Hollowing Out the Middle Class:
Trade Liberalization and Labor Market Polarization in China[*]

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Abstract

This paper examines the role of international trade for household income polarization, the phenomenon in which the size of high- and low- income groups increases but mid-income group declines. We propose a new channel that emphasizes the supply change of skills in rationalizing the phenomenon. We build a simple theory of trade featuring endogenous choices on occupation and firm productivity, where individuals choose to become low skilled workers, high skilled workers, or entrepreneurs based on their innate abilities. Entrepreneurs improve the firm efficiency by investing in the managerial effort. We show that while the household with high human capital optimally responds to export opportunity by moving up the income distribution, other households with median level human capital self-select downward the income distribution, the long run consequence of which may be the polarization in labor market. An empirical test of the model reveals that regions facing more export exposure exhibit stronger pattern of labor market polarization.

1 Introduction

In recent decades, we have witnessed the rapid growth of international trade. Accompanied by the fast integration of the world economy is the rising income inequality. Policy makers tend to use education as a panacea for the growing inequality and the foreign competition, a cure with which the society will be able to maintain a thriving middle class and ever-greater well-being. At the same time, popular sentiment reflects the concern that even a solid education no longer guarantees a well-paid income or membership in the middle class. In this paper, we explore a source of the misalignment between the politics and public perceptions: the reality that workers of different types respond to globalization differently. While household with high human capital optimally responds to export opportunity by moving up the income distribution, other households with median level human capital self-select downward the income distribution, the long run consequence of which may be the polarization in labor market.

The rising income disparity in the past few years has been seen as endangering the middle class or polarization in labor market. For instance, research of International Labour Organization shows that the middle class in Europe shrank by 2.3 per cent during 2004 to 2011, and the drops have continued since then. In the United States, Valletta (2015) also finds the polarization in the earning distribution, which could be partly explained by the flattened wage premium for individuals with high education. Acemoglu and Autor (2011) attribute such change to the widened income differential between managers and workers. The similar pattern is also found in China around the same time. In 2010, the Gini coefficient for family income has now reached to 0.5 compared with 0.45 in the U.S., according to Xie and Zhou (2014). However, the average return to college has fallen from 53.7% to 35.3% [1]. In all these cases, some underlying factors have been active suppressing the return to college and widening the top-bottom income disparity, which cannot be reconciled by the previous literature [2].

We rationalize this phenomenon in a model with endogenous skill supply by allowing individuals to choose their optimal occupations between unskilled worker, skilled worker, and entrepreneur. Specifically, the selection effect from trade liberalization raises the opportunity cost of setting up firms that unambiguously sorts more individuals with high human capital into skilled labor group *per se*. Relative supply of skills increases and return to skill drops as a result, which reconciles the decrease of skill premium. In the meanwhile, reduction in variable trade cost induces more entrepreneurs to serve the global market. Also, it makes income profile of entrepreneurs serving the domestic market flatter and that of entrepreneurs serving the global market steeper, by changing their incentives to invest in the managerial effort. As the top incomes are positively correlated with firm profit [3], the income distribution polarizes by squeezing skilled worker and small-median firm

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[1]The result is based on the estimation using two micro-survey datasets. The details is referred to section 2.

[2]In the context of Heckscher-Ohlin, inequality of developed (abundant in skilled labor) and developing (abundant in unskilled labor) countries cannot rise simultaneously. The literature emphasizing the skill demand change, driven by skill-biased technology, cannot explain the decrease of return to skill.

[3]This is consistent with the findings of Gabaix and Landier (2006), who argue persuasively that market capitalization

owners both in size and average return. And this is consistent the widening gap between the wealthy and the have-nots in the data [4]. According to our estimation, up to 2007, China's WTO entry in 2001 has decreased the returns to college by about 4.2% to 12.3%. The welfare gains from trade are found to be polarized across the income distribution. Besides the polarized change in both population and income distribution, trade liberalization is estimated to increase the average household income by 3.6% to 7.1% for the high-income group, and to decreased the average income by 1.1% to 10.4% and 3.1% to 6.5% for the middle and low-income groups, respectively.

The rest of the paper is organized as follows. In the next section, we present an overview of related literature that is relevant. Section 2 documents the three stylized facts of the labor market in China. Section 4 describes the elements of the model and drives its solution in the context of general equilibrium. Section 5 analyzes the empirical results. Section 6 concludes.

2 Motivational Evidence

This section documents three key facts concerning the trade liberalization and labor market returns, by capitalizing three micro survey dataset. The findings of this section motivate the theoretical analysis of section 4.

2.1 Return to College Education

We employ the China Household Income Project (CHIP)[5], as well as China Health Nutrition Survey (CHNS) to estimate the average skill premium (the detailed information regarding the dataset is presented in the appendix and section 5). The specification used for estimating return to skills is as shown below,

$$lnw_{ir} = \beta_0 + \beta_1 College_{ir} + \beta_2 Exp_{ir} + \beta_3 Exp_{ir}^2 + \gamma X_{ir} + e_r + u_{ir} \tag{1}$$

where w_{ir} is wage of individual i in region r, $College_{ir}$ is a dummy variable indicating that an individual has the tertiary education degree (4-year college or above), Exp_{ir} denotes individual i's working experience, vector X_{ir} includes other controls, i.e., dummies of marriage status, gender, and ethnicity. Moreover, regional fixed effect are included to control other cross-sectional geographic-related factors such as education capacity, openness to trade [6].

The estimated skill premium using CHIP and CHFS datasets is presented in Figure 1. According to the result, skill premium increased in the pre-WTO period (1995-2002), reaching its maximum at

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of large firms can fully explain the changes of CEO pays.

[4]It requires that schooling cost exhibits small difference across innate abilities that is not a strict assumption. In reality, college tuition does not play much role in separating talents from others, as the higher education cost is relatively low in the sense that most families can pay for college without government assistance (https://www.tuition.io/blog/2012/08/how-do-students-around-the-world-pay-for-college/).

[5]We also use China Household Financial Survey (CHFS) for year 2012.

[6]I did not include industry dummies or ownership dummies in regression, as such information has been already reflected via wage when workers optimize their income by choosing which industry to work in. Whereas, factors such as skilled labor supply is related to education capacity, such as universities, whose variation is mostly rigid and specific to the region.

around 2002 with the magnitude of 52.7%. It then has decreased in the post-WTO period [7] when China became more active in world market[8]. The point estimates exhibit a similar pattern when we use CHNS to replicate with the same specification, as shown in Figure 11.
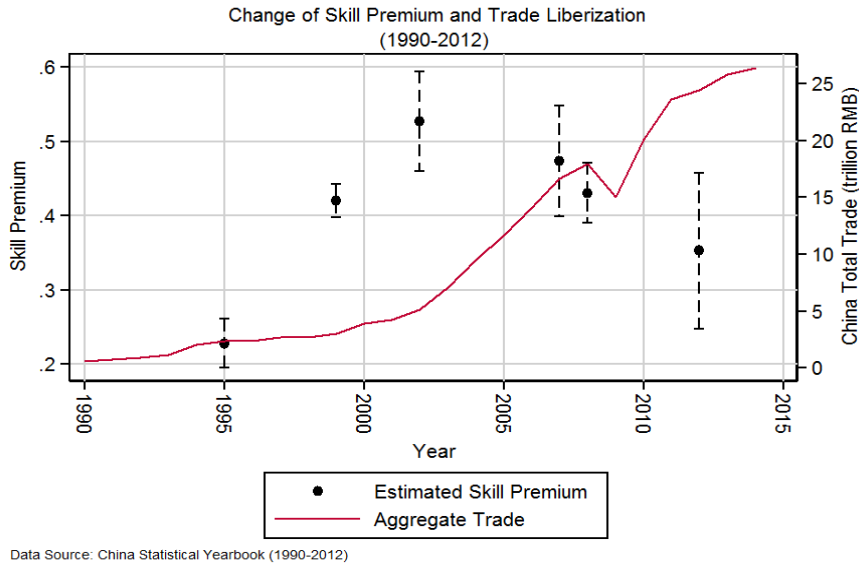

Figure 1: Change of Skill Premium with Trade Liberalization

2.2 Labor Market Polarization

Inspired by Alichi, Kantenga, and Sole (2016), we classify households into three groups namely: high-income group, middle-income group and low-income group[9]. Figure 2 shows the evolution of population share (left panel) and income distribution (right panel) among these three income groups. Population share is defined as the number of households as the percentage of the total, and income share is defined the gross income as a share of the total society income. For instance, in 2006, the gross population and income share of the middle class are roughly 49% and 35%.

According to Figure 2, the income share of households in the low-income group has stagnated since 1990. In contrast, the income share of the middle and high-income groups underwent two different phases. During 1990 to 2000, the income shares of the two group converged with little difference in gross income share in 2000. After 2000, the total income share of the high-income group

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[7]Such pattern is also found in Li, Liang, and Wu (2015) where there is downward sloping trend for college premium after China joined the WTO.

[8]This finding is consistent with Stopper-Samuelson type of responses during China's trade liberalization, which also implies lower income inequality in China (by raising the return to the abundant unskilled worker and lowering the return to scarce labor). However, the rise of overall income inequality in China has also coincided with this period according to Xie and Zhou (2014).

[9]The criteria of classification follow Alichi, Kantenga, and Sole (2016). Specifically, the high-income group refers to the households with more than 150 percent of median income; middle-income group refers to the households with more than 50 to 150 percent of median income; low-income group refers to the households with less than 50 percent of median income.

rose sharply, accompanied by the notable drops in the income share of the middle class. Synchronically, the population share of the middle class has shrunk about 60 percent of the total during 1990 and 2000, to about 50 percent around 2010[10]. Both income distribution and demographic exhibits a pattern of polarization, which features in hollowing out the middle-income group.

The shrinking of the middle class is robust to different reasonable cut-offs of what defines the middle-income group and to the different dataset. Figure 14 shows two alternative definitions for the middle-income group, one consisting of households with 60 to 225 percent of median income (Panel a), and another one comprised of households with 75 to 125 percent of median income (Panel b). For both of these measures, the resulting polarization trends come out qualitatively similar to our baseline definition of the middle class. Labor market polarization is also found in CHIP dataset, as shown in Figure 12.
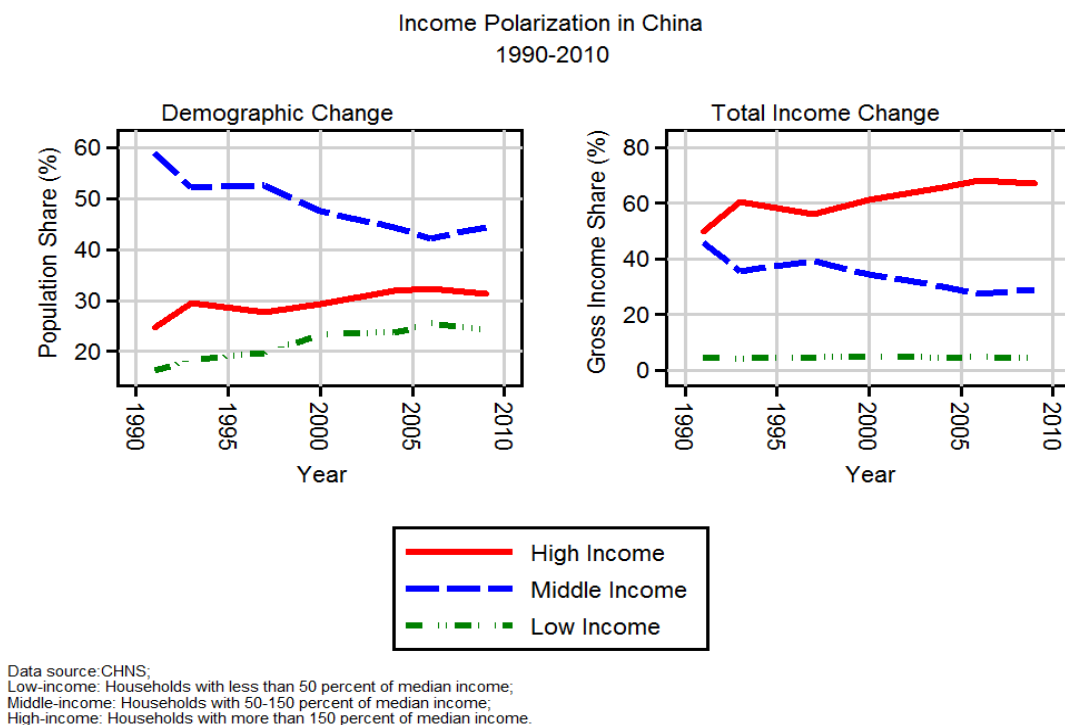

