, defined as the people with a local household registration permit (*hukou*), or the people with a non-local *hukou* but have lived in current city over 6 months (NBS, 2006). Rural migrants are not included in the UHS before 2002. After 2002, some rural migrants with a long-term domicile are included, but they are under-represented and only account for 0.6 percent of the observations in the UHS sample.[7]

Table 1 reports the summary statistics for the key variables during our sample period 1999–2008. Panel A shows the mean and standard deviation for the individual-level variables. About 71 percent of the individuals were working, among which 17 percent worked in the tradable sector while 53 percent worked in the non-tradable sector. However, for those aged below the government mandatory retirement age (i.e., 60 years old for men and 55 for women), the working proportion is 85 percent, which is much higher than that of the people aged above the retirement age.

At the household level, the average household size is slightly below 3, as shown in Panel B. We define a parental co-residence dummy at household level that equals 1 if adult children or their spouses live with their parents within the household at the time of survey. The incidence of parental co-residence is 31 percent on average. We further divide the sample by the age of household head. Among the households with a head aged over 50, almost half are cases of parental co-residence. By contrast, when the household head's age is below 50, the rate of parental co-residence is only 9 percent. In the sample, annual household income per capita is 11.2 thousand yuan, which is significantly higher than the annual consumption per capita of 7.4 thousand yuan. This implies an average saving rate of 28 percent.

Appendix Table A1 reports the summary statistics in 1999, 2002 and 2008. There are indeed substantial changes in some of the key variables between 1999 and 2008. Wages increased sharply and labor force participation rate dropped from 0.84 to 0.68 during this period. We further report the summary statistics by gender in Appendix Table A2. Average labor force participation rate over this period is 0.78 for men and 0.64 for women.

2.2. Regional tariff measure

The key independent variable in our subsequent analysis is the regional tariffs. We construct this variable for each prefecture city and year as follows:

$$Tariff_{ct} = \sum_{j \in \Omega_{Tr}} \lambda_{jc,1998-2001}\, \tau_{jt} \tag{1}$$

where subscripts c, j, and t represent city, industry, and year, respectively. τ_{jt} is the tariff rate of industry j in year t.[8] $\lambda_{jc,\,1998-2001}$ is the average share of industry j in tradable sector employment of city c during 1998–2001. The regional tariffs in earlier works such as Topalova (2010) include the non-tradable sector and sets the tariff changes in the non-tradable sector to zero. Kovak (2013) argues that when the price of non-tradable goods responds to the price changes of the tradable goods, a more theoretically consistent way of constructing the regional tariffs is to exclude the non-tradable sector and to calculate the employment weights using only the tradable sector.[9] Our results are consistent if we use different weighting schemes, such as employment weights in 2001 and the labor-share adjusted weights as in Kovak (2013).[10] We set the tariffs during 1998–2001 to be constant at the year average because the pre-WTO tariffs during 1998–2001 shows very little change and is more subject to endogeneity issues. However, as we will show later in the robustness check section, using the actual tariffs does not change our basic results.

We define each industry at the 4-digit Chinese Industry Classification (CIC) level (453 industries). To calculate these employment

[4] First, all cities are classified into three size categories based on their population. Second, cities within each category are ranked according to the level of wages. Third, they are then selected using a systematic sampling method.

[5] The UHS data provide detailed working status by separating the answers into 15 different categories including working in state-owned firms, working in private-owned firms, being self-employed, retired, house working, students, etc. Among those who are working, the data also provide sector of employment at 1-digit level, including 16 sectors, such as agriculture, mining, manufacturing, and various service sectors.

[6] The 18 provinces are the following: Beijing, Shanxi, Liaoning, Heilongjiang, Henan, Shaanxi, Gansu, Shandong, Shanghai, Jiangsu, Anhui, Zhejiang, Jiangxi, Hubei, Guangdong, Sichuan, Chongqing, and Yunnan. These provinces cover China's eastern, central, and western areas and accounted for 75% of China's urban population in 2008.

[7] We will discuss the impacts of migration on our estimation results in Section 4.

[8] We define a local labor market as a prefecture city. The majority of China's regional policies, including transportation planning, are conducted at the prefecture city level.

[9] Kovak (2013) assumes an inelastic labor supply. However, the shift-share structure of the regional shocks does not depend on this assumption. For example, Adao et al. (2019) assume a positive-sloping labor supply equation and showed that in equilibrium, both regional employment and wages will depend on the shift-share labor demand shocks.

[10] Results are shown in the robustness section. Another concern of using the initial weights is that an industry's employment share may change with tariff liberalization after WTO accession. In the results available upon request, we regress an industry's employment share in a city against the industry-level tariffs, and we find that the industry employment share does not vary systematically with tariffs. This is consistent with the ample evidence of a lack of labor reallocation across manufacturing industries in other developing countries (Goldberg and Pavcnik, 2007).

Table 1
Summary statistics.

	(1)	(2)	(3)
	Panel A: Individual level variables		
Sample	Full sample	Age	Age ≥ Retire age
Working (Yes = 1)	0.71	0.85	0.17
	(0.45)	(0.36)	(0.37)
Working at tradable sector (Yes = 1)	0.17	0.22	0.01
	(0.38)	(0.41)	(0.11)
Working at non-tradable sector (Yes = 1)	0.53	0.63	0.15
	(0.50)	(0.48)	(0.36)
Log (wage)	4.53	4.60	3.30
	(1.06)	(0.95)	(1.78)
Observations	591,063	470,623	120,440
	Panel B: Household level variables		
Sample	Full sample	HH head age	HH head age ≥ 50
Household size	2.95	3.03	2.84
	(0.83)	(0.63)	(1.01)
Parental co-residence (Yes = 1)	0.31	0.17	0.49
	(0.46)	(0.37)	(0.50)
Householdheadlivingwithadultchildren(Yes = 1)	0.26	0.09	0.48
	(0.44)	(0.28)	(0.50)
Householdheadlivingwithparent(s)(Yes = 1)	0.05	0.08	0.02
	(0.22)	(0.27)	(0.13)
Household income per capita (1000 yuan)	11.2	10.6	12.0
	(8.6)	(8.5)	(8.7)
Household consumption per capita (1000 yuan)	7.4	7.1	7.7
	(5.5)	(5.4)	(5.7)
Saving rate	0.28	0.27	0.30
	(0.25)	(0.25)	(0.26)
Observations	251,506	142,278	109,228

Note: Standard deviations in parentheses.

weights, we use the Annual Survey of Industrial Firms (ASIF) from the National Bureau of Statistics.[11] Tariff data between 1998 and 2007 come from China's Customs. The original data are at the HS 8-digit level. We map them to 4-digit CIC industries using a concordance table. Appendix Table A3 shows that tariff cuts vary substantially across industries. The largest tariff cuts occurred in industries such as beverage, furniture, tobacco and textile, while industries such as mining had almost no tariff changes.[12]

It should be noted that weighting the tariffs by local industry employment share only captures the potential labor market effects of tariffs. It ignores the effects of tariffs on consumption prices and thus the cost of living (Porto, 2006; Fajgelbaum and Khandelwal, 2016; Han et al., 2016). However, unless the consumption structure and production structure are systematically correlated across cities, we can still consistently estimate the impact of tariffs through the labor market channel. In the robustness section, we control for the consumption price effects by including a regional consumption-weighted tariffs.

Fig. 1 shows the median and various percentiles of the regional tariffs during 1998–2007. The median regional tariffs went down from 16 percent in 1998 to 9 percent in 2007, a 44 percent drop. The largest tariff cut occurred in 2002, the year immediately after China's WTO entry. Tariffs continued to decline in the next two years but remained almost unchanged afterwards. Same as the case in many other developing countries, the dispersion of tariffs also declined, as the cities with higher initial tariffs experienced larger tariff cuts.

According to Appendix Table A4, tariff cuts range from 1.2 percentage points in Qi Tai He City to 23.6 percentage points in Shi Yan City. Our map in Fig. 2 confirms the substantial geographical variation of tariff cuts across prefecture level cities. The large differences in regional tariff cuts provide valid variation for accurate identification. However, we do not find any visual pattern of tariff reduction between the coastal region and the inland region.[13]

2.3. Descriptive evidence

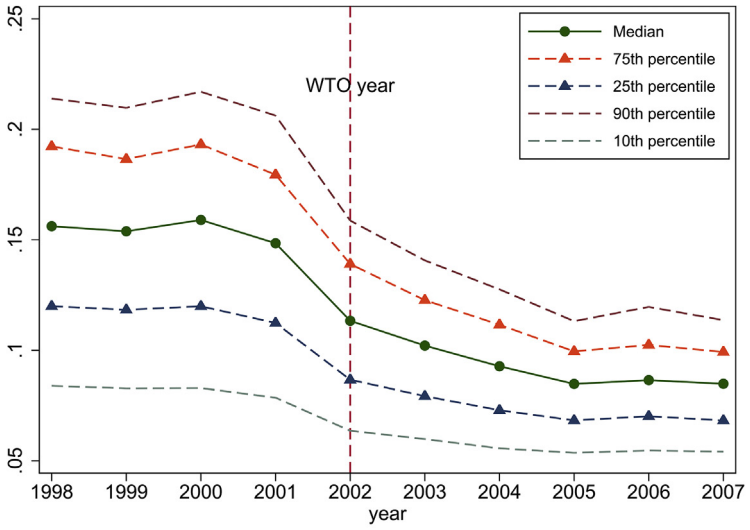
In this section, we provide descriptive analysis on the relationship between regional tariff cuts and the outcome variables, and the next section presents formal econometric analysis. We plot the city-level changes in outcome variables between 2002 and 2008 against the changes in regional tariffs between 2001 and 2007. A significant correlation provides suggestive evidence regarding the effects of regional tariffs. The outcome variables examined here include labor market outcomes such as wages, labor supply, household structure (including household size and parental co-residence), household income, and consumption per capita.

Wages It has been extensively established in the literature that trade liberalization measured by lower tariff rates affects labor market outcomes. We first examine the correlation between wage growth and

[11] The Annual Survey of Industrial Firms covers all state-owned firms and all non-state firms with sales revenue above 5 million Yuan in China's industrial sector, which includes mining, manufacturing and utilities. The firms in the survey accounted for 91% of China's aggregate output and 72% of aggregate employment in the industrial sector in 2004, a year during which we can compare the aggregates of the ASIF with the industrial census data. The data report the firm's city code, industry affiliation at the level of the 4-digit CIC classification, and total employment. We aggregate the data to the city-industry-year level to calculate the employment share used to construct the regional tariffs. In the robustness section, we also calculate the employment weights using the Third Industrial Census data in 1995, which covers all firms in the industrial sector.