Figure 2: Income Polarization between 1990-2010

2.3   The Rise of Business Income

To understand the underlying factors affecting the polarization, we investigate two main income sources of household, namely labor income (wage) and business income. Taking business income

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[10]Among the middle-class households shifting their position through income distribution during 2000 to 2010, about half of them have been able to advance up and the other half have moved down.

into our consideration is motivated by the recent findings of Tan, Zeng, and Zhu (2015), who investigate the role of income sources in shaping overall inequality. They find that the income sources between the rich and poor household are systematically different, which explains a sizable margin of overall inequality. Business income comprises a much larger proportion of income among the top earners than the other groups [11]. All these figures indicate that the rising return to entrepreneurship could contribute to the widening gap between the rich and the poor, which is very likely to happen in the phase when China benefits a fast economic growth after joining the WTO.
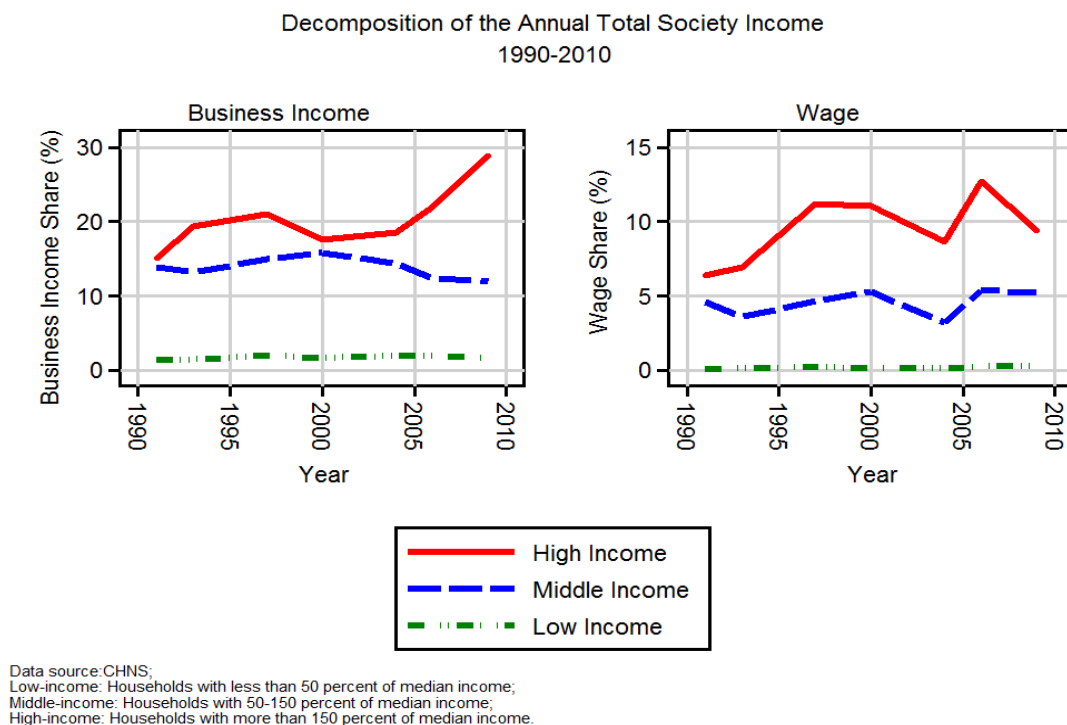

Figure 3: Decomposition of Annual Total Society Income

Figure 3 shows the evolution of business and labor income in contributing to the total social income. For instance, business and wage income from high class account for about 15% and 10% of the total society income in 2000. During 1990 to 2000, there is no significant difference in business income between high and middle-income groups. The striking divergence took place around 2000, with the business income comprising a sizable share of total income among the top earners (close to 30% in 2009). In contrast, the role of business income in middle-income group declines notably, from

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[11]Tan, Zeng, and Zhu (2015) finds that business income accounts for the largest share of 59.09% of the total income for the top 1% households, whereas labor income only account for smaller shares of 21.35%, compared with the fact that the bottom 5% earners only have 7.43% of total income from business and the main sources for this group is transfer income and labor income which account 63.15% and 22.68%, respectively. This finding is quite different from that of the United States, where the labor income is the largest part of the total income for the top 1% earners (28.3%) while business income only accounts for 29.3%, according to Díaz-Giménez, Glover, and Ríos-Rull (2011).

18% in 2000 to 13% in 2009. In the meanwhile, there is no systematic difference in the contribution of wages to the total society income. The rise of business income among the high-income groups is also found in CHIP dataset, as shown in Figure 13.

We further explore the heterogeneity by income percentile. The compositional change of household income, between 2000 to 2010, is demonstrated in Figure 4, with Panel A presenting the change of business income as a share of total household income and Panel B for labor income. The horizontal axis denotes the percentile for the average household gross income, with 0 and 100 standing for the poorest and richest households respectively. The business income share of the bottom 20% of households change very little, as only a few of the low-income families are involved in business activity, then and now. The notable change comes from the middle and high-income groups. The share of business income in the middle class have significantly declined, whereas high-income households have a larger proportion of business activities in their total income, compared with five years ago. In contrast, there is no significant compositional change for the labor income, as the share changes are insignificant from zero according to Panel B.

Summarizing, in this section, we document three stylized facts regarding labor market in China during the post-WTO period. First, the relative returns to skills have decreased. Second, the labor market of China features in the rise of income polarization, whereas a more polarized income distribution is the one with relatively fewer middle-income and more low and high-income households. Thirdly, in contrast to the stagnated change of labor income share, business income share has greatly risen among the top earners, and declined among the middle class. Motivated by these facts, we build a model in which consumers endogenously choose occupation based on innate abilities. Trade liberalization interacts with labor market by affecting the profitability of business activity and the supply of skills, and we show that the model can rationalize these facts well. The details of the the model is discussed in section 4.

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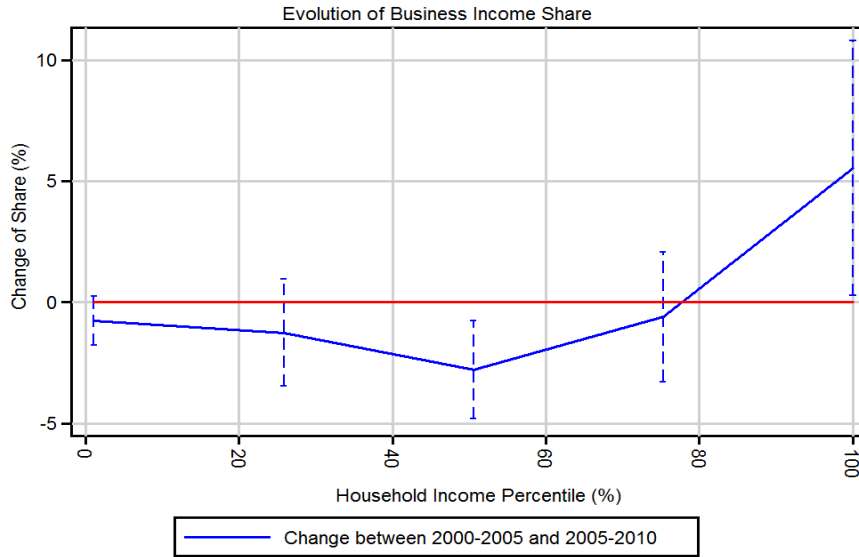
(a) Business Income Change
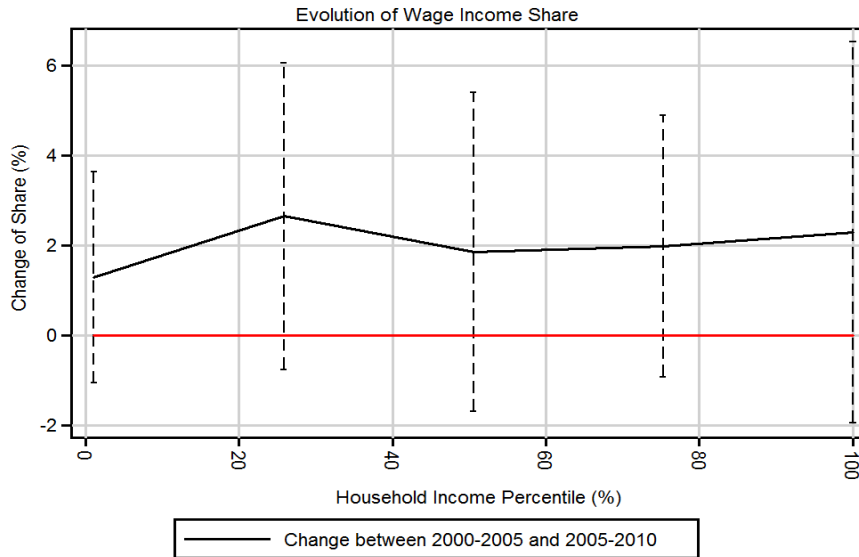
(b) Wage Income Change

Figure 4: Evolution of Business Wage Income Share (1999/2003 and 2005/2008)

3 Related Literature

This paper is related with and contributed to several strands of literature. Firstly, it is related to the endogenous production efficiency literature which deviates from the exogenous firm productivity assumption as in Melitz (2003). Among them, Lileeva and Trefler (2010), Bustos (2011) and Unel (2013) consider the case where firms could improve production efficiency by making a binary choice on adopting technology scheme, according to which a firm incurs fixed costs to capitalize a

project that raises firm productivity by exogenous amount. Alternatively, starting from Yeaple (2005), Costinot (2009), Helpman, Itskhoki, and Redding (2010), Sampson (2014) and Grossman, Helpman, and Kircher (2015) study the productivity gains that sources from the matches between more able workers and more productive firms. [12]. Two contemporaneous papers, Dinopoulos and Unel (2014) and Dinopoulos and Unel (2015) emphasize the role of manganese's human capital in explaining the heterogeneity of firm productivity. They view technology as a continuous process with variable costs that decline with the managerial talent of the firm owner, i.e., the manager. The model of this paper is built upon Dinopoulos and Unel (2014) that features occupational choice and endogenous firm productivity. Inspired by Davidson and Sly (2014), the methodological innovation of our model is the introduction of the different types of working status [13], namely, the unskilled workers, the skilled workers, and entrepreneurs, whose masses are governed by the distribution of innate ability as well as the cost function of the college education.

Secondly, the paper contributes to the literature studying the impact of trade liberalization on skill premium by providing a brand new mechanism, through which open to trade could hurt the return to skill *per se*. Along with the large body of literature, Burstein and Vogel (2010), Harrigan and Reshef (2011) and Parro (2013) attribute the risen skill premium to the trade-induced skill-biased technology change. Essentially, trade liberalization raises the relative demand for skilled labor which increases the skill premium. However, previous studies nuance the mechanism where the relative skill supply could also adjust in response to global opportunities, as emphasized in this paper. Selection effect of trade liberalization raises the opportunity cost of setting up firms, which sorts more able individuals into the skilled labor group, and relative supply of skills increases and return to skill drops as a result. The paper also implies that the effect of trade liberalization on return to skill might be overestimated if one ignore this endogenous skill adjustment at the supply side.

Another important prediction of our model that trade liberalization by reducing variable trade cost leads to income polarization is consistent with the recent empirical studies that have documented the labor market polarization for of U.S. in David and Dorn (2013), and for Europe in Goos, Manning, and Salomons (2009). However, the sources of labor market polarization are different. In David and Dorn (2013) and Goos, Manning, and Salomons (2009), polarization is primarily driven by technological change among working class and occupations. Whereas we attribute polarization to the expansion of the rich entrepreneurs, and this is also emphasized by Dinopoulos and Unel (2014) and consistent with the recent empirical findings of China. [14].

The research also relates to various studies on the recent inequality of China [15]. For instance, using multiple data sources, Xie and Zhou (2014) document a fast increase in income inequality in

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[12]Grossman (2013) provides detailed literature survey on this topic.

[13]Dinopoulos and Unel (2014) and Dinopoulos and Unel (2015) consider the case where individuals choose occupations between homogeneous workers and entrepreneur. Besides top income inequality, they emphasize the trade effect on unemployment in the search context. Moreover, their model is not able to study any effects on return to education.

[14]The detailed survey on inequality induced by trade liberalization can refer toGoldberg and Pavcnik (2007).

[15]See Knight (2013) for surveys. We emphasize the phenomena of polarization, and it is positively correlated with inequality.

China's recent past. The overall income inequality has risen to a very high level since 2005, with Gini coefficient ranging from 0.53 to 0.55. As shown in Figure 15, the overall inequality of China surpasses that of U.S. by a large margin, which makes China stand among the *unequal* countries in the world. Xie and Zhou (2014) investigate inequality issue mostly from macro-perspective. They emphasize regional disparities and the urban-rural gap in explaining the rising inequality. As staggering as these factors are, research of inequality from micro-perspective, e.g. individual income source, is understudied. We add to this literature by focusing on the income polarization and studying the possible channels through which trade induced occupation switches affect the polarization and inequality.

Finally, the paper is related to the interdisciplinary research on education and international trade. Recent work of Davidson and Sly (2014) studies trade effect on skill acquisition when education has properties of productivity enhancing and ability signaling. To endogenize skill supply, we introduce the schooling cost, which differs in worker's ability, in a similar way as Davidson and Sly (2014). Education cost is also emphasized in Blanchard and Willmann (2015), where they find that free trade can crowd out the middle occupations towards the skill acquisition extremes, and the key determinant is educational cost structure. However, they only focus on the working group, while our paper considers polarization in the context of allowing occupation choice between working class and entrepreneurship. Empirically, this paper predicts trade liberalization raises college dropout rate, which is supported by Atkin (2012). The most closely related empirical analysis of trade effect on skill premium, allowing endogenous education acquisition, is Shastry (2012).She investigates the interaction of human capital responds and globalization in affecting skilled wage premium, and she finds that the increasing skill premium is mitigated if allowing human capital to response to global opportunities [16]. Along with Shastry (2012), the paper also suggests that trade effect on skill premium might be overestimated if one ignore the endogenous skill adjustment at the supply side.

4   Theoretical Analysis

In this section, motivated by the evidence that the skill premium has decreased and the labor market has been more polarized after the post-WTO period, we build a general equilibrium model of trade, based on Dinopoulos and Unel (2015), which features endogenous occupation choice. In particular, the model introduces a supply-side mechanism to rationalize these empirical findings.

4.1   Model Environment

To keep the analysis tractable, I study a world economy consisting of two symmetric countries. A unit mass citizens populate each country. For each country, individuals differ in innate ability indexed by a which follows an exogenous cumulative distribution $G(a)$ with density function as $g(a)$ and support $[a_{min}, +\infty)$. Based on the innate ability and return to occupations, citizens endogenously choose the occupations that pay the most net income as in Lucas Jr (1978). There are three occupations

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[16]As shown in section 4, in the case of no biased technology shock, free trade decreases skill premium.

in the economy, which are unskilled workers (U), skilled workers (S) and entrepreneurs (E). In the model, there are three sectors in each country, namely, the final good sector, intermediate good sector as well as schooling sector. The intermediate good sector is tradable and consists of differentiated firms which are set up by entrepreneurs. Each firm produces a differentiated variety of intermediate input used for producing final good and competes in monopolistic competition. The final good sector is assumed to be non-tradable and is faced with the perfectly competitive market. The final product is produced using differentiated intermediate good, domestic produced or imported, under a CES technology. Lastly, education service is supplied by the absentee agents in school sector who provide college degree to citizens who choose to be skilled workers or entrepreneurs. Education incurs tuition $c(a)$ that differs by student's ability. The absentee agents use the tuition to consume the final product [17].

Though our model is static by nature, it is convenient to think of it as unfolding in three sub-period. In the first sub-period, citizens observing his ability and returns to occupation decide whether to attend college. Individuals who receive education from schooling sector will pay a cost $c(a)$ that differs in student's ability. In the second sub-period, the non-college citizens will work as unskilled workers and receive the unskilled wage, while the individuals who attend college have options of being skilled workers or entrepreneurs. An entrepreneur invests fixed cost to open a firm and earn a profit while skilled worker earns skilled wage. Finally in the third sub-period, once firms finish hiring unskilled and skilled workers, production of all goods and consumption take place.

4.1.1 Consumer

Agents[18] in this economy consume a composite final product Q and we assume the utility is linear in consumption of Q. When choosing which labor market to enter, citizens only concerned with the corresponding net return. Individual with ability a maximizes utility by selecting occupation among three working class as shown below

$$
\begin{aligned}
max_{i \in \{U,S,E\}} \quad & Q \\
s.t. \quad & PQ \leq w_i(a)
\end{aligned}
\tag{2}
$$

where P is the price of the final product and $w_i(a)$ denotes the net income of individual of ability a when choosing occupation $i \in \{U, S, E\}$.

Citizens who do not obtain college degree work as unskilled labor and earn unskilled wage that is normalized to 1, i.e., $w_L = 1$. Among the rest of individuals who pay the schooling cost, the skilled workers earn w_H and entrepreneurs make the firm profit, $\pi(a)$ that differs in their managerial talents a. Disposable income of occupation i for the individual with ability a is presented as below,

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[17]Tuition can be regarded as payment transfer from citizens to schooling sector, and there is no welfare loss from schooling as the total income keeps constant in the society.from schooling as the total income keeps constant in the society

[18]Consumers of economy consist of citizens and the absentee agents in schooling sector.

$$w_i(a) = \begin{cases} w_L = 1 & i = U \\ w_H - c(a) & i = S \\ \pi(a) - c(a) & i = E \end{cases} \tag{3}$$

4.1.2 Schooling Sector

Citizens can purchase schooling service at the cost of $c(a)$, and earn a college degree from schooling sector. we assume that the cost of schooling, $c(a)$, is decreasing in individual's ability. Note that the college degree in the model only function as a signaling device that allows workers to distinguish themselves from unskilled workers. However, schooling along does not improves employee's ability. As the absentee agents of schooling sector also consume the final good, total schooling payment plays a role of wealth transfer and doesn't affect the overall consumption. $c(a)$ is assumed to have properties as below.

Assumption 1. The cost of schooling $c(a)$ is a continuous function which satisfies the following properties:

$$c(a) \geq 0, \ c'(a) < 0 \text{ and } \lim_{a \to +\infty} c(a) = 0 \tag{4}$$

Assumption 1 implies students with higher ability require less schooling cost, which is quite standard in the human capital literature. Such assumption is also used in Davidson and Sly (2014) where schooling cost is in the form of disutility.

4.1.3 Final Good Sector

Production of the composite final good Q requires a continuum differentiated intermediate input $y(\omega)$ which are aggregated under a CES technology in perfectly competitive market,

$$Q = \left(\int_{\omega \in \Omega} y(\omega)^\beta d\omega \right)^{\frac{1}{\beta}}, \ \beta \equiv \frac{\sigma - 1}{\sigma} \text{ and } \sigma > 1 \tag{5}$$

where Ω denotes the set of varieties available for producing the final product, and $y(\omega)$ refers to the usage of variety ω that is either produced by a domestic firm or imported from a foreign firm. The price elasticity of demand for each variety equals the constant elasticity of substitution tween any two varieties $\sigma > 1$.

Let $\mathcal{E}$ be the total expenditure on final good. Cost minimization implies that the inverse demand for typical variety $y(\omega)$ is given by

$$p(w) = Aq^{\beta-1}(\omega), \ A \equiv P^\beta \mathcal{E}^{1-\beta} \tag{6}$$

where $p(\omega)$ is the unit cost of variety ω, A is a demand shifter for variety ω, and P is the marginal cost of final product:

$$P = \left(\int_{\omega \in \Omega} p(\omega)^{1-\sigma} d\omega \right)^{\frac{1}{1-\sigma}} \tag{7}$$

4.1.4 Intermediate Good Sector

A continuum of firms produces differentiated intermediate input facing the monopolistic competition, and each firm produces a single variety. As in Dinopoulos and Unel (2015), firms are created, owned and managed by entrepreneurs (E) with different innate abilities. Production of intermediate input requires both skilled (H) and unskilled labor (L), combined with a Cobb-Douglas technology. The productivity of a firm depends on manager's effort z, which captures the factors such as the implementation of worker incentive schemes, information flows relevant to technology adoption, and managerial decisions that could affect firm's production efficiency. The production function of a firm with manager's effort z is given as

$$y(z) = \kappa_y z^{\frac{1}{\sigma-1}} H^\alpha L^{1-\alpha}, \quad \kappa_y = \alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)} \text{ and } 0 < \alpha < 1 \tag{8}$$

where H is the number of hired skilled workers and L for unskilled workers. Firm's productivity is given by $\phi = z^{1/(\sigma-1)}$ that increases with manager's effort z. Profit and occupational choice considerations endogenously determine Manager's effort z[19].

The manager has to pay a fixed cost [20] to equip firm with productivity as $\phi = z^{1/(\sigma-1)}$, which depends on both manager's effort level as well as his innate abilities. Specifically, an entrepreneur with managerial talent a faces a cost of $f(z,a) = \frac{\lambda z^2}{2a}$ to invest z effort in setting up a firm, where λ is a constant parameter. The fixed cost captures the idea of disutility of effort for a manager when running his business. This specification of managerial effort costs mirrors the spirit of the human capital theory of Becker (2009), which implies that entrepreneurs with higher managerial ability incur a lower marginal cost of improving firm efficiency through better management of firm's operation. This specification also used in Dinopoulos and Unel (2014), Dinopoulos and Unel (2015) and Unel (2015). Parameter λ captures the other factors that could affect manager's utilization of managerial talent, such as input, experience, schooling, on-the-job training, etc. More talented entrepreneurs are faced with a lower cost of creating and maintaining business which enhances productivity. Trade liberalization influences firm's productivity via manager's effort that responds to the increasing export opportunities.

Entrepreneurs make decisions of exporting after firms are created. Serving the foreign market involves a fixed cost [21] of $f_x > 0$ and an iceberg variable trade cost, such that $\tau > 1$ units of variety

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[19]As discussed in Dinopoulos and Unel (2015), the modeling way of firm's productivity $\phi = z^{1/(\sigma-1)}$ is for algebra simplicity. Results do not change qualitatively if the exponent of z varies.

[20]For algebra simplicity, I assume the fixed cost is measured in the monetary value of the final good.

[21]The fixed cost is also measured in monetary value of the final product.

has to be exported in order for one unit to arrive in the foreign market. Given love-of-variety in the final good sector and a fixed production cost of exporting, no firm will serve the foreign market without also serving the domestic market. If a firm exports, the manager allocates firm's output $y(z)$ between the domestic and foreign market ($y_d(z)$ and $y_x(z)$, respectively) to equate firm's marginal revenues between the two markets. Specifically,

$$y(z) = y_d(z) + \mathbb{I}_x y_x(z) \tag{9}$$

where $\mathbb{I}_x$ is an indicator function which equals one if firm z exports and zero otherwise. Applying the inverse demand function (6), domestic and foreign revenue are expressed as

$$r_d(z) = A y_d(z)^\beta, \quad r_x(z) = A \left(\frac{y_x(z)}{\tau}\right)^\beta \tag{10}$$

and firm's total revenue $r(z) = r_d(z) + \mathbb{I}_x r_x(z)$ is given by [22]

$$r(z) = (1 + \mathbb{I}_x \tau^{1-\sigma})^{1-\beta} A y(z)^\beta \tag{11}$$

where $A \equiv P^\beta \mathcal{E}^{1-\beta}$ is demand shifter of variety good. As expected, firm's revenue increases with total output $y(z)$, market size that is captured by A and exporting status. By the nature of Cobb-Douglas production function, the marginal cost of output with firm's manager investing z effort in operating the firm is given by $mc(z) = \frac{\tilde{w}}{z^{\frac{1}{\sigma-1}}}$, where $\tilde{w}$ is the composite factor price defined as $\tilde{w} \equiv w_H^\alpha w_L^{1-\alpha} = w^\alpha$. As expected, marginal cost of production decreases with entrepreneur's effort z and increases with factor price w.