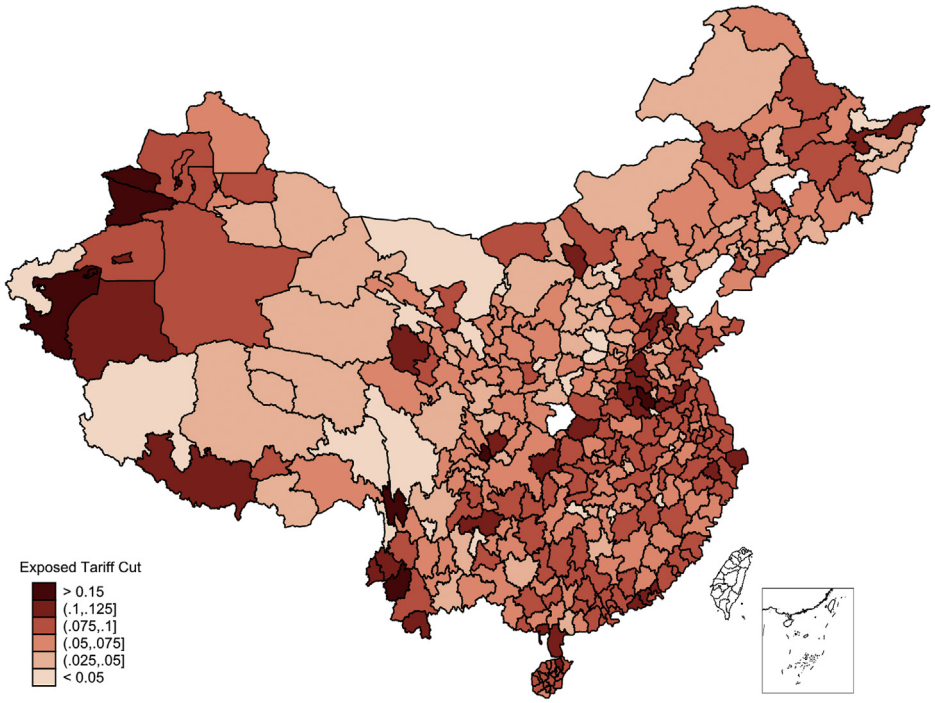
[12] In our sample, only 1% of the individuals work in the agricultural sector. We conduct a robustness check by adding the agricultural tariffs in our measure of regional tariff exposure. Including the agricultural sector does not change our main findings. The estimation results are available upon request.

[13] Appendix Fig. A2 shows the same map with the 179 prefectures in our UHS sample.



Data source: author's calculation based on Annual Survey of Industrial Firms (ASIF) and the tariff data from Chinese Customs.

Fig. 1. Regional tariffs by various percentiles (1998–2007).



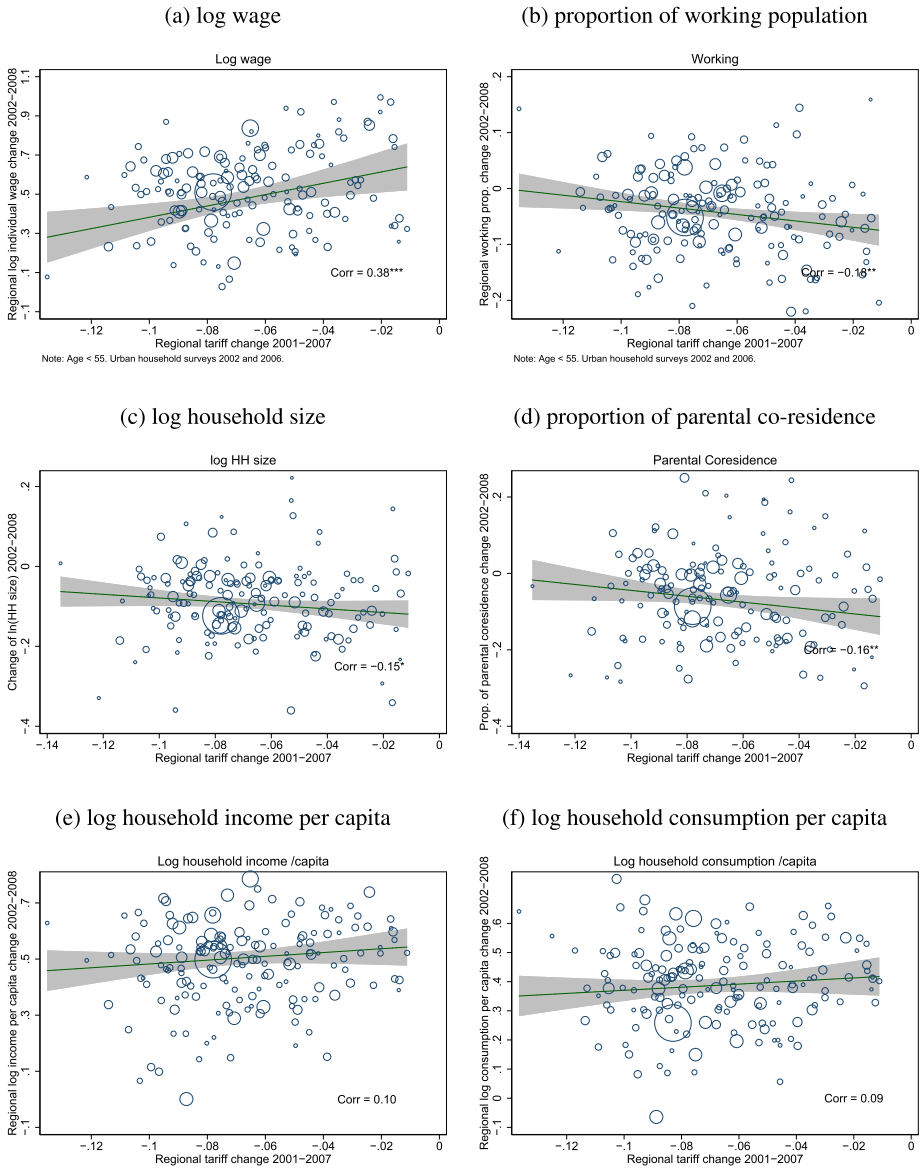
Data source: author's calculation based on Annual Survey of Industrial Firms (ASIF) and the tariff data from Chinese Customs.

Fig. 2. Geographical distribution of regional tariff cut between 1998 and 2007.

regional tariff changes. In Fig. 3(a), the circle area represents the sampling size of each city in the UHS data. We find that a larger regional tariff cut is associated with relatively lower wage growth. These results support the predictions of the existing trade models regarding the relationship between regional tariffs and wages (Kovak, 2013). They are consistent with the evidence found in other developing countries such as India and Brazil (Topalova, 2010; Kovak, 2013; Dix-Carneiro and Kovak, 2019). The findings are also consistent with Dai et al. (2020) who show that the regional tariff reduction could have long lasting negative effects on the job market entrants in China.

Labor Supply Although a strand of labor literature has documented that individual/household labor supply responds to income shocks (Hyslop, 2001; Blundell et al., 2016; Gorbachev, 2016), there is scarce evidence on how the labor supply responds to import tariff liberalization (Arkolakis and Esposito, 2014). In this study, we examine the impact of tariff reduction on the probability of working. We create a dummy variable for individual working status that equals 1 if the individual is working at the time of the survey and 0 otherwise.

From Fig. 3(b), interestingly, we find that larger tariff cut is associated with a larger proportion of working population. Generally speaking, tariff reduction lowers labor demand. However, it is also possible that people may increase their labor supply if a negative wage shock reduces reservation wage. For example, the female labor supply may increase in the event of negative wage shocks to the husband.



Notes: Each circle represents a city. Circle size represents sampling size of the city in the UHS sample. X-axis: regional tariff change between 2001-2007. Y-axis: the outcome change between 2002-2008. Data source: author's calculation based on UHS and tariff data.

Fig. 3. Correlations between Outcome Changes in 2002–2008 and Regional Tariff Change in 2001–2007.

Therefore, it is an empirical question how trade liberalization in terms of lower tariffs affects the proportion of people working. The pattern in Fig. 3(b) suggests that the labor supply effect dominates the labor demand effect. However, it is important to examine whose labor supply increased, and in which sector. We will try to answer this question in the next section.[14]

Household Size and Parental Co-Residence Young adults often need to decide whether to live with their parents. The literature on co-residence typically finds that the option to co-reside with parents provides important insurance against labor market risks (Kaplan, 2012). This is especially important in China, given the high parental co-residence rate. It is natural to expect that the income shocks induced by tariff cuts would also affect people's parental co-residence decisions.

We construct two variables to examine the co-residence decision. The first variable is log household size, defined as the number of family members aged above 20. The second variable is a co-residence dummy, which equals one if parents and adult children live in the same household.

Because of different living arrangement patterns between younger and older households, as shown in the summary statistics, we only include those households with heads aged 50 years or above. Among these households, larger regional tariff cuts are associated with relatively larger increases in household size and co-residence probability, as illustrated in Fig. 3(c) and (d), respectively. As a comparison, we conduct the analysis for the households with younger heads and do not find any significant correlation.

Household Income and Consumption We also examine the correlations of tariff cuts with household income and consumption per capita. The fitted lines in Fig. 3(e) and (f) indicate that the regional

[14] In an unreported regression, we find that the regional unemployment rate is not significantly affected by regional tariffs.

tariff reduction is associated with a decline in household income and consumption. The slope for household consumption is smaller, suggesting that households reduced their saving rate in order to smooth consumption.

Our descriptive analysis shows that households adjusted to the trade shocks in a variety of dimensions. However, such a simple correlation may not be sufficiently convincing, as there are many other confounding factors. In addition, in Fig. 3, we only use data from two years, and thus we should question whether the effects are consistent in the whole sample. We turn to more rigorous econometric analyses in the next section.

3. Econometric results

3.1. Empirical strategy

We estimate the following equation to investigate the effects of the regional tariffs[15]:

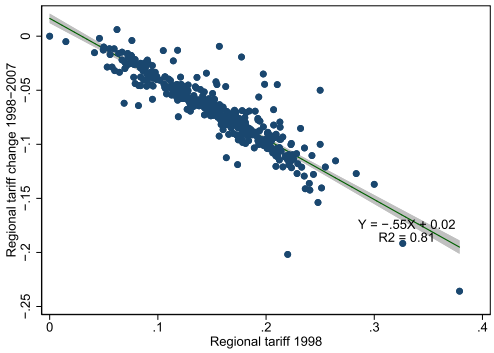
$$Y_{ict} = \alpha + \beta * Tariff_{c,t-1} + \gamma D(city_c, year_t, age_{it}, gender_i, educ_i) + \epsilon_{it} \quad (2)$$

We conduct the regressions at the individual or household level. The subscripts i, c, and t, represent individual or household, city, and survey year, respectively. The dependent variable is the interested outcomes mentioned above, such as wages, labor supply, household size, co-residence indicator, household income per capita, and household consumption per capita. $Tariff_{c,t-1}$ stands for the regional tariff level of city c in year $t-1$.[16] The coefficient, β, is of central interest because it captures the effects of the regional tariffs on outcome variables.

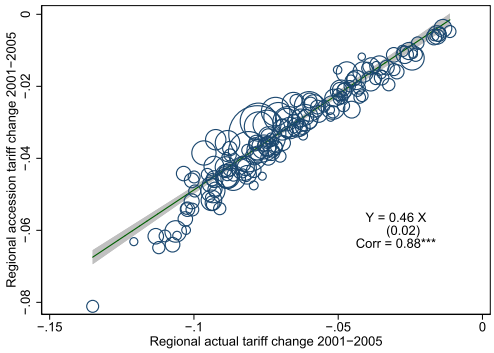
The covariates $D(.)$ is the temporal, geographical, and demographic control. For individual level regressions, it includes dummies of prefecture level cities, survey year, gender, and education level (junior high or below, senior high, and college or above). It also includes interactions between year and age to allow heterogeneity across birth cohorts. Moreover, we include gender dummy interactions with all the covariates to control for male-female differences. For household level regressions, we use the demographic characteristics of the household head. The standard errors are clustered at the city level.

Tariffs might be endogenous because of political considerations and contemporary economic conditions (Grossman and Helpman, 1994). This is not a major concern in the Chinese context because the Chinese government had very little policy discretion over the extent of tariff cuts in each industry. Tariffs across all tradable industries are required to be reduced to a certain level after a country enters the WTO. To visualize this, Fig. 4(a) plots the regional tariff changes between 1998 and 2007 and the initial tariffs in 1998, and it shows an almost one-to-one relationship between the two. In other words, the post-WTO tariff rates converged to the same low level regardless of the initial tariff level. Another concern is that the tariff changes or initial tariffs may be correlated with some key industry variables such as employment. In Appendix Table A5, we regress the initial tariffs in 1998 and tariff changes between 1998 and 2007 against the following industry level characteristics in 1998: share of the state-owned-enterprises (SOEs) in total sales, log total employment, log capital-output ratio, and log exports. In column (2) we further control for 2-digit industry fixed effects. The tariff changes do not seem to be strongly correlated with the initial industry employment.[17]

(a) Tariff Change vs. Initial Tariffs



(b) Change in Actual Tariffs vs. Change in Maximum Allowable Tariffs



Data source: author's calculation based on the tariff data from Chinese Customs.

Fig. 4. Relationship between actual tariffs and regional maximum allowable tariffs.

To further address the endogeneity issue, we follow Brandt et al. (2017) and use the maximum allowable tariff rate as an IV for the actual tariff rate. We then create an IV for the regional tariff rate using the pre-WTO employment share. China's WTO accession agreement specifies the entry tariff rate, target rate and target year, and most of these were determined in 1999. The entry rate is the tariff rate at the time of accession; the target rate is the reduced rate that must be achieved in the target year. Our IV assumes that after entry to the WTO, China could maintain the entry rate until it switched to the target rate in the target year.[18] Fig. 4(b) plots the maximum allowable tariff changes at the prefecture level against the changes in the actual tariff before and after the WTO entry; it shows a fairly strong positive correlation. In our paper, we provide estimation results from both OLS and two-stage least squares (2SLS).

Another issue is the anticipation of the WTO entry. It took a long time for the Chinese government to negotiate with other WTO members regarding its entry. It is possible that firms and households in China expected the tariff cuts before the country actually entered the WTO. We argue that this cannot be the first order issue in this study. First, if regions with larger tariff cuts formed accurate expectations and started

[15] Our baseline specification estimates a model in levels. As an alternative, we also estimate a long-difference model. The long difference model allows us to better study the long-term effects. But we can only estimate the model at the city level and can only use the data of two years. The estimation results shown in Appendix Table A12 are generally consistent with our baseline results in the paper.

[16] We lag the tariff variable by one year to alleviate the endogeneity concerns. The results are similar if we use contemporaneous tariffs.

[17] After the WTO accession, some local governments may use various policy tools to protect those industries that were more affected by the tariff liberalization. However, this concern tends to attenuate our estimates since these policies would weaken the negative impact of tariff cuts on the labor market. In other words, in the absence of these favorable government policies, we would find bigger negative impacts of tariff cuts.

[18] The accession tariff data are only available since 2002. We set the accession tariff during 1998–2001 as the 2002 value.

to adjust to the expected lower tariffs before the WTO entry, we would underestimate the effects by conducting regressions as in equation (2). Second, if firms and households started to alter their behaviors before the WTO entry, it is likely that the outcome changes before joining the WTO would be correlated with actual tariff cuts after 2002. However, we do not find significant evidence for this, as shown by our placebo tests in Section 4.

Two important points about the interpretation should be noted. First, because the constructed regional tariff measure captures the labor market effects, our empirical strategy identifies the impact of tariff cuts on outcomes through the labor market channel. Our estimation equation should be viewed as a reduced-form relationship between various individual or household outcomes and the wage shocks caused by a lower tariff. Second, since our identification is based on a difference-in-differences (DID) framework, the identified effects should be interpreted as relative effects across different regions rather than overall effects at the national level.

3.2. Effects on wages

We start our empirical analysis with the impact of tariff reduction on wages. We estimate equation (2) at the individual level. The dependent variable is log individual real yearly wage. Panel A presents the OLS estimation results. In column 1 of Table 2, we obtain a positive and significant coefficient of the regional tariff variable. The magnitude suggests that a one-percentage-point reduction in the regional tariff is associated with a 1.8 percent reduction in wages. During 1998–2007, the difference in the regional tariff changes between the cities in the 25th percentile and 75th percentile of the tariff change distribution is 4 percentage points. Based on our estimate, wage growth of the cities in the 25th percentile of the tariff change distribution is 7 percentage points (1.76∗0.04) lower than that of the cities in the 75th percentile during our sample period.[19]

In columns 2 and 3, we estimate the wage effects for workers in the tradable and non-tradable sectors separately. As expected, the effects are larger in the tradable sector, with a coefficient of 2.2. For the non-tradable sector, tariff cuts also lead to wage reduction, but the magnitude is only about two-thirds of that of the tradable sector. The significant wage effects in the non-tradable sector are consistent with the recent evidence documented for other countries such as Brazil and the US (Kovak, 2013; Hakobyan and McLaren, 2016; Dix-Carneiro and Kovak, 2019). The results also suggest that labor may reallocate between tradable and non-tradable sectors in response to trade reform, as we will show shortly. Panel B reports the 2SLS results. The previous conclusions still hold qualitatively, though the magnitude is a bit larger than the results from OLS.

To strengthen the validity of our wage results and explore the possible mechanisms underlying the wage adjustments, we use the Annual Survey of Industrial Firm to investigate the response of firms to tariff cuts. The details of data processing are reported in Appendix A1. We find that industries or regions with larger tariff cuts indeed experienced slower growth of firm-level wages. This corroborates our findings from the household survey data that regional tariff reduction reduced regional wages. To explore the underlying mechanism of the wage reduction, we further investigate other firm-level outcomes. The estimation results in Appendix Table A6 show that tariff reduction, either at the industry or regional level, is associated with declines in firm investment, sales and profit. In addition, using the same firm-level data as ours, Brandt et al. (2017) find that tariff reduction in China reduced output prices and markups of Chinese manufacturing firms. These findings are consistent with rent-sharing models in which changes in firm's markup and profitability transmit to changes in wages (Amiti and Davis, 2011).

3.3. Effects on labor supply

In column 4, the dependent variable is a dummy indicating whether an individual is working or not. In columns 5–6, we further distinguish whether the individual is working in the tradable or non-tradable sector. By construction, the coefficients in columns 5 and 6 add up to that in column 4.

Based on the estimate in column 4 of Panel A, we find that a one-percentage-point tariff reduction increases the probability of working by 0.42 percentage points. However, the effects are highly heterogeneous in the tradable and non-tradable sectors. The probability of working in the tradable sector decreases by 0.43 percentage points, while that in the non-tradable sector increases by 0.85 percentage points. Therefore, while regions with larger tariff reduction experienced relative increases in labor participation, the overall increase is composed of an employment contraction in the tradable sector and a larger offsetting employment expansion in the non-tradable sector. This employment shift may be due to either the reallocation of the existing workforce from the tradable sector to the non-tradable sector, or the net exit of workers from the tradable sector and net entry of new workers into the non-tradable sector.[20] The estimation results reported in Panel B with 2SLS show a similar pattern.

Our results in Table 2 mask important heterogeneous labor supply effect across age and gender groups. To investigate which segments of the population are more likely to show an increased labor supply in the case of a lower regional tariff, we estimate the labor supply responses for each gender and each age group (20–29; 30–39; 40–49; 50–59; 60+), and report the coefficient on regional tariff for each group in Table 3. First, from columns 1 and 2, we find stronger labor supply effect for females. The labor supply coefficients of females are 2–5 times larger than those of males, depending on the age group. This is consistent with the "added worker effect" described in the labor literature, in which wives' labor supply increases in response to husbands' negative wage shocks (Lundberg, 1985; Hyslop, 2001; Stephens, 2002; Gorbachev, 2016; Blundell et al., 2016). Second, the labor supply of the age 60+ men also increased, while we find no statistically significant effect for young men. Finally, the employment adjustment of males exhibits more "churning", that is, reallocation from the tradable to non-tradable sectors. This can be seen in columns 3 and 5. The contraction of tradable sector employment and the expansion of non-tradable sector employment are often of similar magnitude, leading to less net labor supply increase in column 1. For females, in contrast, labor supply adjustment is mainly characterized by new entry into the labor market, as can been from columns 4 and 6, where the employment expansion of the non-tradable sector is much larger than the employment contraction of the tradable sector, resulting in a large net entry in column 2.

Next, we examine the labor supply response of the couple and non-couple households. We split our sample into two parts. The first subsample includes all observations that have both husband and wife in the same household. We call it the "couple sample". Then the "non-couple sample" includes all other observations. We only include the working age sample (age¡60) to focus exclusively on the labor supply of husbands and wives. Panel A of Table 4 shows the OLS estimation results using the working dummy as the dependent variable, while in Panels B and C the dependent variables are dummies of "working at tradable sector" and "working at non-tradable sector," respectively. The

[19] We can also compare the impact of a 10% tariff cut with the aggregate wage growth between 1998 and 2007. A 10% tariff cut leads to a 0.176 log point decline in wages. Since the average wage growth during 1998–2007 is 134% (from 7800 to 18,300 yuan), the negative wage effect from the tariff cut is substantial.

[20] Existing works, such as Dix-Carneiro and Kovak (2019) and Costa et al. (2016), also find employment shifts from the tradable sector to the non-tradable sector in response to intensified import competition in the tradable sector.

Table 2
Effects of tariffs on wages and labor supply.

Dep. Var.	(1)	(2) Log (Wage)	(3)	(4) Working (Yes = 1)	(5) Tradable sector (Yes = 1)	(6) Non-tradable sector (Yes = 1)
Sample	Full sample	Tradable	Non-tradable	Full sample		
Panel A: OLS						
$Tariff_{c,t-1}$	1.76***	2.22***	1.45***	−0.42***	0.43**	−0.85***
	(0.47)	(0.77)	(0.42)	(0.14)	(0.18)	(0.21)
Observations	379,389	95,205	282,225	591,063	591,063	591,063
R-squared	0.35	0.36	0.36	0.53	0.12	0.28
Panel B: 2SLS						
$Tariff_{c,t-1}$	2.67***	3.05***	2.47***	−0.59***	0.29	−0.88***
	(0.74)	(0.90)	(0.72)	(0.18)	(0.21)	(0.24)
Observations	379,389	95,205	282,225	591,063	591,063	591,063
R-squared	0.35	0.36	0.36	0.53	0.12	0.28
Controls in both panels						
Basic controls	Yes	Yes	Yes	Yes	Yes	Yes
Clusters	179	179	179	179	179	179

*Notes: Panel A and Panel B report estimation results with OLS and 2SLS, respectively. Columns 2 and 3 only include workers in the tradable sector (manufacturing and mining) and workers in the non-tradable sector, respectively. Basic controls include dummies of city, year, gender, education level, interactions between year and age, and interactions between gender and all covariates. Standard errors in parentheses are clustered at the city level. ***p < 0.01, **p < 0.05, *p < 0.1.*

Table 3
Labor supply adjustments across gender and age groups.