Finally, closely following Dinopoulos and Unel (2015), we also assume entrepreneurial income equals firm profit, which abstracts from other effects such as profit taxation that affects wealth distribution among firm owners and employees. It is made for tractability purpose and consistent with empirical literature regarding top income and profits of small, family-owned firms such as Kaplan and Rauh (2010). As a result, an entrepreneur with managerial ability a maximizes her income (firm profits) by optimally choosing entrepreneur's effort level z, total production y and exporting status $\mathbb{I}_x$. Combining (8) and (11), the profit maximization problem can be written as:

$$\pi(a) = \max_{\mathbb{I}_x \in \{0,1\}, y, z} \left\{ Y(z)^{1-\beta} A y^\beta - \frac{\tilde{w}}{z^{\frac{1}{\sigma-1}}} y - \frac{\lambda z^2}{2a} - \mathbb{I}_x f_x \right\} \tag{12}$$

where $\tilde{w}$ is the composite wage rate, $\tilde{w} \equiv w_H^\alpha w_L^{1-\alpha} = w^\alpha$, and $Y(z)$ is firm's market access variable that is defined as follows

$$Y(z) = \begin{cases} 1, & \text{if } \mathbb{I}_x(z) = 1 \\ 1 + \tau^{1-\sigma}, & \text{if } \mathbb{I}_x(z) = 0 \end{cases} \tag{13}$$

---

[22]Expression of $r(z)$ is derived from an exporting firm's maximization $r(z) = r_d(z) + r_x(z)$ subject to $y(z) = y_d(z) + y_x(z)$. The optimal solution implies $y_x(z) = \tau^{1-\sigma} y_d(z)$ and $r_x(z) = \tau^{1-\sigma} r_d(z)$. Substituting $y_x(z) = \tau^{1-\sigma} y_d(z)$ in (9) yields $y_d(z) = (1 + \mathbb{I}_x \tau^{1-\sigma})^{-1} y(z)$. Jointly using this expression and $r_x(z) = \tau^{1-\sigma} r_d(z)$ in $r(z) = r_d(z) + \mathbb{I}_x r_x(z)$ delivers equation (11).

Firm's maximization problem with respect to z yields

$$z(a) = \frac{\kappa_\pi (1 + \mathbb{I}_x \tau^{1-\sigma}) A^\sigma \tilde{w}^{1-\sigma}}{\lambda} a \tag{14}$$

where κ_π is a constant defined as $\kappa_\pi = \beta^{\sigma-1}/\sigma$. Above equation states that the optimal managerial effort increases with managerial talent a and firm-market size A; and decreases with the marginal cost of utilization of managerial effort λ and composite wage $\tilde{w}$. Equation (14) established a general-equilibrium, demand-based mechanism through which trade liberalization influences firm's productivity via manager's responds to global opportunities, which is missing from literature like Melitz (2003) that assume firm's production efficiency is exogenous and independent of policy-related parameters. Substituting $z(a)$ in equation (12), the entrepreneurial income (firm profit) is derived as

$$\pi(a) = \frac{[\kappa_\pi (1 + \mathbb{I}_x \tau^{1-\sigma}) A^\sigma \tilde{w}^{1-\sigma}]^2}{2\lambda} a - \mathbb{I}_x f_x \tag{15}$$

Note that the entrepreneurial income also increases with manager's ability a. As shown in (15), exporting activity generates larger revenue return, i.e., larger $\pi'(a)$, while also involves an exporting fixed cost. It implies that there is an exporting cutoff for manager's ability, a_x, such that an entrepreneur with managerial talents below a_x does not find it profitable to serve the foreign market. This is also consistent with a large body of empirical literature which finds evidence of selection into export markets, where only the most productive firms export.

4.2 Occupational Choice

Occupational choice is driven by net income maximization. Individual of ability a decides his working class after observing the net return of each occupational $w_i(a), i \in \{U, S, E\}$.

4.2.1 Skilled and Unskilled Labor

For a worker with ability a, the benefit of purchasing schooling is that this qualifies him for the skilled job that pays $w_H = w$, as compared to taking an unskilled job that pays $w_L = 1$. On the other hand, the cost of schooling is $c(a)$ which decreases with innate ability. Thus, let a_s denote the threshold ability level of the worker who is just indifferent between purchasing college education and working as a unskilled worker, a_s must satisfies

$$w = c(a_s) + 1 \tag{16}$$

All workers with ability below a_s strictly prefer working as unskilled labor, while workers with ability $a \geq a_s$ purchases schooling and must also decide whether to setting up a firm.

4.2.2 Entrepreneur and Skilled Worker

An individual with managerial ability a chooses to become an entrepreneur if and only the entrepreneurial income is larger than the wage income of being a skilled worker, that is $\pi(a) \geq w$. As entrepreneurial income increases with manager's ability a, there exist an ability cutoff, where the

marginal individual is indifferent between becoming a skilled workers or an entrepreneur. On the other hand, due to selection to export, the marginal entrepreneur serves domestic market only. Let a_e be such talent cutoff, and it must satisfy [23] $[\kappa_\pi A^\sigma \tilde{w}^{1-\sigma}]^2 a_e/(2\lambda) = w$, which reduces to

$$a_e = \frac{2\lambda w}{(\kappa_\pi A^\sigma \tilde{w}^{1-\sigma})^2} \tag{17}$$

Consequently, among individuals who purchase schooling, the ones with lower innate ability than a_e choose to enter the skilled labor market earning skilled wage w, whereas others with managerial talent higher than a_e choose to become entrepreneurs producing differentiated intermediate varieties and receiving firm profit $\pi(a)$.

The mechanism that determines the domestic cutoff level of manager's ability in this paper is different from the one embedded in Melitz (2003), where free entry condition equalizes the fixed cost of entry and the expected profit, which in turn determines the domestic threshold productivity of the firm. Melitz (2003) type of model with exogenous productivity distribution focus on the impact of product markets and uncertainty as determinants of firm's heterogeneity, while along with Dinopoulos and Unel (2014) and Dinopoulos and Unel (2015), our model highlights the role of labor market and managerial ability as the key factors that influence firm heterogeneity within endogenous production efficiency framework.

4.2.3 Exporter and Non-exporter

Due to selection to exporting, only entrepreneurs with high enough managerial ability will serve the foreign market, which in turn leads to higher entrepreneurial income, that is

$$\frac{[\kappa_\pi(1+\tau^{1-\sigma})A^\sigma \tilde{w}^{1-\sigma}]^2}{2\lambda}a - f_x \geq \frac{[\kappa_\pi A^\sigma \tilde{w}^{1-\sigma}]^2}{2\lambda}a \tag{18}$$

Managerial talent cutoff a_x, where the marginal entrepreneur is indifferent between serving the exporting market or not, is determined by setting above expression as equality, which implies

$$a_x = \frac{f_x}{w(\tau^{2-2\sigma} + 2\tau^{1-\sigma})}a_e \tag{19}$$

Note that $a_x > a_e$ if and only if $\frac{f_x}{w(\tau^{2-2\sigma}+2\tau^{1-\sigma})} > 1$, which ensures that only a subset of firms export that is consistent with empirical findings that only larger and more productivity firm export. Selection to exporting hold under Assumption 4.2.3 shown below.

Assumption 2. Fixed cost of exporting f_x is large enough, which satisfies:

$$f_x > 3(c_{min} + 1), \quad \text{where } c_{min} = c(a_{min}) \tag{20}$$

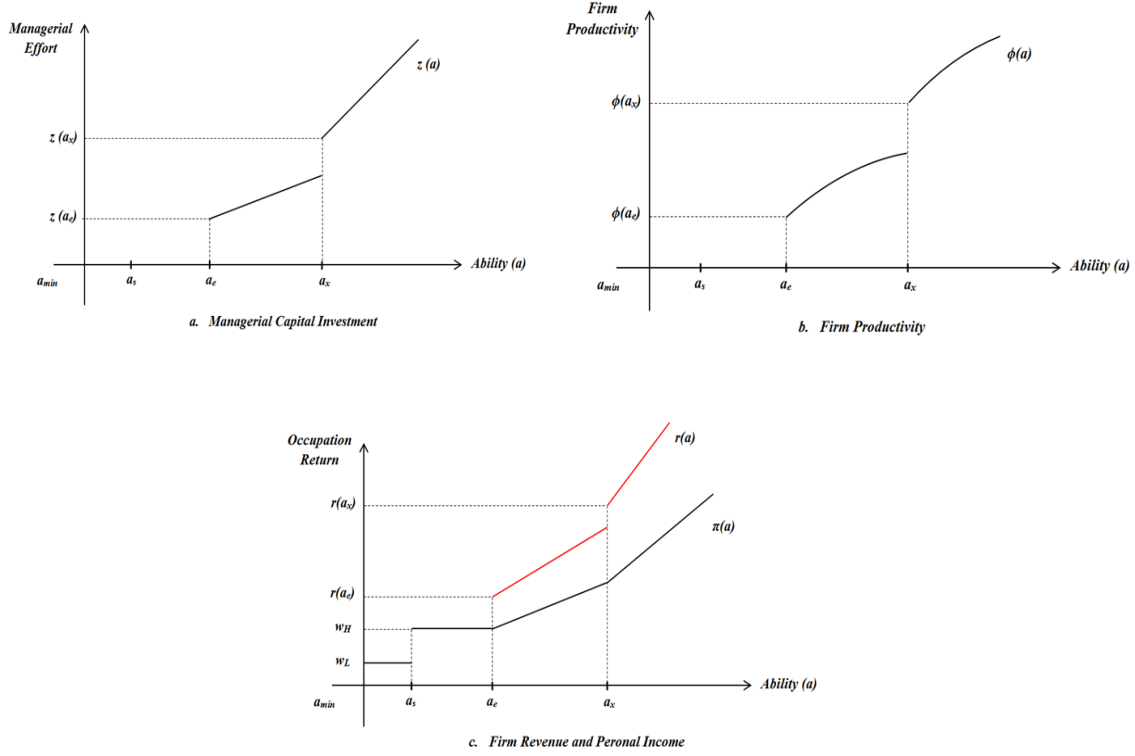[23]The LHS of equality comes from profit function of a domestic firm as shown in (15).