Dep. Var.	(1) Working or not		(2) Working at tradable sector		(3) Working at non-tradable sector	
Sample	Male	Female	Male	Female	Male	Female
Panel A: OLS						
20–29	−0.42	−1.23***	0.15	−0.13	−0.57	−1.10**
	(0.53)	(0.45)	(0.40)	(0.33)	(0.48)	(0.47)
30–39	−0.10	−0.59**	0.30	0.11	−0.40	−0.69
	(0.13)	(0.25)	(0.40)	(0.39)	(0.40)	(0.45)
40–49	−0.13	−0.76**	0.60	0.64	−0.73**	−1.40***
	(0.12)	(0.31)	(0.38)	(0.47)	(0.35)	(0.42)
50–59	−0.03	−0.45	0.48	−0.02	−0.51	−0.43
	(0.46)	(0.44)	(0.44)	(0.20)	(0.46)	(0.41)
60+	−2.39***	−1.08***	−0.06	0.02	−2.33***	−1.10***
	(0.72)	(0.41)	(0.09)	(0.03)	(0.71)	(0.41)
Panel B: 2SLS						
20–29	−0.31	−0.98***	0.19	−0.03	−0.50	−0.95***
	(0.45)	(0.33)	(0.33)	(0.27)	(0.40)	(0.33)
30–39	−0.11	−0.49***	0.57*	0.32	−0.68**	−0.81*
	(0.09)	(0.19)	(0.33)	(0.34)	(0.32)	(0.41)
40–49	−0.03	−0.55**	0.89***	0.67	−0.92***	−1.22***
	(0.10)	(0.24)	(0.32)	(0.41)	(0.30)	(0.37)
50–59	−0.21	−0.26	0.76**	0.05	−0.97***	−0.30
	(0.34)	(0.34)	(0.37)	(0.16)	(0.34)	(0.32)
60+	−1.48***	−0.61**	−0.07	0.04	−1.41***	−0.65**
	(0.49)	(0.31)	(0.06)	(0.03)	(0.49)	(0.31)

*Notes: Panel A and Panel B report estimation results by gender and age group with OLS and 2SLS, respectively. Basic controls include dummies of city, year, gender, education level, interactions between year and age, and interactions between gender and all covariates. Standard errors in parentheses are clustered at the city level. ***p < 0.01, **p < 0.05, *p < 0.1.*

labor supply patterns of the couple sample in columns 1–3 are similar to those reported in Table 3. In contrast, in column 6 we don't observe the "added worker effect" for the women in the non-couple sample where women are single or live separately from their husbands. Moreover, the heterogeneous effects on the tradable and non-tradable sectors also disappear in the non-couple sample. In sum, Table 4 provides some suggestive evidence that the female labor supply effect is indeed intra-household adjustment.

To provide more direct evidence, we investigate how the regional tariffs affect the labor supply arrangement within households. The dependent variables are household level dummies for the following four scenarios: both husband and wife working, only husband working, only wife working, and neither working. As shown by the estimation results in Table 5, a larger regional tariff cut is associated with fewer households with only husband working and more households with both husband and wife working, suggesting that more wives participated in the workforce when facing a larger regional tariff cut. Our results are in contrast with the findings in Keller and Utar (2018). They discover that when facing import competition, Danish women are more likely to leave the labor force and focus on family. The "added worker effect"

Table 4
Labor supply adjustments by couples and non-couples.

Sample	(1)	(2) Couple Sample (Age<60)	(3)	(4)	(5) Non-Couple Sample (Age<60)	(6)
	All	Male	Female	All	Male	Female
Panel A: Working (Yes = 1)						
$Tariff_{c,t-1}$	−0.26**	−0.08	−0.43**	0.05	0.23	0.01
	(0.11)	(0.09)	(0.17)	(0.42)	(0.77)	(0.45)
Observations	390,427	189,524	200,903	11,881	2797	9084
R-squared	0.34	0.16	0.33	0.41	0.34	0.40
Panel B: Working at tradable sector (Yes = 1)						
$Tariff_{c,t-1}$	0.63***	0.83***	0.44*	0.23	−0.77	0.45
	(0.24)	(0.25)	(0.25)	(0.50)	(1.29)	(0.54)
Observations	390,427	189,524	200,903	11,881	2797	9084
R-squared	0.10	0.07	0.10	0.23	0.27	0.18
Panel C: Working at non-tradable sector (Yes = 1)						
$Tariff_{c,t-1}$	−0.89***	−0.91***	−0.87***	−0.18	1.00	−0.44
	(0.24)	(0.25)	(0.27)	(0.58)	(1.24)	(0.66)
Observations	390,427	189,524	200,903	11,881	2797	9084
R-squared	0.14	0.09	0.17	0.27	0.30	0.26
Controls in all panels						
Basic controls	Yes	Yes	Yes	Yes	Yes	Yes
Clusters	179	179	179	179	179	179

Notes: Columns 1–3 are based on the couple sample and columns 4–6 on the non-couple sample. The dependent variables in Panel A, B, and C are dummy variables for working, working at tradable sector, and working at non-tradable sector, respectively. All columns are estimated by OLS. Basic controls include dummies of city, year, gender, education level, interactions between year and age, and interactions between gender and all covariates. Standard errors in parentheses are clustered at the city level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

discussed in our paper is weak in Denmark probably because Denmark is a high income country and the government provides generous social safety programs.

We also examine how the increase in wife's labor supply is related to the fall in husband's wages. We group all households into different subsamples according to the age and education level of the household head (3 educational groups ∗ 6 age groups). The idea is to split all households into subsamples by exogenous household characteristics. For each subsample, we run two separate regressions. We first regress the log of husband's wage against tariffs and obtain the coefficient of tariffs. The coefficients are interpreted as the impacts of tariff on husband's wages. Then we regress a "both working" dummy (equal to one if both husband and wife are working) against tariffs and obtain the coefficient again. These coefficients are then interpreted as the impacts on female labor supply. For the 18 subsamples, we plot the coefficients of tariffs in the two regressions against each other and check whether there is any systematic pattern across household groups. The negative correlation in Fig. 5 suggests that the subsamples with larger reduction of husband wages saw stronger increases in the labor supply of wives. By doing so, we provide additional evidence of the "added-worker effect" in which wives increase their labor supply when their husbands face adverse labor market conditions.

The aforementioned results on labor supply have several important implications. First, our results suggest that changes in wage reduction and labor supply should be considered together. For example, wage reduction in the non-tradable sector may be caused not only by lower prices, as suggested in previous literature (Kovak, 2013), but also by increased labor supply among the female population. It is important to distinguish between the two because the welfare implications are different. Second, changes in labor supply arrangements within households add an important dimension for understanding the effects of tariff reduction on regional employment. For example, if lower labor demand for males induced more females to enter the workforce, aggregate employment may increase in response to tariff cuts. Third, the increased labor supply has direct implications for understanding the impact of tariff liberalization on household income and consumption. Increasing labor supply is an important channel for household members to offset the adverse income shocks caused by import competition.

3.4. Effects on household size and parental co-residence

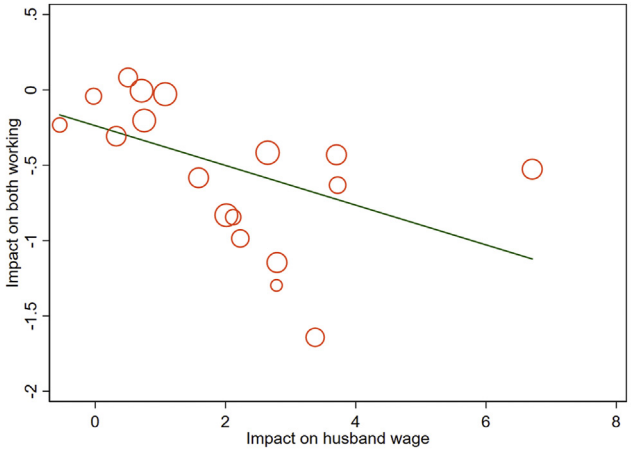
Table 6 reports the regression results for household structure on regional tariffs. Consistent with the pattern in Fig. 3(c) and (d), we find that a lower regional tariff is associated with a higher probability of parental co-residence as well as larger household size. According to the estimates of columns 1 and 4 in Panel A, a one-percentage-point regional tariff cut increases the probability of co-residence by 0.5 percentage points and increases household size by 0.27 percent. Therefore, cities in the 25th percentile of the tariff change distribution experienced a 2-percentage-point increase in co-residence probability relative to the cities in the 75th percentile during our sample period. Given that the average probability of co-residence is approximately 0.3, the effect of tariff cuts is not small. Considering different living arrangements between households with younger and older heads, in the next two columns, we split the sample into two groups based on whether the household head is aged 50 or above. We find that the impact of tariffs on household size and co-residence is much smaller in the households with a younger household head.

Because parental co-residence could refer to either a household head living with their children or with their parents, the last two columns distinguish between the two. The results suggest that a lower regional tariff only affects the co-residence of household heads and their adult children. As household heads are defined as those who play the major role in household decision making, more household heads living with

Table 5
Labor supply adjustments within household.

Dep. Var.	(1) Both working	(2) Only husband working	(3) Only wife working	(4) Neither working
Mean of dep. Var.	0.748	0.182	0.027	0.043
Panel A: OLS				
$Tariff_{c,t-1}$	−0.55***	0.45***	0.03	0.06
	(0.20)	(0.16)	(0.06)	(0.06)
Observations	192,247	192,247	192,247	192,247
R-squared	0.29	0.14	0.04	0.21
Panel B: 2SLS				
$Tariff_{c,t-1}$	−0.72***	0.71***	−0.05	0.06
	(0.26)	(0.22)	(0.06)	(0.09)
Observations	192,247	192,247	192,247	192,247
R-squared	0.29	0.14	0.04	0.21
Controls in both panels				
Basic controls	Yes	Yes	Yes	Yes
Clusters	179	179	179	179

*Notes: Panel A and Panel B report estimation results with OLS and 2SLS, respectively. The sample is composed by the households with head's age below 60. Basic controls include dummies of city and year, and household head characteristics including dummies of gender, education level, interactions between year and age, and interactions between gender and all covariates. Standard errors in parentheses are clustered at the city level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.*



Notes: Each dot represent an age-education group. X-axis: Coefficient of regressing log husband's wage against tariffs. Y-axis: Coefficient of regressing a "both working" dummy against tariffs. See text for details.

Fig. 5. Correlation between Labor Supply Effects and Wage Effects.

their adult children suggests that it is the children who move to co-reside together with parents, not vice versa. Therefore, these results suggest that young people are more likely to stay in their parents' home when facing tougher labor market conditions induced by tariff reduction.

However, we need to consider other possibilities. For example, fertility behaviors may be affected by tariff liberalization. Young couples may move to live with their parents so that the elderly can help care for grandchildren. Although we cannot rule out all the other possibilities, we try to further clarify this issue by investigating how the regional tariffs affect the age structure. The results presented in Appendix Table A7 suggest insignificant effects on the proportion of those aged below 16 in households. Meanwhile, a lower regional tariff leads to a lower proportion of those aged over 60, which is consistent with our hypothesis that more adult children co-resided with their parents.

It should be noted that the effects of tariff liberalization on household structure is related to the consumption effects. Co-residing with parents has the benefits of reducing per capita housing costs and sharing public goods within the parental home. Therefore, consumption demand per capita of the household may fall. This observation is especially important when interpreting the results. For example, the lower consumption per capita shown in Fig. 3(f) could be caused by the co-residence induced lower consumption demand. Out of this consideration, in the next section, when we discuss the effects on household income and consumption, we provide results with and without household structure controls (including size, co-residence, and age structure).

3.5. Effects on household income, consumption, and saving

We estimate how household income and consumption respond to tariff reduction in Table 7. In the first two columns, we regress log real household income per capita against regional tariffs. We find a coefficient of 1.17 in column 1 of Panel A, which is smaller than the wage effects in Table 2 (the coefficient for wage effects is 1.76). Columns 3

Table 6
Effects of tariffs on household size and parental Co-residence.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. Var.	Log (Household size)			Parental co-residence (Yes = 1)			Head with children	Head with parents
Sample	Full sample	HH head age < 50	HH head age ≥ 50	Full sample	HH head age < 50	HH head age ≥ 50	HH head age ≥ 50	HH head age ≥ 50
Panel A: OLS								
$Tariff_{c,t-1}$	−0.27**	−0.12	−0.54**	−0.50**	−0.19	−1.09**	−1.13**	0.03
	(0.13)	(0.11)	(0.25)	(0.24)	(0.18)	(0.50)	(0.50)	(0.05)
Observations	251,492	142,264	109,228	251,492	142,264	109,228	109,228	109,228
R-squared	0.11	0.10	0.08	0.21	0.14	0.09	0.09	0.03
Panel B: 2SLS								
$Tariff_{c,t-1}$	−0.35**	−0.24*	−0.50*	−0.35	−0.16	−0.79*	−0.86*	0.08
	(0.15)	(0.13)	(0.29)	(0.26)	(0.20)	(0.48)	(0.48)	(0.08)
Observations	251,492	142,264	109,228	251,492	142,264	109,228	109,228	109,228
R-squared	0.11	0.10	0.08	0.21	0.14	0.09	0.09	0.03
Controls in both panels								
Basic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clusters	179	179	179	179	179	179	179	179

Notes: Panel A and Panel B report estimation results with OLS and 2SLS, respectively. Columns 2 and 5 include households whose household head are aged below 50. Columns 3 and 6 include households whose household heads are aged 50 or above. Basic controls include dummies of city and year, and household head characteristics including dummies of gender, education level, interactions between year and age, and interactions between gender and all covariates. Standard errors in parentheses are clustered at the city level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

and 4 estimate the consumption effects, with log real household consumption per capita as the dependent variable. Column 3 in Panel A shows a positive coefficient of 1.03. As expected, a regional tariff cut leads to a relative decline in household consumption per capita through the labor income channel. In summary, the magnitude of the consumption effects is much smaller than that of the wage effects, and it is also smaller than the household income effects.

By definition, saving equals income minus consumption. The difference between income effect and consumption effect implies that households must have reduced their saving rate in order to smooth consumption. In the last two columns, we find that the saving rate declines in response to tariff cuts, although the estimated coefficients are only statistically significant with 2SLS.

3.6. Effects on government transfers

In principal, government can help individuals smooth the trade-induced adverse income shocks through transfer payments and social safety networks. Although China does not have the trade-adjustment assistance programs like those in the United States, in this paper we consider two related government programs - subsistence allowances and unemployment allowances.[21] These two programs could potentially help offset the adverse income shocks induced by tariff liberalization. In our sample, only 4% of households are subject to the subsistence allowances and 3% are subject to the unemployment allowances. Conditional on receiving the transfers, the average yearly value of subsistence allowances and unemployment allowances per capita is 540 and 570 yuan, accounting for 6.3% and 6.4% of the total household income, respectively. These simple statistics suggest that it is not likely that these transfer schemes will fully insure all households against trade-induced adverse income shocks.

We first investigate how regional tariffs affect the probability of receiving subsistence allowances and unemployment allowances. We report the results with and without household structure controlled for. The results in Table 8 suggest that neither probability is significantly affected by tariff cuts. We then examine the intensive margin by regressing the log value of transfers per capita against regional tariffs for those households with positive government transfers. We do not find any evidence that tariff cuts increased the value of transfers. On the contrary, in some cases transfer income decreased with regional tariffs, though the significance is somewhat sensitive to the estimation methods.[22] It should be noted that only a very small proportion of households are subject to the subsistence and unemployment allowances. Thus, the sample sizes for the intensive margin regressions are small and the significance and the magnitudes of the coefficients should be viewed with caution.

The lack of government transfers further highlights the importance of the household behaviors documented in our study. For many developing countries, the welfare systems are still underdeveloped. Our results suggest that when the government cannot provide sufficient formal insurance to the trade shocks, the self-insurance provided by households may act as a major substitute.

We also investigate other incomes and expenditures in the appendix. Appendix Table A8 shows the estimation results of the private transfer income. Appendix Table A9 examines the effect of tariff cuts on household-level borrowing and lending, as households can also insure against negative income shocks by borrowing more from or lending less to other households. However, we do not find any significant evidence

[21] The subsistence allowances targets low-income people to maintain a minimum subsistence-level living standard.

[22] One explanation for the reduced transfer income is that regional tariff cuts may reduce local fiscal revenue by shrinking business activities that are sources of taxes, and the local government respond by cutting social welfare expenditures, as documented by Feler and Senses (2017) for the United States.

Table 7
Effects of tariffs on household income, consumption and savings.

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Var.	Log (Household income per capita)		Log (Household consumption per capita)		Saving rate	
Panel A: OLS						
$Tariff_{c,t-1}$	1.17***	1.05***	1.03***	0.90***	0.07	0.08
	(0.36)	(0.36)	(0.33)	(0.32)	(0.12)	(0.12)
Observations	251,492	251,492	251,492	251,492	251,492	251,492
R-squared	0.42	0.47	0.36	0.42	0.07	0.07
Panel B: 2SLS						
$Tariff_{c,t-1}$	1.58***	1.42***	1.08**	0.91*	0.31**	0.32**
	(0.55)	(0.54)	(0.51)	(0.50)	(0.15)	(0.15)
Observations	251,492	251,492	251,492	251,492	251,492	251,492
R-squared	0.42	0.47	0.36	0.42	0.07	0.07
Controls in both panels						
Basic controls	Yes	Yes	Yes	Yes	Yes	Yes
Household structure	No	Yes	No	Yes	No	Yes
Clusters	179	179	179	179	179	179

*Notes: Panel A and Panel B report estimation results with OLS and 2SLS, respectively. Basic controls include dummies of city and year, and household head characteristics including dummies of gender, education level, interactions between year and age, and interactions between gender and all covariates. Standard errors in parentheses are clustered at the city level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.*

of these practices.[23]

3.7. Discussion

The previous analysis shows that households would increase their labor supply, enlarge their household size, and reduce their saving rate to offset the adverse effects of tariff cuts. This section attempts to answer a natural question: how much do these responses matter? We gauge the impacts of these behavioral responses through some simple back-of-envelope calculations.

Labor Supply Table 2 suggests that a one-percentage-point increase in the regional tariff leads to a 0.42 percentage point increase in the labor supply and a 1.8 percent decrease in wages. Because on average 71 percent of individuals are working, and the mean level of the tariff cut is 7 percentage points, the reduction of the regional total wage income caused by the tariff cut is $-0.06w_0$, where w_0 is the initial wage for the working people.[24] By contrast, if we hold the labor supply and other parameters constant, the reduction of the regional total wage income caused by the tariff cut would be $-0.09w_0$.[25] Therefore, the increased labor supply would offset the negative income shocks by 30 percent. However, this is an upper-bound estimate because we assume that the wage decline remains the same even if labor supply does not increase. We can further relax this assumption by setting the wage elasticity with respect to the labor supply to −0.5, which is larger than most estimates in the labor literature (Card, 2005; Borjas and George, 2009) and thus yields a lower bound estimate. With this assumption, the increased labor supply would offset the effects on regional wages by 15 percent.

Parental Co-Residence Part of the effects of tariffs on consumption should be explained by the larger household size and higher probability of parental co-residence. Columns 3 and 4 in Table 7 show that the coefficients on household consumption become 13–16 percent smaller after controlling for household structure. We argue that this could be a meaningful index: the larger the proportion of the effects on consumption absorbed by co-residence, the more consumption reduction is caused by the sharing of housing costs and public goods in the parental home, buffering the negative effect of tariff cuts on the consumption of private goods. However, because consumption is recorded at the household level rather than individual level and the costs of co-residence – such as reduced privacy – are hard to measure, it is difficult to quantitatively determine – in a reduced form framework – the extent to which parental co-residence offsets the utility loss due to income shocks.

Saving As shown in Table 7, the coefficients of log consumption are smaller than those of log income. By construction, if saving rate were held constant, the coefficient of consumption would be equal to the coefficient of income. Therefore, the estimates suggest that 13–35 percent of the impact of income shocks on consumption could be offset by the reduction of savings.

4. Pre-trends, export, and other robustness checks

4.1. Pre-trends examination

Our main identification is based on the variation in regional tariffs across cities over time. Unbiased estimation of the difference-in-differences framework requires that the time trends of outcome variables in regions with larger tariff cuts would be parallel with those in other regions if China had not lowered tariffs. However, this may not be taken for granted. For example, if individual wages are expected to fall relatively because of unobserved factors that are correlated with regional tariff cuts, our estimates would overestimate the effects of regional tariffs. To check this possibility, we conduct the pre-trends examinations as follows.

First, we use the UHS data for the pre-WTO period (i.e., 1997–2001), calculate the changes in outcome variables at the city level between 1997 and 2001, and then plot these changes against the post-WTO tariff changes between 2001 and 2007. The outcome variables include wages, labor supply, household size, parental co-residence, household income per capita, and household consumption per capita. It would be a concern if the outcome changes in the pre-WTO period are systematically correlated with the tariff cuts in the post-WTO period. Fig. 6 shows that there is no such pattern for these outcomes. The correlations between the pre-WTO outcome changes and the post-WTO tariff

[23] In our sample, wages account for 66% of total income. The non-wage income includes pensions, housing allowance, household business income, subsistence allowance, unemployment allowance, private transfer income, and financial income such as interest revenue. To see the impacts of tariff cuts on the non-wage income as a whole, we run the same wage regression with the non-wage income as the dependent variable. We obtain a coefficient of 1.09. It is, however, not statistically significant. It seems that the tariff cut also affects the non-wage income, but not as much as the wage income.

[24] This is calculated by $[(1 - 1.8^*0.07)w_0{}^*(0.71 + 0.42^*0.07) - 0.71w_0]$.

[25] This is calculated by $[(1 - 1.8^*0.07)w_0{}^*0.71–0.71w_0]$.

Table 8
Effects of tariffs on household received public transfer income.