Figure 5: Key Variables as Function of Innate Ability

We summarize above analysis so far by considering properties of following key variables: managerial effort $z(a)$, firm productivity $\phi(a)$, firm revenue $r(a)$ as well as entrepreneur income $\pi(a)$, which are listed as equation (21) to (24). Notably, managerial effort $z(a)$, firm sales revenue $r(a)$ and entrepreneur income (firm profit) $\pi(a)$ are linear increases with managerial ability a. :

$$z(a) = (1 + \mathbb{I}_x \tau^{1-\sigma}) \left(\frac{2w}{\lambda a_e} \right)^{\frac{1}{2}} a \tag{21}$$

$$\phi(a) = (1 + \mathbb{I}_x \tau^{1-\sigma})^{\frac{1}{\sigma-1}} \left(\frac{2w}{\lambda a_e} \right)^{\frac{1}{2(\sigma-1)}} a^{\frac{1}{\sigma-1}} \tag{22}$$

$$r(a) = \frac{2\sigma(1 + \mathbb{I}_x \tau^{1-\sigma})^2 w}{a_e} a \tag{23}$$

$$\pi(a) = \frac{(1 + \mathbb{I}_x \tau^{1-\sigma})^2 w}{a_e} a - \mathbb{I}_x f_x \tag{24}$$

Figure 5 above presents these key variables by plotting the corresponding variable as function of innate ability a. Panel (a) illustrate manager's effort $z(a)$. As individuals with ability $a < a_e$ choose to enter labor market as workers, $z(a) = 0$ for $a \in [a_{min}, a_e)$. Managerial effort increases with manager's ability and jumps at the export cutoff a_x, after which it rises with a steeper slope for higher value of managerial talent. Panel (b) illustrates the relationship between firm productivity and entrepreneur's ability, which increases and is concave (convex) in managerial talent when $\sigma > 2$
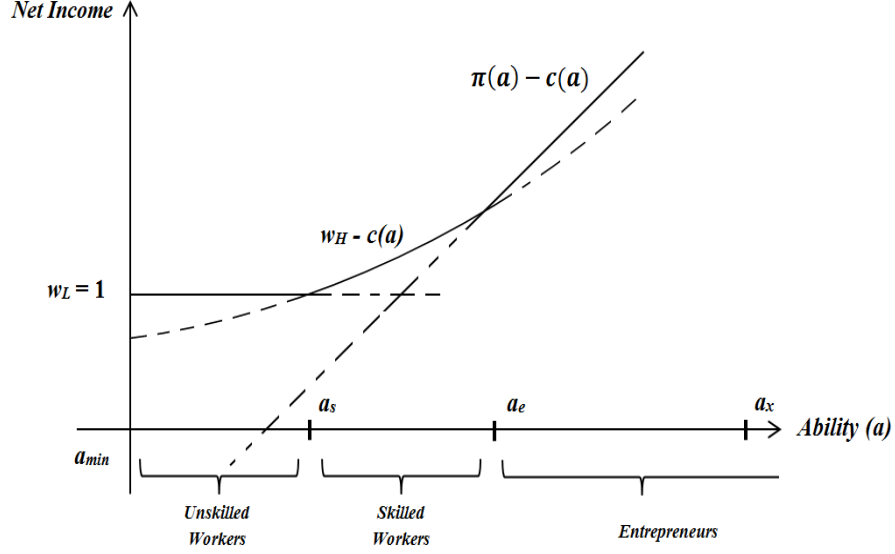
Figure 6: Equilibrium Occupation Sorting

$(1 < \sigma < 2)$. Similar to the case of managerial effort, firm productivity jumps at the export cutoff a_x. Panel (c) illustrates the profiles of firm revenue $r(a)$ and occupational income. The latter consists of unskilled wage, skilled wage as well as entrepreneurial income. Firm revenue $r(a)$ increases with manager's ability from a_e, and exhibits an upward jump at export cutoff a_x due to access to the foreign market. It rises at a steeper slope for the higher level of managerial talent. Personal income profile consists of four working class. Individuals with low innate ability $a \in [a_{min}, a_s)$ choose to become the unskilled labor and earn the unskilled wage which is normalized to one $w_L = 1$. The ones with intermediate innate ability $a \in [a_s, a_e)$ become skilled workers earning $w_H = w$. Individuals with even higher ability $a \in [a_e, a_x)$ become entrepreneurs that serve the domestic market only and collect the firm profit. Lastly, entrepreneurs with $a \geq a_x$ export and earn a higher income. The sorting rule is also illustrated in Figure 6.

4.3 Equilibrium

To solve for the general equilibrium outcome of this economy, we have to specify how equilibrium skilled wage is determined. We start by describing labor market clearing for both skilled and un-skilled workers. Let η be the measure of the openness of economy which is defined as $\eta = \tau^{1-\sigma}$ and bounded by $\eta \in (0, 1)$ (a higher value represents a more open economy). Denote $l(a)$ and $h(a)$ as the measure of unskilled and skilled workers hired by the entrepreneur of type a. The firm-specific labor demand is given:

$$l(a) = \frac{2(1-\alpha)(\sigma-1)[1+\eta\mathbb{I}_x(a)]^2 w}{a_e} a \tag{25}$$

$$h(a) = \frac{2\alpha(\sigma-1)[1+\eta\mathbb{I}_x(a)]^2}{a_e} a \tag{26}$$

This suggests that more productive firms employ a greater number of both types of workers than the less productive firms, and the relative demand for skilled labor decreases with skill premium. The overall demand for both types of labor is obtained by aggregating firm-specific labor demand across domestic firms $[a_e, a_x)$ and exporters $[a_x, +\infty)$.

Assumption 3. The distribution function of innate ability $G(a)$ is Pareto and given by

$$G(a) = 1 - a^{-k} \tag{27}$$

where $a_{min} = 1$ and k is the shape parameter.

Under Assumption 3, one can derive the aggregate demand explicitly which are given in (28) and (29).

$$L^D = \frac{2k(1-\alpha)(\sigma-1)w}{k-1} \times \frac{(\eta^2 + 2\eta)a_x^{-k+1} + a_e^{-k+1}}{a_e} \tag{28}$$

$$H^D = \frac{2k\alpha(\sigma-1)}{k-1} \times \frac{(\eta^2 + 2\eta)a_x^{-k+1} + a_e^{-k+1}}{a_e} \tag{29}$$

On the other hand, aggregate labor supplies of unskilled and skilled labor are determined by the sorting pattern in occupation choice, according to which the segments of the unskilled and skilled worker are $[1, a_s)$ and $[a_s, a_e)$, respectively. As the mass of the population is one for both countries, the aggregate labor supply is expressed as

$$L^S = 1 - a_s^{-k} \tag{30}$$

$$H^S = a_s^{-k} - a_e^{-k} \tag{31}$$

Labor clearing conditions imply the supply meet demand.

The equilibrium is characterized by several conditions. First, consumers choose their occupations based on innate ability to maximize their levels of utility subject to the budget constraint. Secondly, entrepreneurs (firms) maximize profits given the wage of both types of labor and prices of the final good. Thirdly, the labor market clear for both types of labor. To summarize, the equilibrium is defined as follows.

Definition. *The symmetric equilibrium is characterized by total nominal output $\mathcal{E}$, labor supply $\{H^s, L^s\}$ and wage of skilled workers w, which satisfy:*
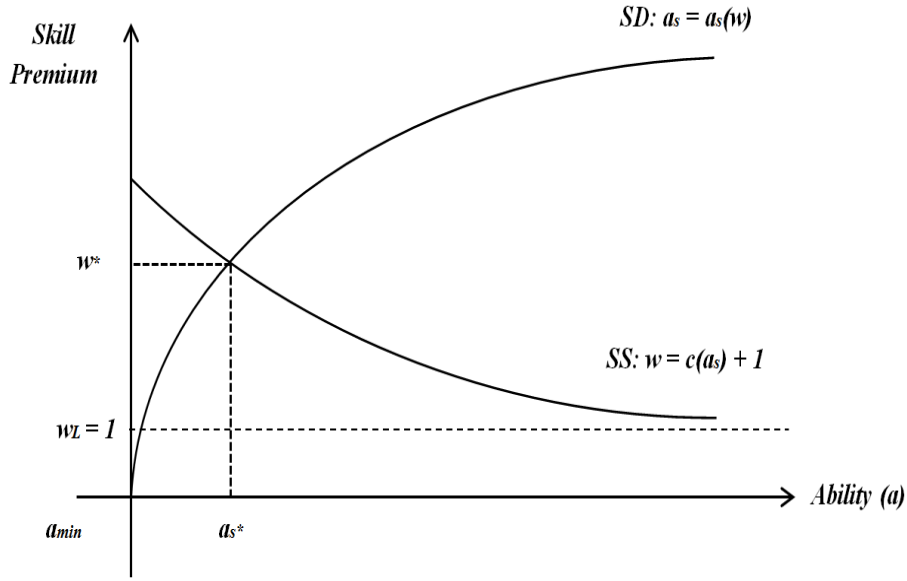
Figure 7: The Joint Determination of a_s^* and w^*

1. Utility maximization: Consumers optimally choose their occupations $\{L, H, E\}$ and consumption to maximize utility subject to budget constraint, given their innate ability and prices.

2. Profit maximization: Entrepreneurs maximize profit given factor prices $\{w_L = 1, w_H = w\}$ and price index P .

3. Labor market clearing: The labor market clears for both skilled and unskilled type .

4. Balance payment: The aggregate expenditure (consumption & service) equals the aggregate revenue[24] :

$$\mathcal{E} = \int_{\omega \in \Omega} p(\omega)q(\omega)d\omega = L^s + wH^s + \int_{a \in \Omega} \pi(a)da + \int_{a \in \Omega} f(z(a), a)da + \int_{a \in \Omega_x} f_x da \qquad (32)$$

Alternatively, equilibrium can be solved by uncovering three ability cutoff a_s, a_e and a_x, as well as skill premium w via the system of equations as shown in the appendix.

Proposition 1. *There exists a unique symmetric equilibrium in the two-country economy under Assumption 4.1.2.*

The joint determination of a_s and skilled wage w is illustrated in Figure 7. The curve labeled *SS* represents skill supply condition given by (16), and curve *SD* denotes the skill demand as shown in (50) of Appendix. *SD* slopes up because a lower skilled wage increases the aggregate demand for skilled workers which in turn leads to more citizens to pursue college degree and thus lower the schooling cutoff ability a_s. *SS* curve slopes down because a lower skilled wage increases the opportunity cost of schooling, as individuals could receive $w_L = 1$ by doing nothing anyway, which

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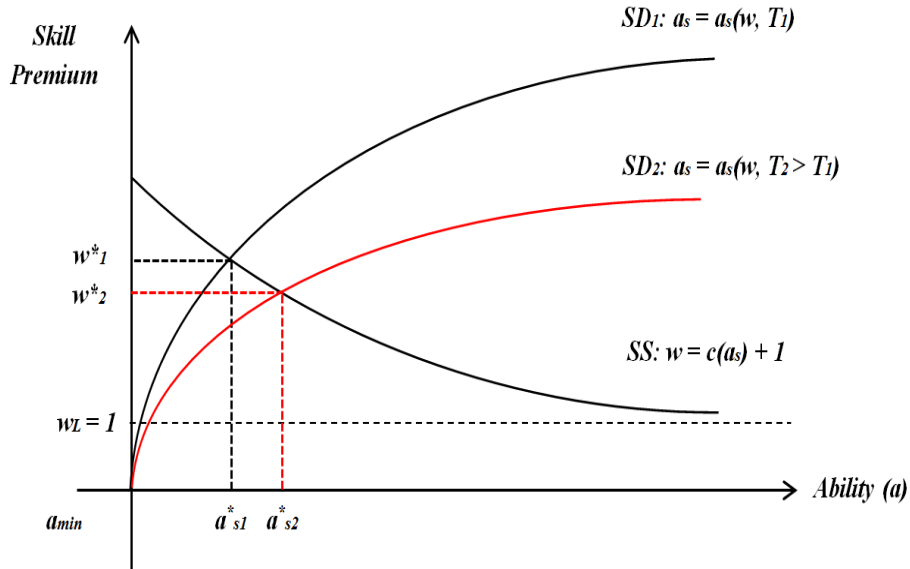[24] *Balance payment holds due to Walrasian Law.*

Figure 8: Impact of Trade Liberalization

decreases the willingness of purchasing education and increases ability cutoff a_s. The equilibrium is determined by the intersection of SD and SS.

Corollary 1. *In the equilibrium, skill wage w is no less than unskilled wage and the cutoff ability satisfies* $a_s < a_e < a_x$, *i.e., there is positively sorting to occupations based upon innate ability.*

The proof of Corollary 1 is immediate. w is no less than unskilled wage ($w_L = 1$) is derived from equation (16). As $c(a) \geq 0$, $a_e > a_s$ is confirmed from (49). Lastly, $a_x > a_e$ holds according to Assumption 4.2.3 and equation (19).

Proposition 2. *Trade liberalization (reducing f_x or τ) decreases skill premium and increase college dropout rate.*

The impact of trade liberalization on return to skill is driven by the supply channel in the model, which is quite different from previous studies such as Burstein and Vogel (2010), Harrigan and Reshef (2011) and Parro (2013). They emphasize the demand channel through which skill premium responds to trade liberalization. Specifically, they rely on the role of biased technology change induced by trade liberalization, such as complementarity between capital and skill, in affecting skill premium. The finding is consistent with Shastry (2012) in that the rise of skilled wage premium induced by globalization could be mitigated if human capital responds to global opportunities which is exactly what this model present and is ignored by the previous studies on skill premium.