Dep. Var.	(1) Received government subsistence allowance	(2)	(3) Log (Government subsistence allowance/capita)	(4)	(5) Received unemployment allowance	(6)	(7) Log (unemployment allowance/capita)	(8)
Mean of Dep. Var	0.043		1.01		0.028		1.23	
Panel A: OLS								
$Tariff_{c,t-1}$	0.06	0.06	3.02	2.72	0.14	0.15	8.78**	8.74**
	(0.08)	(0.08)	(2.07)	(2.06)	(0.11)	(0.11)	(4.26)	(4.30)
Observations	218,819	218,819	9373	9373	218,819	218,819	5952	5951
R-squared	0.04	0.19	0.26	0.81	0.04	0.14	0.26	0.83
Panel B: 2SLS								
$Tariff_{c,t-1}$	0.11	0.10	6.34**	5.99**	0.22	0.22	7.36	6.96
	(0.15)	(0.15)	(3.00)	(2.92)	(0.16)	(0.16)	(5.66)	(5.76)
Observations	218,819	218,819	9373	9373	218,819	218,819	5952	5951
R-squared	0.04	0.19	0.26	0.81	0.04	0.14	0.26	0.83
Controls in both panels								
Basic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household structure	No	Yes	No	Yes	No	Yes	No	Yes
Clusters	166	166	164	164	166	166	135	135

Notes: Panel A and Panel B report estimation results with OLS and 2SLS, respectively. Basic controls include dummies of city and year, and household head characteristics including dummies of gender, education level, interactions between year and age, and interactions between gender and all covariates. Standard errors in parentheses are clustered at the city level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

changes are rather weak. These results suggest that the outcome trends between larger tariff cut cities and other cities would not significantly differ had there not been WTO accession.

Second, we further investigate the pre-trends by examining how the outcome difference between the cities with different tariff exposure evolves over time. Specifically, we create a dummy variable indicating whether the regional tariff cut is large or small according to the median of the regional tariff reduction. We regress the outcome variables against the interaction between this dummy variable and the year dummies, and plot the coefficient for each year in Fig. 7. The coefficients reflect the outcome difference between the large tariff cut regions and the small tariff cut regions in each year compared to the reference year (1999). We can see that the patterns we documented in the previous sections only occurred after WTO entry. For example, wages, household income and consumption started to fall in the large tariff cut regions relative to other regions only after 2002. Similarly, labor supply, co-residence and household size started to rise only after 2002. This further precludes the possibility of spurious pre-trends in driving our results.

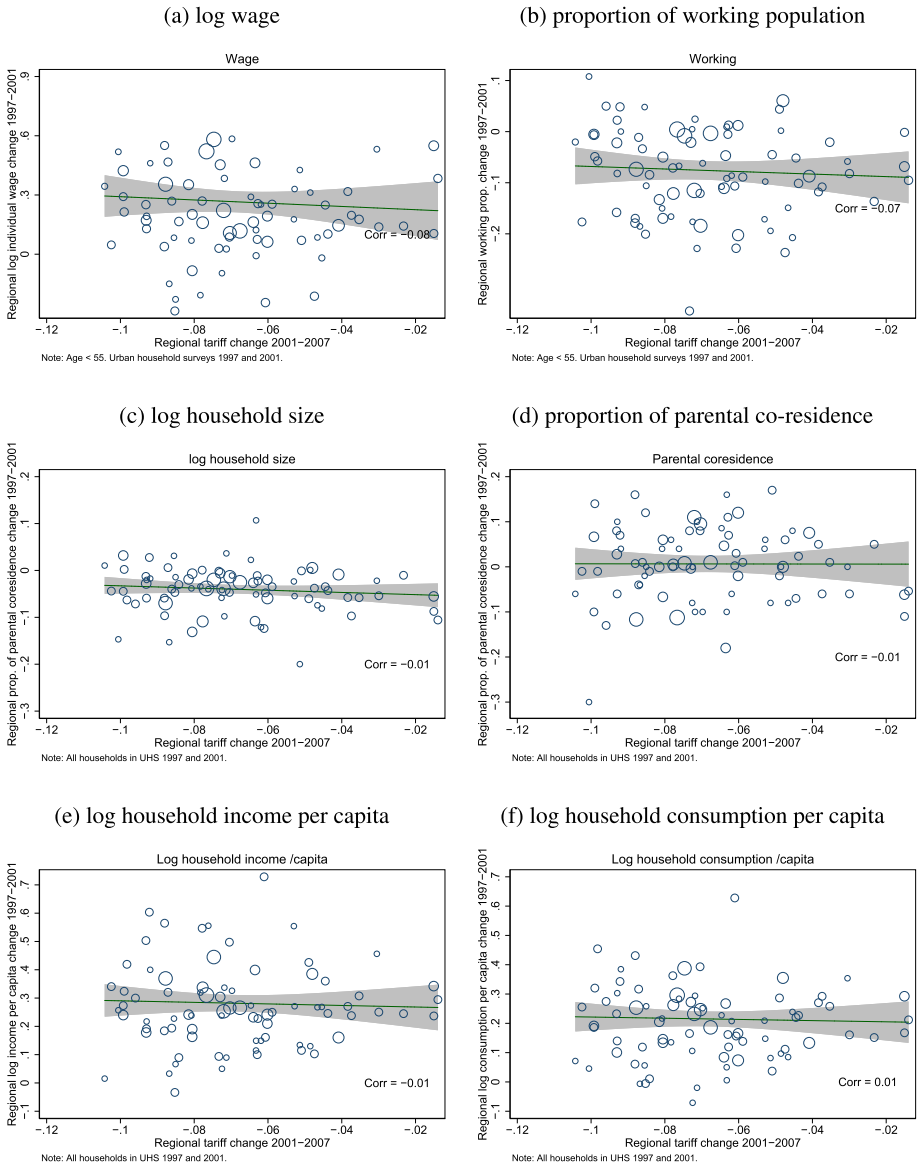
4.2. Local export shocks

China's WTO entry is also associated with a remarkable export boom. While the focus of our study is on the impact of tariff reduction and the resulting import competition, we may need to explicitly control for the impacts of exports. If regional export growth correlates with tariff reduction, our previous estimates on the impacts of tariff reduction may be biased.

We provide four alternative measures to capture the regional export shocks. All details of the data construction are described in Appendix A2. First, we construct a Bartik-type city-level export measure following Autor et al. (2013). This variable computes regional weighted averages of industry-level exports *per* worker, weighted by the industry's initial share of regional employment. Second, we directly control for the city's log total exports. Third, previous studies have found that tariff uncertainty reduction resulting from the US granting permanent normal trade relations (PNTR) to China after China's WTO entry has substantially increased Chinese exports (Handley and Limao, 2017; Pierce and Schott, 2016). Our city-level NTR gap measures captures such export effects. In the regressions, we interact this variable with a post-WTO dummy that equals 1 for years later than (including) 2002. We expect the exports to grow faster in the post-WTO years in these regions facing larger pre-WTO NTR gap. Fourth, we follow Aghion et al. (2018) and construct a variable of city-level foreign demand shocks. This measure takes the regional weighted average of all China's export destination countries' import demand from the world (excluding the imports from China) at the country-product level, with the weights reflecting the initial-period importance of these exports in the regional total production.

We re-run our baseline regressions, including each of the four export measures one at a time. In Table 9, we report the results on wages, employment, household income per-capita, and other household behavior variables investigated in Section 3.

Two messages emerge from Table 9. First, including the export measures hardly affects our estimates of the impact of tariff reduction. Both the sign and the statistical significance of the regional tariff coefficient are unchanged. This suggests that our previous results are not driven by the correlation between regional tariff shocks and regional export expansions. In fact, the correlations between regional tariff and each of the four export shocks are quite low. The unconditional correlation coefficient between regional tariff cut and export growth is only 0.02. Second, as for the effects of exports, generally we find little impact of export expansions on regional wages, employment rate, and various household behaviors. Most coefficients of the export shocks are very small and statistically insignificant.



Notes: Each circle represents a city. Circle size represents sampling size of the city in UHS. X-axis: regional tariff change between 2001-2007. Y-axis: the outcome changes between 1997-2001.
Data source: author's calculation based on UHS and tariff data.

Fig. 6. Placebo Test: Correlation between Outcome Changes in 1997–2001 and Regional Tariff Changes in 2001–2007.

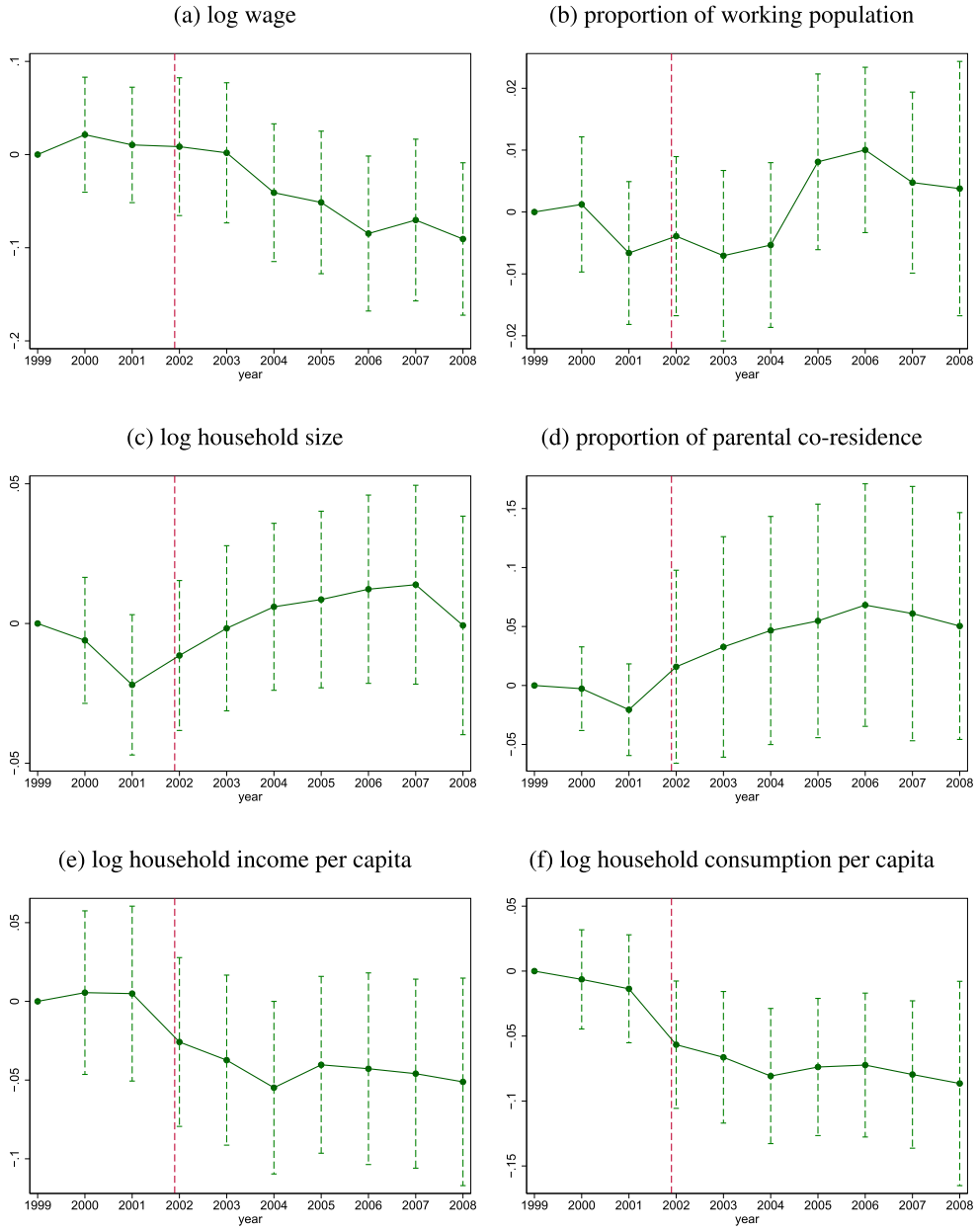
Our finding of a muted wage effect from the exports is not entirely surprising. In fact, it is consistent with recent studies on the impact of export expansion on China's regional labor market outcomes.[26] Regarding the employment effects of exports, existing studies using administrative aggregate data generally find positive and significant effects on local employment size (Cheng and Potlogea, 2017; Ouyang and Yuan, 2019). However, in this paper we can only study the employment rate, not total employment size because such investigation requires exactly consistent sampling rate across cities in the data. In fact, our finding of the lack of employment rate effect is consistent with other survey-based studies (e.g., Facchini et al., 2019; Crozet et al., 2018).[27]

4.3. Migration

A challenge to the regional approach in this paper is that labor may migrate across regions in response to trade shocks, thus arbitranging away any cross-regional wage differences. Another concern is that the migrant workers are under-represented in the UHS. We address the

[26] Cheng and Potlogea (2017), for example, uses city-level wage data from China's City Statistical Yearbook and find that improved market access to the U.S. have little effect on local wages during 1998–2007. Ouyang and Yuan (2019) reach similar conclusions using a slightly different identification strategy and combining wage data from multiple sources. Based on the household data from China Family Panel Studies (CFPS), Crozet et al. (2018) find that regional export expansions induced by improved foreign demand shocks have no significant effects on household income per-capita during 2010–2014.