Figure8 illustrates how skill premium responds to the trade shock. Due to selection effect of trade liberalization, the less able entrepreneurs shut down their business and change their occupation to

skilled workers, which increases the aggregate supply of skilled labor and leads to a drop in skilled wage. Trade policy that improves openness shifts SD curve downward (from $SD1$ to $SD2$ with $T_2 > T_1$), while SS curve is not influenced. As return to college decreases, fewer people are willing to buying education and the college dropout rate rises, i.e., a_s^* increases, which is also found in Atkin (2012).

Corollary 2. *Trade liberalization (reducing f_x or τ) increases entrepreneur ability cutoff a_e and the relative supply of skilled labor H^S/L^S.*

Relative employment of skilled workers increases as they become more favorable by entrepreneurs due to the decrease of skilled wage. Trade liberalization increases entrepreneur's cutoff a_e as a consequence of two opposite effects. Firstly, due to pro-competitive effect of trade, the less productive firms exit domestic market and are replaced by the more productive foreign counterparts, which increases the manager's cutoff. Secondly, as skilled wage drops, the opportunity cost of being entrepreneur also decreases, which leads to more entrepreneurs by decreasing the cutoff a_e. The former effect dominates the latter overall.

Proposition 3. *Trade liberalization (reducing f_x or τ) affects exporting cutoff a_x depending on the education cost. Specifically, reduction in exporting fixed cost f_x or per-unit trade cost τ decreases (increases) exporting cutoff when $|c'(a)|$ is sufficiently small (large), i.e., schooling cost exhibits little (great) difference across innate abilities.*

One intriguing implication of Proposition 3 is that the selection effect of trade liberalization depends crucially on the education scheme of a country. When schooling cost exhibits some difference (but not much) across innate abilities, selection effect functions in the same way as Melitz (2003) as well as the subsequent trade models. However, if the school cost exhibits extraordinary difference across innate abilities there is over-selection induced by trade liberalization, i.e., the cutoff of exporting firms also increases. The difference of selection effects in these three models is presented in Table 1. As shown in the table, the selection effect is measured as the ratio of productivity cutoff between exporting firm and domestic firm ($a_x/a_e > 1$). The first row of Table 1 gives the original measures of selection effects implied by each model. The second and third rows present the change of selection effects after a reduction in variable trade cost τ and fixed exporting cost f_x. As shown in the table, trade liberalization ($\hat{\tau} < 1$ and $\hat{f}_x < 1$) decrease the magnitude of selection effect ($\widehat{a_x/a_e} < 1$) in both Melitz (2003) and Dinopoulos and Unel (2015). While in the baseline model, selection effect also depends on the change of skilled wage and that is further determined by the cost schedule of education. Specifically, when education cost is in good shape (there is no magnificent drop with the marginal increase of ability), the change of skilled wage is modest and it cannot overturn the decrease of selection effect ($\widehat{a_x/a_e} < 1$), in which case the implication of baseline model is the same with Melitz (2003) and Dinopoulos and Unel (2015). However, if the education cost is steep around the equilibrium states, the drop of return to college could be so large ($\hat{w}$ is very small) that the selection effect is overturned ($\widehat{a_x/a_e} > 1$).
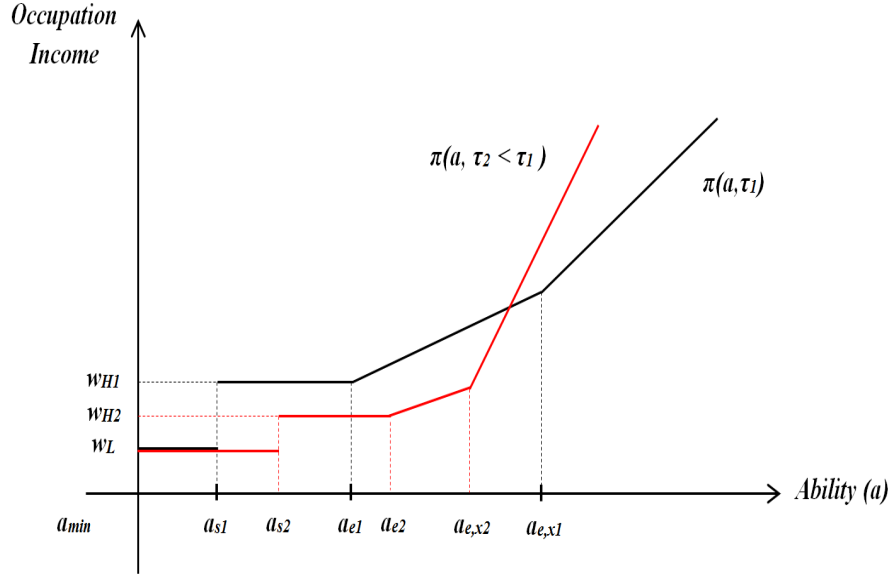
Occupation Income

$\pi(a, \tau_2 < \tau_1)$

$\pi(a, \tau_1)$

w_{H1}
w_{H2}
w_L

Ability (a)

a_{min} a_{s1} a_{s2} a_{e1} a_{e2} $a_{e,x2}$ $a_{e,x1}$

Figure 9: Impact of Reducing Per-unit Trade Cost τ on Income Distribution

Table 1: Selection Effect Comparison

$\sigma > 1$	Melitz (2003)	Dinopoulos (2016)	Baseline
a_x / a_e	$\tau \left(\dfrac{f_x}{f_d} \right)^{\frac{1}{\sigma-1}}$	$\dfrac{2f_x}{(\Psi_0 + 2f_d)\tau^{1-\sigma}(2+\tau^{1-\sigma})}$	$\dfrac{f_x}{w\tau^{1-\sigma}(2+\tau^{1-\sigma})}$
$\widehat{a_x / a_e}$ due to $\hat{\tau}$	$\hat{\tau}$	$\dfrac{2+\tau^{1-\sigma}}{\hat{\tau}^{1-\sigma}(2+\hat{\tau}^{1-\sigma}\tau^{1-\sigma})}$	$\dfrac{2+\tau^{1-\sigma}}{\hat{\tau}^{1-\sigma}(2+\hat{\tau}^{1-\sigma}\tau^{1-\sigma})} / \hat{w}$
$\widehat{a_x / a_e}$ due to $\hat{f}_x$	$\hat{f}_x^{\frac{1}{\sigma-1}}$	$\hat{f}_x$	$\hat{f}_x / \hat{w}$

Notes: f_d and f_x denote the domestic and exporting fixed costs; σ is the CES elasticity of substitution; τ is the ice-berg trade cost; Ψ_0 captures the labor market friction and is assumed to be an exogenous constant parameter; w denotes the skill premium in the baseline model. $\hat{x} \equiv x'/x$ where x is the value before some shock and x' denotes the value after some shock.

Proposition 4. *If schooling cost exhibits small difference across innate abilities, i.e., $|c'(a)|$ is sufficiently small, trade liberalization induced by reducing variable trade cost τ leads to labor market polarization by:*

1. expanding low income group $da_s/d\tau < 0$

2. squeezing middle income for skilled workers $dw/d\tau > 0$ and the small-firm owners $d\pi_d(a)/d\tau > 0$

3. boosting the top income $d\pi_x(a)/d\tau < 0$ and $da_x/d\tau > 0$

Above analysis indicates that school cost plays an important role in determining the wealth distribution due to trade liberalization. As shown in Proposition 4, when schooling cost exhibits small

difference across innate abilities, the model predicts the drop of skill premium and the rise of labor market polarization in response to trade liberalization, which is consistent with our empirical evidence in China. In the following welfare analysis, we study the case where $|c'(a)|$ is small.

Proposition 5. *Trade liberalization*

    1. increases both nominal and aggregate real output;

    2. has an ambiguous impact on the aggregate real consumption. Specifically, when preference exhibits weak degree of love-variety, trade liberalization increases the real consumption overall.

The impact of trade liberalization on real consumption is mixed. It raises the aggregate level of nominal output, and this raises the real consumption. In the meanwhile, the loss of variety due to over-selection boosts the price index decreasing the real consumption. The net outcome is determined crucially by the degrees of love of variety. However, when consumers care less on varieties, we show that trade liberalization increases the real consumption.

5 Empirical Evidence

In this section, we test the main predictions of the model that a reduction in variable trade cost suppresses the returns to college, and leads to the selection of business activity (decreases the extensive margins of business activity and increases the profitability conditional on entry), as well as induces labor market polarization. To do so, we start by describing the construction of the key explanatory variable *ExportShock* (expansion measured in exports per worker, in units of thousand dollars). We then introduce the instrument variable for this export expansion measure, which capitalizes the tariffs faced by Chinese exporters of different sectors.

5.1 Export Shock Measures

The identification relies on variation that regions in China differ in their composition of employment across industries and the fact that tariff changes vary across industries.The heterogeneous exposure to export shock ultimately affects our interested variables to the different extent, as further discussed below. This method is inspired by various studies using micro-level data to evaluate local effects of trade liberalization[25]. We follow the previous studies, such as Wang (2015); Bombardini and Li (2016), by assuming that labor is sufficiently immobile across regions (cities/prefectures) in China, so that we are able to exploit the regional heterogeneity in exposure to trade liberalization to identify the potential effects on outcome variables. In the spirit of David, Dorn, and Hanson (2013), similar with Wang (2015) and Bombardini and Li (2016), export index is defined as the prefecture level employment-weighted sum of exports per worker,

$$Export_{r,t} = \sum_k \frac{L_{rk,t-2}}{L_{r,t-2}} \frac{EX_{k,t}}{L_{k,t-2}} \tag{33}$$

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[25]Related literature includes Kovak (2013); David, Dorn, and Hanson (2013); Edmonds and Pavcnik (2006).

where $L_{rk,t}$ stands for the number of employment in industry k, region r, in year t; $L_{r,t}$ is the size of total employment in region r and in year t, and $EX_{k,t}$ denotes China's total export of industry k in year t. The index depends on the concentration of employment in export-intensive industries within each location. As the employment composition does not affect the regional export exposure, we difference the (33) to obtain[26]:

$$\Delta Export_{r,t} = \sum_k \frac{L_{rk,t-2}}{L_{r,t-2}} \frac{\Delta EX_{k,t}}{L_{k,t-2}} \tag{34}$$

$\Delta Export_{r,t}$ measures thousand dollar value of export expansion on a per-worker basis in region r[27]. The variation of $\Delta Export_{r,t}$ stems from the initial difference in the composition of employment across regions, and it is a feature common to the Bartik method.

Even after including many controls, we are still concerned with the potential endogeneity issue of the export expansion measure, given in (34). Firstly, one may concern that the local productivity or factor supply change may affect local export, and this may also influence the outcome variable in the mean time. This type of endogeneity is controlled by the measure of (34), as we employ the weighted average export expansion at the national level (not at the local level). The second type of endogeneity is the omitted variables. For example, export expansion and domestic demand could be positively correlated. Due to the lack of demand data, the identification could suffer from this omitted variable issue. The main endogeneity issue stems from the fact that other time and region-specific shocks could be correlated with industry shock at the national level. For instance, the national shock will coincide with the local shock if an industry clusters in specific regions while these regions specialize in this industry. In this situation, $\Delta Export_{r,t}$ as constructed in (34) is not able to generate the exogenous local shock from the national shocks. To tackle this issue, we need to construct instrument variable (IV) to isolate the changes of export at the national level due to changes purely in foreign demand. We choose to capitalize the change of average exporting (to the rest of the world) tariff of China, which is denoted as $ExportTariff_t$ and is constructed as the weighted average of tariff shown below

$$ExportTariff_{k,t} = \sum_j \frac{EX^j_{k,t-2}}{EX_{k,t-2}} \tau_{kj,t} \tag{35}$$

where $\tau_{kj,t}$ standards for the tariff imposed by country j in sector k and year t; $EX^j_{k,t}$ denotes the total export of sector k to country j in year t, and $EX_{k,t} = \sum_j EX^j_{k,t}$ is the China's total export of sector k in year t. We believe the tariff is exogenous in the sense that they are determined by political consideration and other countries' trade policy, which is unlikely to be correlated with China's internal shocks.

Given the measures of $ExportTariff_{k,t}$, we follow Bombardini and Li (2016) and assume the

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[26]One can difference (33) with two subsequent years, or with some base years e.g., 2000, the years before China's joining WTO, as adopted in Wang (2015). Both difference ways give the similar empirical conclusion.

[27]It is equivalent to the import value change at commuting zone level in David, Dorn, and Hanson (2013).
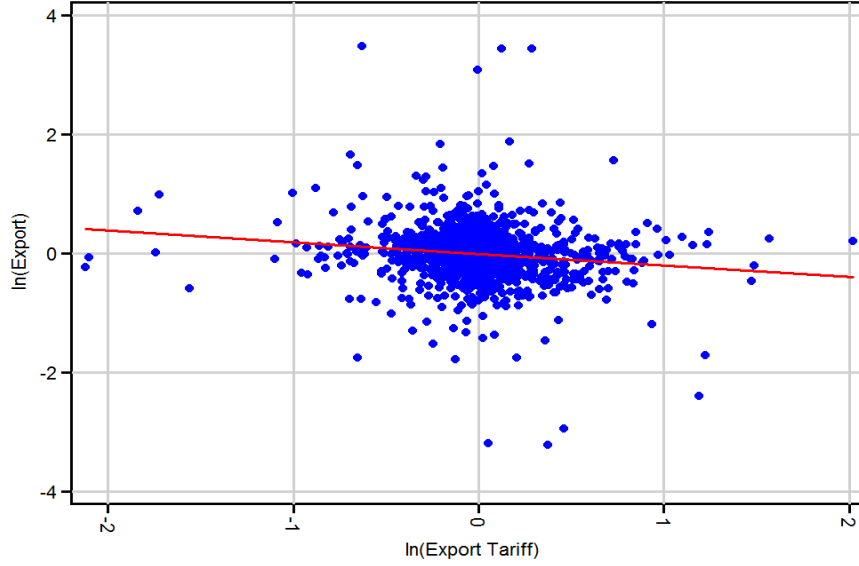
Note: Both axes report the residuals of the variable after controlling the time and sector fixed effects.

Figure 10: Relationship Between $\ln Export$ and $\ln ExportTariff$

China's export can be explained by the reduction in tariffs faced by exporters with the specification as shown blow

$$\ln EX_{kt} = \delta_k + \eta_t + \gamma \ln ExportTariff_{kt} + \epsilon_{kt} \tag{36}$$

where δ_k and η_t denotes sector and time fixed effects. The regression result is presented in Figure 10, which presents the clear negative slope between tariff and export. The point estimate indicates that a 1% rise in export tariff decreases China's export by 0.19%. This effect is highly significant and economically sizable. Given the estimated parameters, we then obtain the predicted export $\hat{X}_{kt}$ using (36),

$$\hat{EX}_{kt} = exp(\hat{\delta}_k + \hat{\eta}_t + \hat{\gamma} \ln ExportTariff_{kt})$$

With the predicted value of export, we construct the instrument variables using (34) as follows[28]

$$\widehat{\Delta Export}_{r,t} = \sum_k \frac{L_{rk,t-2}}{L_{r,t-2}} \frac{\Delta \hat{EX}_{k,t}}{L_{k,t-2}} \tag{37}$$

The instrument is exogenous in the sense that it is resulted from the trade policy of other countries and is unlikely to be affected by the change of local market as well as the domestic demand in China. In this sense, this instrument is also able to tackle another endogeneity issue, i.e., the omitted variables.

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[28]We construct the change by differencing between the subsequent years, and one can also differencing with the base year, i.e. 2000. Both ways do not influence the main conclusion.

5.2 Empirical Strategy

In this section, we describe our specifications to test model. Specifically, a decline in variable trade cost decreases the returns to college; leads to the selection of business activity; and induces labor market polarization.

5.2.1 Return to College

The first main prediction of the model is that the trade liberalization suppresses the relative returns to the skilled workers, as shown in Proposition 2. To do so, we employ the specification as follows,

$$\ln w_{ict} = \beta_0 + \beta_1 College_{ict} + \beta_2 College_{ict} \times ExportShock_{ct} + \mathbf{I}_i \gamma' + \mathbf{R}_{ct} \delta' + \mu_t + \lambda_c + e_{ict} \tag{38}$$

where $\ln w_{ict}$ is the logarithmic labor income of individual i in prefecture c in year t, $College_{ict}$ is the dummy variable which equals unity if individual i obtains a college degree (or above), $College_{ict} \times ExportShock_{ct}$ is the interaction term of college dummy and the export shock measure, $\mathbf{I}_i$ is the collection of individual characteristics variables that control for marriage status, gender, experience and minor ethnicity, $\mathbf{R}_{ct}$ denotes the controls for the local labor market that include regional average wage level and the population of total labor force. Finally, μ_t and λ_c are the time and city fixed effects that control for other common time trend and regional time-invariant unobserved characteristics[29]. According to (38), relative returns to skilled labor is $\beta_1 + \beta_2 \times ExportShock_{ct}$. The model predicts that export expansion are associated with the decline of return to college, and it implies $\beta_2 < 0$.a detail report of this dataset can be found in Griffin, Zhao, et al. (1993) and Gustafsson, Shi, and Sicular (2008)

5.2.2 Selection Effect on Business Activity

The second main prediction of the model indicates that trade liberalization selects the more talented manager to serve the market, i.e., the extensive margin of business activities are to decline in regions with the rapid expansion of export all else equal. Similar with Dinopoulos and Unel (2015), the business activity referred in the model is close to the entrepreneurship, whereas in the data we corresponds it to the household reported business income. To reduce the misalignment due to data limitation, we consider a business activity is a real business if the generated profit is large enough, i.e., we exclude the small business, such as selling in cart, from the definition of business activity[30].

We test the extensive margins by employing the probability models as shown in specification (39)

$$Prob(BI_{hct} > 0) = \rho_0 + \sum_{i \in \{High, Low/Mid\}} \rho_{1i} BusinessType_i \times ExportShock_{ct} + u_g^1 + \gamma_{ct}^1 + v_{hct}^1 \tag{39}$$

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[29]We refer region as the city in CHIP and the province in CHNS due to data limitation. In the regression tables, we also control for time-region specific effect for CHIP, in which case we do not include the regional characteristics.

[30]We consider the business activity is real if the generated profit accounts for at least 50% of the total household income.

where BI_{hct} stands for the business income of household h in region c and time t, and $Prob(BI_{hct} > 0)$ denotes the probability that a household have their own business. $ExportShock_{ct}$ is the export expansion measures, u_g^1 are the income class (high, middle, and low type) fixed effects that control for the fact that household of the high, intermediate and low-income groups may systematically differ in their motivation of starting business. γ_{ct}^1 denotes the region-time specific fixed effects. The model predicts that the export expansion increases the ability cutoff of entrepreneurship as shown in Corollary 2, and we test this hypothesis with (39) using logit and probit model. We expect $\rho_{1i} < 0$ in general.

Next, we turn to the adjustment of the intensive margin of business activities to global opportunities. Based on the theory, trade liberalization reallocates resource towards the most productive entrepreneurs, which increases the return to entrepreneurship conditional on surviving. We test this hypothesis by employing the specification shown in (40)

$$\ln(BI_{hct}|BI_{hct} > 0) = \delta_0 + \sum_{i \in \{High, Low/Mid\}} \delta_{1i} BusinessType_i \times ExportShock_{ct} + u_g^2 + \gamma_{ct}^2 + v_{hct}^2 \quad (40)$$

where $\ln(BI_{hct}|BI_{hct} > 0)$ denotes the business income of household h in city c and year t, in nature log. $ExportShock_{ct}$ is the export shocks, u_g^2 are the income class fixed effects, and γ_{ct}^2 denotes the region-time specific fixed effects. We would expect $\delta_1 > 0$. Moreover, Proposition 4 also implies the effects on business income are heterogeneous on the types of business activities. Specifically, it shrinks the profit margin of small and medium firms (firms who do not export) while increases profit of the large firms (firms who are engaged in export). To illustrate this heterogeneity, we adopt an alternative specification as shown in (41)

$$\ln(BI_{hct}|BI_{hct} > 0) = \tilde{\delta}_0 + \sum_{i \in \{High, Low\}} \tilde{\delta}_{1i} BusinessType_i \times ExportShock_{ct} + u_g^3 + \gamma_{ct}^3 + v_{hct}^3 \quad (41)$$

where the new term $BusinessType_i$, $i \in \{High, Low\}$ is the dummy variable that equals unity if the business is owned by the household from income group i [31]. Being not able to observe whether the business activity is involved in export and motivated by the motivational evidence that the business income from high-income group accounts for a sizable proportion of the total society income [32], we argue that the business activities from the high-income group household benefit more from trade liberalization, i.e., the likelihood of exporting for high-income group are higher than the other groups due to the ability selection. As a result, we expect $\tilde{\delta}_{1H} > \tilde{\delta}_{1L} > 0$.

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[31] We combine the middle and low-income group and denote it as *Low*, with high-income group remains the same with *High*.

[32] The high-income group has a higher probability of having self-business and generating larger business income compared to the middle and low income groups. The proportion of households having self-business are 4.6 for the low/middle-income groups, and 5.3% for the high-income group. The average business income per household is 5854 RMB for high-income group 1407 RMB for the low/middle-income groups.

5.2.3 Labor Market Polarization

Lastly, we turn to the induced labor market polarization due to export expansion, which is implied by Proposition 4. We test this hypothesis from two aspects, namely the demographic change and income redistribution of each income group. Firstly, trade liberalization increases the population share of the low and high-income group and decreases that of the middle-income group (demographic change). To do so, we employ the specification as shown in (42) .

$$\ln PopShare_{gct} = \alpha_0 + \sum_{s \in \{H,M,L\}} \alpha_s Group_s \times ExportShock_{ct} + \mathbf{R}_{ct}\delta' + u_g + \mu_t + \lambda_c + e_{ict} \qquad (42)$$

where $PopShare_{gct}$, $g \in \{H, M, L\}$ is the population share of group g in city c and year t. $Group_s$ denotes the dummy variable that equals unity if the observation is from group $s \in \{H, M, L\}$. $\mathbf{R}_{ct}$ controls for the local labor market characteristics including regional average wage level and population of total labor force. Finally, u_g, μ_t and λ_c stand for the income group, time and city fixed effects. Polarization in demography implies $\alpha_H > 0$, $\alpha_L > 0$ and $\alpha_M < 0$.

Next, labor market polarization also implies that the total society income is allocated more towards the low and high type income groups (income redistribution). We adopt a similar specification to the one testing demographic change, which is given in (43)

$$\ln IncomeShare_{gct} = \kappa_0 + \sum_{s \in \{H,M,L\}} \kappa_s Group_s \times ExportShock_{ct} + \mathbf{R}_{ct}\delta' + u_g + \mu_t + \lambda_c + e_{ict} \qquad (43)$$

where $IncomeShare_{gct}$, $g \in \{H, M, L\}$ is the aggregate income share of group g in city c and year t. $Group_s$ denotes the dummy variable that equals unity if the observation is from group $s \in \{H, M, L\}$. $\mathbf{R}_{ct}$ are the city controls and u_g, μ_t and λ_c stand for the income group, time and city fixed effects. Polarization in income distribution implies $\kappa_H > 0$, $\kappa_L > 0$ and $\kappa_M < 0$.

5.3 Data Source

The empirical analysis involves various dataset, such as household survey, manufacture firm surveys, customs data of China. This section describes the main sources of data that is used in the empirical analysis.