[27] Note that the results on total employment and employment rate are not necessarily contradictory. This is because people may migrate to the cities with larger export expansions, increasing the total employment of those cities but not necessarily their employment rate.



Notes: We replace the tariff variable in equation (2) with a dummy variable for prefectures with larger tariff cuts and its interactions with year dummies, and report the corresponding coefficients and confidence intervals.
Data source: author's calculation based on the UHS and tariff data.

Fig. 7. Outcome Difference between Regions with Larger and Smaller Tariff Cuts, by Year.

migration issue in several ways. First, we only include those individuals who lived in their current city since 2001, and we conduct our baseline regressions on various outcome variables with this new subsample. The last row of Panel C in Table 10 shows that restricting the sample to people who lived in their current city since 2001 does not affect our conclusion about the effects of tariff cuts on the various outcomes.

Second, the UHS provides information on when the individual began living in their current location, which enables us to directly examine how the tariff affects the migration decision. Column 1 of Appendix Table A10 shows that whether an individual moved to their current city after 2002 is not significantly affected by the regional tariffs. Similarly, column 2 suggests that the regional tariff is not significantly correlated with whether an individual had a registration permit *(hukou)* different from their current city.

Third, using Chinese population census data in 2000 and 2005, we calculate the log change in the working age population in each city between 2000 and 2005 and regress it on the regional tariff changes between 1999 and 2004. Column 3 of Appendix Table A10 shows that the change in the working age population in the city is not significantly correlated with the regional tariff changes. Taken together, these results indicate that migration decisions are not affected by tariff shocks, and excluding migrants does not introduce significant changes to our baseline results.

Table 9
Consistent results after controlling for exports.

Dep. Var.	(1) Log wage	(2) Working	(3) Log HH size	(4) Parental co-residence	(5) Log (HH Income per capita)	(6) Log (HH consump. per capita)
Panel A: Regional exports per worker (ADH)						
$Tariff_{c,t-1}$	1.77***	−0.42***	−0.51**	−0.98**	1.18***	1.03***
	(0.47)	(0.14)	(0.23)	(0.40)	(0.36)	(0.33)
Regional exports (ADH)	−0.03	0.01	−0.02	−0.08	−0.02	0.01
	(0.02)	(0.01)	(0.02)	(0.05)	(0.02)	(0.03)
Panel B: Regional log *exports*						
$Tariff_{c,t-1}$	1.81***	−0.44***	−0.55**	−1.07**	1.16***	1.01***
	(0.48)	(0.14)	(0.24)	(0.47)	(0.37)	(0.33)
Log regional exports	−0.01	0.01*	0.01	−0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Panel C: Regional NTR gap						
$Tariff_{c,t-1}$	2.00***	−0.42***	−0.45*	−0.81**	1.27***	1.05***
	(0.49)	(0.15)	(0.24)	(0.38)	(0.39)	(0.36)
Regional NTR gap	0.39	0.01	0.12	0.40	0.13	0.03
	(0.27)	(0.04)	(0.10)	(0.29)	(0.22)	(0.20)
Panel D: Regional foreign demand						
$Tariff_{c,t-1}$	1.83***	−0.41***	−0.50**	−0.75**	1.24***	1.03***
	(0.48)	(0.14)	(0.22)	(0.33)	(0.37)	(0.33)
Regional Foreign demand	−0.19	−0.16***	0.02	0.10	−0.21	−0.11
	(0.27)	(0.05)	(0.10)	(0.15)	(0.25)	(0.22)
Basic Controls	Yes	Yes	Yes	Yes	Yes	Yes
Clusters	179	179	179	179	179	179

Notes:"Regional exports (ADH)" controls for a regional export measure constructed following Autor et al. (2013). *"Regional* log *exports" controls for the* log *of regional total exports. "Regional NTR gap" controls for the interaction between the post-WTO dummy and the regional NTR gap measure. "Regional foreign demand" controls for the regional foreign demand shocks. See* Appendix A2 *for the construction of these variables. Basic controls include dummies of city and year, and household head characteristics including dummies of gender, education level, interactions between year and age, and interactions between gender and all covariates. Standard errors in parentheses are clustered at the city level.* $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

4.4. Input tariffs

Previous studies (e.g., Goldberg et al., 2010) have shown that the tariff reduction of the final goods and the intermediate goods could have different impacts on the local economy. The tariff cut of some goods may benefit those firms that use them as intermediate inputs. That being said, we believe the import competition effects are potentially present for both final goods and intermediate inputs. For example, the tariff cut of steel is likely to intensify the import competition faced by the domestic steel producers (although steel is an input for other firms). The way we construct the tariff measures in our baseline specification actually captures these import competition effects for both final goods and intermediate inputs.

To deal with the possibility that the tariffs on the intermediate inputs may affect the labor demand of the upstream industries, we conduct two robustness checks. First, instead of the output tariffs, we use the effective rate of protection (ERP) as the dependent variable. The ERP considers both the output and input tariffs. In particular, the industry level ERP is constructed as follows:

$$ERP_{it} = \frac{outputtarif\, f_{it} - MS_i \times inputtarif\, f_{it}}{1 - MS_i}, \quad (3)$$

where $outputtarif\, f_{it}$ is the output tariff in industry i in year t, and $inputtarif\, f_{it}$ is the input tariff.[28] MS_i is the share of intermediate input costs over total output. We then calculate the regional-level ERP using the initial employment shares. Second, we put the output tariffs and input tariffs separately in the same regression. To do that, we calculate the industry level input tariffs (adjusted by the input intensity, MS_i). Then we aggregate the input tariffs to the regional level. Panels A and B of Appendix Table A11 report the estimation results of the two exercises. We can still see the evidence of output tariff effects on wages and labor supply even when we take account of the input tariff effects.[29]

4.5. Other potentially confounding factors

Non-tariff barriers First, in addition to tariff reduction, China also substantially reduced various non-tariff barriers (NTBs). One potential confounding factor in our analysis is the relaxation of import license control. Every year, Chinese Customs announces a list of products requiring an import license. Because the total number of licenses is subject to government control, the license essentially serves as a quota. Drawing on annual circulars of the Ministry of Foreign Trade and Economic Cooperation and the Ministry of Commerce, we construct a city-level measure of import license control as the share of products produced in a city that are under import license control. The details of the measure's construction are described in Appendix A2. The average city-level measure of import licenses declined by 6.5 percentage points during 1998–2007. We include this measure in the regression to control for the impact of import licenses. Second, some Chinese industries, such as textile and clothing, benefited tremendously from the removal of the quotas under the Multifiber Agreement (MFA). The MFA effects could be confounding factors as the effects could be correlated with regional tariff and household outcomes. To test the robustness to controlling for the MFA effects, we calculate the export share of those products subject to the MFA restrictions imposed by the United States and the European Union for each city in the year 2001, the year before

[28] We use China's 2002 input-output table to calculate the input tariffs.

[29] In Panel B, the effects of input tariffs cannot be precisely estimated, as can be seen from the very large standard errors. This is probably due to a collinearity problem. In our data, output tariffs and input tariffs are highly correlated, because by construction, the input tariffs is simply a weighted average of the output tariffs.

China's WTO entry.[30] Since these quotas were gradually removed after the WTO accession, we interact this share with the dummy variable indicating the calendar years after 2002, include these interactions in the regressions, and report the results in Table 10.

FDI restrictions Another major form of liberalization accompanying China's WTO entry is FDI liberalizations. FDI restrictions in China took various forms, such as higher initial capital requirements, less favorable tax treatment, more complicated business registry and approval procedures, and in the case of joint ventures, the requirement of majority shareholding by a Chinese party. Most of the restrictions were removed immediately following China's WTO accession. Based on FDI restriction data from the Catalogue for the Guidance of Foreign Investment Industries issued by the Ministry of Commerce of China,[31] we construct a city-level FDI restriction measure as the share of industries that are either "prohibited" or "restricted" in the Catalogue. See details in Appendix A2. Notably, because the Catalogue covers all industries, including services, our city-level FDI restriction measure captures FDI liberalization not only in tradable but also in non-tradable sectors. The average city-level FDI restriction declined by 2 percentage points during 2001–2007.

Consumption price Tariff reduction can affect household consumption and saving by changing good prices. Our estimates of labor market effects will be biased if regional consumption and production patterns are correlated. In order to alleviate this concern, we follow Edmonds et al. (2010) and include in the regression a regional consumption-weighted tariff, constructed by weighing the tariff of each product with the product's expenditure share in the region's consumption basket. The UHS records the consumption of 74 tradable goods, including food, clothing, furniture, home appliances, telecommunication equipment, etc. We calculate the expenditure share of each product in the region's total consumption based on these records. The details of the construction of the consumption-weighted tariff is reported in Appendix A2.

Minimum wage policy Another confounding factor is the minimum wage policy. The prefecture governments set the minimum wage on a yearly basis, which may impact the wages and consumption of households. If a larger tariff cut is associated with slower minimum wage growth, the identified effects in our previous estimation may have a problem. We collect the minimum wage of all cities after 1998 from City Statistical Yearbooks.

Housing price Housing prices affect many dimensions of household behaviors, including labor supply, co-residence, consumption, and saving. To ensure that our results are not driven by changing housing prices, we control for an index of housing prices at the city level obtained from Fang et al. (2016).

Privatization China experienced a massive privatization of its state-owned enterprises (SOEs) during 1998–2005. The employment share of SOEs in the urban economy decreased from 44% in 1998 to 24% in 2005. While the privatization of the SOEs may have substantial labor market consequences on China's aggregate economy, it will bias our estimated effects of tariff cuts only if regional tariff cut is systematically correlated with the extent of privatization. We find no evidence of this in the data. As a robustness check, we include the employment share of the SOE in each prefecture as a control variable.

Initial conditions First, to better deal with the concern of pre-trends, we include the interaction terms between year dummies and the initial outcome variables at the city level as additional controls. For example, when running the wage regressions, we include the average wage of each city in its initial year, interacted with a full set of year dummies. This helps to alleviate the concern that cities with different initial wages prior to WTO entry may have differential wage growth trajectories during the liberalization years. Second, if the initial share of manufacturing sector in total employment correlates with the wage growth after the WTO accession, then our estimates of the regional tariff effects may be biased. To obtain a robust result, in all regressions, we include the initial manufacturing employment share interacted with year dummies.

In Pane A of Table 10, we conduct the robustness checks with all these potentially confounding variables. To save space, we report the OLS estimation results of the tariff variable when a potentially confounding variable is included in the regression. Column 1, for example, shows the estimated impact of the tariff on log wage with the import license as an additional control variable in the regression. We can see that the estimated coefficient is still statistically significant at the 5 percent level. Other results reported in Panel A are qualitatively similar to the baseline results in the previous tables, although the magnitude of the coefficients may be different. These exercises indicate that our results are not sensitive to the inclusion of other control variables.

4.6. Alternative measures of regional tariffs

First, we use the theory-consistent measure of regional tariffs as in Kovak (2013), where the employment weights are adjusted for labor cost share. Second, we use the employment weights in 2001, i.e., the year just prior to China's WTO entry, instead of using the average employment weights over 1998–2001. Third, we recalculate the employment weights using the 1995 Third Industrial Census data, so that the employment includes all industrial firms instead of only relatively large firms in the ASIF data. Finally, we allow the tariff level during 1998–2001 to vary by year, instead of setting them constant as in our baseline regression. As seen in Panel B of Table 10, all the baseline results still hold with these alternative regional tariff measures.[32]

4.7. Alternative samples

We now conduct more robustness checks with alternative samples. First, in our sample, not all cities exist in the sample throughout the entire period between 1999 and 2008. To address the potential selection issue, we re-estimate everything using a balanced sample of cities that exist in our sample every year during 1999–2008. Second, we drop the workers in the agriculture industry, since our tariff measure only includes mining and manufacturing industries.

The estimation results are shown in Panel C of Table 10. The estimated effect of tariffs on wages, labor supply, household size, co-residence, household income per capita, and household consumption survived all these tests.

4.8. Alternative standard errors

Adao et al. (2019) show that in shift-share designs, due to similarities in the initial shares, the error terms could be correlated across regions even if these regions are not geographically proximate. This could lead to over rejection of the null hypothesis. We want to argue that this is not a serious problem for this study. First, as pointed out in Adao et al. (2019), the over-rejection problem is more severe when the

[30] We draw the data for US MFA quotas from Brambilla et al. (2010) and for EU MFA quotas from Utar (2014).

[31] The Catalogue is a major source of reference for the government in approving foreign investment projects. The Catalogue lists the industries in "encouraged," "restricted" or "prohibited" categories. The unlisted industries are considered "allowed". Investments in the "prohibited" industries are completely banned, while those in the "restricted" industries are subject to the various forms of restrictions mentioned above. The Catalogue is amended every 3–5 years. For our sample period, we use the Catalogue issued in 1997, 2002 and 2004.

[32] Since China entered WTO in December 2001, firms may anticipate the change before the accession. In a further robustness check, we drop year 2001 when calculating the pre-WTO employment shares. Our main conclusions still hold. The estimation results are available upon request.

Table 10
Robustness checks.

Dep. Var.	(1) Log wage	(2) Working	(3) Log HH size	(4) Parental co-residence	(5) Log (HH Income per capita)	(6) Log (HH consump. per capita)
Panel A: Control for confounding factors						
Import license	1.26**	−0.38***	−0.51*	−1.22*	0.92**	0.74**
MFA controls	1.91***	−0.43***	−0.49**	−1.11**	1.19***	0.88***
FDI restrictions	1.77***	−0.42***	−0.53**	−1.06**	1.18***	1.04***
Regional consump. Tariffs	1.63***	−0.40***	−0.46**	−0.89**	1.07***	0.91***
Minimum wage	1.78***	−0.43***	−0.48**	−0.92**	1.21***	1.02***
Housing price	1.74***	−0.43***	−0.54**	−1.04**	1.19***	0.99***
SOE share	1.76***	−0.42***	−0.54**	−1.11**	1.19***	1.09***
Initial outcome variable∗Year	1.31***	−0.47***	−0.54**	−1.10**	0.89***	0.38
Initial manu. Share∗Year	1.92***	−0.48***	−0.44*	−0.63*	1.38***	0.92***
Panel B: Alternative regional tariff measures						
Labor share adjustment	1.38***	−0.32***	−0.40*	−0.41*	0.95***	0.82***
2001 wt	1.68***	−0.43***	−0.55**	−0.85*	1.05***	0.92***
Industrial census weights	1.93***	−0.39**	−0.46*	−0.79*	1.34***	1.03***
1998–2001 actual tariffs	1.57***	−0.39***	−0.48**	−0.99*	1.00***	0.79**
Panel C: Results in alternative samples						
Consistent cities	2.94***	−0.66***	−0.60*	−1.38**	1.25**	1.24**
Drop agriculture industry	1.80***	−0.42***	−0.55**	−1.10**	1.18***	1.02***
Living here since 2001	1.77***	−0.42***	−0.53**	−1.09**	1.19***	1.04***

Notes: This table reports the OLS coefficients of regional tariff measures under different robustness checks. In Panel A, "Import license" controls for regional measure of import license restrictions. "MFA controls" controls for each city's export share of products subject to the MFA restrictions, interacting with a post- 2002 dummy. "FDI restrictions" controls for regional measure of FDI restrictions. "Regional consumption tariff" controls for regional consumption-weighted tariff measure. "Minimum wage" controls for prefecture minimum wage standards. "Housing prices" controls for prefecture housing price index. "SOE share" controls for prefecture SOEs' share in employment. "Initial outcome variable∗Year" controls for each city's initial outcome variable interacting with year to control for pretends. "Initial manu. Share∗Year" controls for each city's initial manufacturing employment share interacting with year. In Panel B, "Labor share adjustment" uses labor share adjusted weights as in Kovak (2013) when calculating the regional tariffs. "2001 wt" uses employment weight in 2001 to construct regional tariff measure. "Industrial census weights" uses employment weights from the 1995 Industrial Census. "1998–2001 actual tariffs" uses the actual tariffs in 1998-2001. In Panel C, "Consistent cities" uses the cities that exist every year during 1999-2008. "Drop agriculture industry" drops workers in the agriculture industry. "Living here since 2001" only keeps those households who have been living in local region since 2001. Standard errors not reported here are clustered at the city level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

number of industries is small or there are some industries that are significantly larger than others. Fortunately, there are over 450 industries in the data when we construct the initial employment share. Actually we use the finest industry classification for the Chinese data. If we rank the industry employment share at the national level during 1998–2007, the median industry accounts for 0.09 percent of total employment, and the largest industry's share at the 99 percentile of the distribution is only 2.2 percent. Put simply, no industry is dominant in terms of the employment share.

Second, consistent with the spirit of Adao et al. (2019), we construct alternative standard errors based on the similarity of prefecture's industry employment composition.[33] Our method follows Campante et al. (2019). Specifically, for each prefecture, we calculate the similarity index of this prefecture to all other prefectures in their initial employment share. The similarity index is constructed as follows:

$$SimilarityIndex_{ij} = \sum_{k} min\left\{s_{ik}, s_{jk}\right\}, \tag{4}$$

where $s_{ik}(s_{jk})$ is the initial employment share of industry k in city i (j). By construction, this index ranges from 0 to 1. A higher index indicates a more similar industry employment structure. If two cities have identical industry employment composition, the index takes the value of 1. If two cities don't have any industry in common, the index should be 0. In Table 11, we report the results of our main regressions, using different methods of clustering. Row 1 shows the results with clusters at the prefecture level, which are the same results reported in earlier tables. Row 2 reports the two-way cluster standard errors by prefecture and the prefecture with the highest similarity index. Row 3 presents the two-way cluster standard errors by province and the provincial capital city with the highest similarity index. Row 4 reports the two-way cluster standard errors by province and the provincial capital city outside its own province with the highest similarity index. The results in Table 11 show that the statistical significance is preserved under these alternative standard errors.

5. Conclusions

The extant literature finds that the labor market makes substantial adjustments in response to import tariff liberalization. However, insufficient attention has been paid to how households adjust to such trade-induced labor market shocks. Using a comprehensive household survey in urban China, we systematically examine how tariff liberalization affects household behaviors and outcomes, including family labor supply, living arrangements, income and consumption. We explore the regional variation in the exposure to tariff reduction brought by China's WTO accession. Our results suggest that regional tariff cuts resulted in relative declines in local wages. However, households adopted a set of behaviors to buffer such income shocks. First, household members worked more, especially in the non-tradable sector. The increase in labor supply only occurred for females and the elderly. Second, more young adults moved to live with their parents for the purpose of expenditure sharing. Finally, households also reduced their savings to smooth the consumption. We conclude that household played an important insurance role against the adverse trade shocks.

Our findings contribute to several on-going literature and provide important policy implications. First of all, the investigation of household behaviors enriches our understanding of how the economy adjusts to tariff reduction and its potential welfare effects. For example, the

[33] We are unable to exactly implement the Adao, Kolesar, and Morales (AKM) approach for two reasons. First, AKM approach requires that the number of regions be larger than the number of industries, while our data includes 179 regions and 453 industries. Second, the AKM method is designed for region-level aggregated data (as in Autor et al., 2013) but we use micro-level household data.

Table 11
Alternative standard errors.

Dep. Var.	(1) Log wage	(2) Working	(3) Log HH size	(4) Parental co-residence	(5) Log (HH income per capita)	(6) Log (HH consump. per capita)
$Tariff_{c,t-1}$	−0.42***	1.76***	−0.54**	−1.09**	1.17***	1.03***
SE Clusters						
City	(0.14)	(0.47)	(0.25)	(0.50)	(0.36)	(0.33)
city & city with highest SI	(0.13)	(0.45)	(0.24)	(0.51)	(0.38)	(0.32)
province & provincial capital with highest SI	(0.12)	(0.69)	(0.29)	(0.53)	(0.58)	(0.47)
province & other provincial capital with highest SI	(0.15)	(0.59)	(0.27)	(0.48)	(0.52)	(0.43)
Observations	591,063	379,389	109,228	109,228	251,492	251,492
R-squared	0.50	0.35	0.08	0.09	0.42	0.36
Basic Controls	Yes	Yes	Yes	Yes	Yes	Yes
Clusters	179	179	179	179	179	179

Note: This table reports regression results of equation (2)*, using alternative methods of clustering. "city" clusters the standard error at the city level, which is our baseline results in* Table 2*. "city & city with highest SI" two-way clusters the standard error by prefecture and the prefecture with the highest similarity index. "province & provincial capital with highest SI" clusters by province and the provincial capital city with the highest similarity index. "province & other provincial capital with highest SI" two-way clusters by province and the provincial capital city outside its own province with the highest similarity index. Standard errors in parenthesis.* ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

effects on household structures can have important implications for the earning trajectories of young people, the living arrangements of the seniors, and the design of social insurance. In addition, our results also emphasize the importance of insurance role of mutual protection and support among household members in the episode of trade liberalization, especially in the case where the government-funded social safety-net is generally less developed.

In this paper, we do not attempt to quantitatively access how much tariff liberalization affects household welfare, and how the option of changing household behaviors matter for the welfare effects of trade. Answering these questions requires a computable model, and we leave this to future work.

Data availability

The authors do not have permission to share data.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jdeveco.2021.102628.

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