5.3.1 Micro Survey Data

The micro-level information sources from the China Health Nutrition Survey (CHNS) and the China Household Income Project (CHIP). China Health Nutrition Survey was funded by the National Institutes of Health, designed to evaluate the effects of government policy on public health and nutrition intake. Despite that CHNS is a health related micro survey, it also provides rich information on respondents' wealth and income. Several studies have used this dataset to research on the inequality issues, such as Zhang and Wan (2006); Liu (2008); Goh, Xubei, and Nong (2009). The Chinese

Household Income Project was launched by the Chinese Academy of Social Science and the Ford Foundation. It is a widely used dataset for studying labor market, migration and inequality. A detailed report of CHIP can refer to Griffin, Zhao, et al. (1993) and Gustafsson, Shi, and Sicular (2008). As CHIP provides more disaggregated regional information (city-level) than CHNS (province-level), we use CHIP as the baseline and CHNS for robustness checks.

In the analysis, we refine the sample to the years between 2000 and 2008 [33]. As the both surveys are conducted every several years, the time periods covered in the analysis are 2000, 2004 and 2006 for CHNS, and 1999, 2002 and 2007 for CHIP, respectively. The regions included widely spread across the mainland[34]. We have enough time and region variations to identify the causal effect of export expansion on our variables of interest.

5.3.2 Annual Survey of Industrial Production

The annual total region-industry specific employment and average wage are derived from the Annual Survey of Industrial Production (ASIP) conducted by the National Bureau of Statistics of China. The dataset surveys all types of firms (state owned / non-state owned) whose revenue is more than five million RMB each year in the manufacturing sector. The sample size varies from 165,119 in 1998 to 336,768 in 2007. Besides the rich essential firm-level information, such as employment, output, the annual survey also provides the complete information on three major accounting statement- "Balance Sheet", "Profit & Loss Accounts" and "Cash Flow". The detailed information regarding ASIP can refer to Brandt, Van Biesebroeck, and Zhang (2014). The industry classification of ASIP uses China Standard Industrial Classification (GB/T4754- 1984, GB/T4754-1994 and GB/T4754-2002) at the 4-digit level.

5.3.3 Export Tariff and Export Data

The foreign tariff data sources from the Trade Analysis and Information System (TRAINS) database, which is maintained by the United Nations Conference on Trade and Development (UNCTAD). The raw tariff data is withdrawn with the simple average by destination-industry (HS 6-digit level). The export information is derived from China Custom Dataset, which provides the annual trade data on values and quantities at the HS 8-digit level by transaction for the period 1998 to 2008. This dataset covers the universe of Chinese exporters.

As the industry classification are different between the Annual Survey of Industry Production (CSIC 4-digit) and tariff and China Custom Dataset (HS 6-digit), we correspond them to International

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[33] As the earlier available export data is 1998 and we uses the lag of two, the starting year is thus 2000. To avoid the systematic financial crisis shock in 2008, we focus on the time before it, during which periods there are rich variations in tariff cut across regions over time.

[34] In CHNS, the refined sample covers nine provinces, namely Liaoning, Heilongjiang, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, and Guizhou. In CHIP, the refined sample includes 14 provinces and 66 cities. The sample includes Beijing, Shanxi, Liaoning, Shanghai, Jiangsu, Zhejiang, Hanhui, Henan, Hubei, Guangdong, Chongqing, Sichuan, Yunnan, and Gansu.

Standard Industrial Classification (ISIC) revision three at the 4-digit level to construct various export shock measures in practice.

5.4 Main Results

5.4.1 Return to College

In this section, we report the results of estimated effect of $ExportShock_{ct}$ on return to college as shown in equation (38). The results are presented in Table 2 for CHIP. The first four columns report the results using Bartik method as shown in (34). Columns (1) through (4) employ different controls and fixed effects. In particular column (4) controls for region-year specific effects to account for omitted variables, such as the supply of skilled labors, that could be contemporaneously evolving in different regions and years in China and correlated with the export expansion. Columns (5) through (8) repeated the estimation by using the instrument variable as constructed in equation (37). From Table 2, workers with a college degree (or above) earn 39% to 45% higher wage than the ones without a college degree. As shown by the coefficients of $ExportShock_{ct}$, regions with rapid export expansion have a higher average wage for the unskilled workers. Our variable of interest is the interaction term, which is significantly negative across all the regressions. We choose column (8) of Table 2 as the preferred specification. Accordingly, a one standard deviation increase in $ExportShock_{ct}$ decreases the skill premium by about 2.3% (the standard deviation of the instrumented export shock measure is about 7.95)[35].

5.4.2 Selection Effect on Business Activity

In this section, we summarize estimation results regarding the selection of business activities. Table 3 reports the results of the extensive margin of business (the likelihood that a household is involved in business activities), and Table 4 presents the results of the intensive margin (the size of business activity, in terms of the total income from it). The discussion of this section focuses on the baseline case (CHIP sample). In Panel B of Table 3, columns (1)-(2) and (5)-(6) report the estimated coefficients of overall effects. Both Bartik method and IV reveal the significantly negative effects of export expansion on the extensive margins business, under both logit and probit models. According to the point estimate of columns (5) and (6), a standard deviation increase of $ExportShock_{ct}$ decreases the log odds of owning self-business by -6.2 to -13.1 for Probit and Logit models, respectively. We further calculate the marginal effect by evaluating the probability using the estimated parameters at the mean values of the explanatory variables. It is estimated that a 1 million USD per worker $ExportShock_{ct}$ decreases the probability of self-business by about 5.9% (Logit) to 6.5% (Probit). Columns (3)-(4) and (7)-(8) present the evidence of heterogeneity in the extensive margin changes of business activities on business types. All the point estimates indicate that the adverse effect of $ExportShock_{ct}$ are more

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[35]From 2001 to 2007, the $ExportShock_{ct}$ has increased by about 1.81 standard deviation (the mean is 1.27 in 2001 and 15.65 in 2007). This implies trade liberalization decreases the return to college by about 4.2% since China joined the WTO.

pronounced for the business activities of the middle and low-income groups. Trade liberalization triggers the selection of the least able managers out of the market.

We then turn to the intensive margin adjustment of the business activity, as reported in CHIP part of Table 4. Columns (5) and (7) report the overall effect of export expansion, which is both positive and significant. According to column (7), According to column (7), a standard deviation increase of $ExportShock_{ct}$ increases business income by 44% conditional on being active in the market. To see the magnitude, it is estimated that the average business income has increased by about 60% from 2001 to 2007. Similarly, columns (6) and (8) reports the heterogeneity pattern across business types. As expected, the magnitude of point estimate is larger for business activities from the high-income group, who also benefit more from trade liberalization.

5.4.3 Labor Market Polarization

Finally, we summarize the effects of $ExportShock_{ct}$ on the labor market polarization. The results are reported in Table 5. Column (1) through (4) reports the results using Bartik method, and columns (5) to (8) for IV approach. The demographic change is presented in Panel (A) of Table 5. The point estimates are quite stable across specifications. A one million USD per worker $ExportShock_{ct}$ increases the population share of the high-income and the low-income groups by about 0.9% to 1.4% and 1.1% to 1.8%, while decreasing the population share of the middle-income group by about 0.4% to 0.9%. According to point estimates of column (8), the overall demographic changes from 2001 to 2007 are 12.4% for the high-income group, -11.3% for middle-income group, 17.8% for the low-income group. Panel (B) reports the results of income distribution changes in response to trade liberalization. The point estimates indicate that not only does the population distribution reveal a polarized pattern, but so, in general, are the overall income distribution. Based on the estimates of column (8), during 2001 to 2007, the total income have increased by 20.4% and 14.1% for the high and low-income groups, while declined by -12.3% for the middle-income group. Jointly applying the estimate of the demographic changes, trade liberalization has increased the average per-household income by 7% for the high-income group, decreases it by 3.1% for the low-income and 1.1 % for the middle-income group. The patterns revealed by demographic change and income distribution are both consistent with our theory (Proposition 4), i.e., export expansion leads to the labor market polarization.

5.5 Robustness

For robustness, we apply the same specifications to CHNS dataset. Table 6 reports the results regarding skill premium, where we refer region as province due to data limitation. Similarly, we report the result of Batik method from column (1) to (4), and results of IV from column (5) to (8). As shown in the table, we still observe that expansion of export suppresses the relative return to skills. A one standard deviation rise in $ExportShock_{ct}$ decreases the skill premium by about 6.8%, which is about three times as large as the results of using CHIP. To see the magnitude, we translate it to the overall percentage decrease in skill premium from 2001 to 2007. As $ExportShock_{ct}$ increases by about 1.81

standard deviations, it implies that trade liberalization is estimated to decrease the return to college by about 12.3%.

Panel (A) of Table 3 reports the results of the extensive margin of the business. According to columns (5) and (6), a one million USD per worker rise of $ExportShock_{ct}$ decreases the probability of self-business by about 3.2% (Logit) to 3.1% (Probit), which is quite close to the results of CHIP in magnitude. The heterogeneous effects remain stable, as shown in columns (3)-(4) and (7)-(8). Trade liberalization triggers the selection of the least able managers out of the market. Table 4 reports the point estimates of business intensive margin adjustment in the left panel, denoted by "CHNS". Column (1) and (3) present the overall effects, and column (2) and (4) explores the heterogeneity. According to column (3), a standard deviation increase of $ExportShock_{ct}$ raises the business income by about 10% for the surviving businessman. From 2001 to 2007, the average household business income has increased by approximately 22.7%, and the rise of business income is more pronounced for the high-income group than middle/low-income group.

Finally, we re-evaluate the labor market polarization using CHNS and report the results in Table 7. Columns (1) through (4) present the regressions with population share as dependent variables, and columns (5) through (8) summarize the outcome regarding the income distribution. As each observation is at province level, the number of observation is much smaller than our baseline case. Despite that the significant level of coefficients of the interaction terms declines due to limited observations, we are still able to observe the clear pattern that trade expansion increases the population and income share for the high/low-income groups while decreasing both for the middle class. According to column (4) and (8), during 2001 to 2007, the population shares of high/low-income groups have increased by 17.0% and 13.4%, respectively, while the middle class' population share have decreased by about 4.6%. In the meanwhile, the total income has increased by 21.2% for the high-income group, and 6.0% for the low-income group, with 14.5% declines for the middle class. The change of overall income and population indicates that the average income per household have increased by 3.6% for the high-income group, and have decreased by 10.3% and 6.5% for the middle-income and low-income groups.

6 Concluding Remark

The goal of this paper is to study the relationship between trade liberalization and income distribution. To do so, we present three stylized facts since China joined the WTO: a) the relative return to college education (skill premium) has decreased; b) income polarization has increased substantially over the past decade; c) business activity has generated a large proportion of household income for the top earners, while being less important for the middle class.

We then present a novel tractable general equilibrium trade model that incorporates the heterogeneous firms, endogenous firm productivity, and occupational choice. In the model, individuals with low ability become low skilled workers; the ones with intermediate ability become skilled workers

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or create and manage the small and medium firms that serve the domestic market only; the high-talented individuals become entrepreneurs operating the large firms that serve the global market via exporting. Selection effect of trade raises the opportunity cost of setting up firms, which unambiguously increases the supply of skilled labor by selecting out the less productive domestic firms, and return to skill drops as a result. We show that when education cost exhibit limited difference across abilities, a reduction in variable trade cost raises the inequality among the top group, and generate labor market polarization by hurting the middle-income households and by raising the top incomes.

Finally, using several datasets, the main predictions of the model are examined and validated. According to our estimation, up to 2007, China's WTO entry in 2001 has decreased the returns to college by about 4.2% to 12.3%. The welfare gains from trade are found to be polarized across the income distribution. Trade liberalization is estimated to increase the average household income by 3.6% to 7.1% for the high-income group, and to decrease the average household income by 1.1% to 10.4% and 3.1% to 6.5% for the middle and low-income groups, respectively. Overall, this paper is the first to show and confirm the key mechanisms underlying the WTO effect on the income distribution in labor market of China. We believe this research makes a positive contribution to the trade liberalization study by expanding our understanding of the channels that raises the unequal gains, which are both policy relevant and academically robust.

Appendix

Theoretical Appendix

Characterization of Equilibrium

The equilibrium can be solved by uncovering three ability cutoff a_s, a_e and a_x, as well as skill premium w via the system of equations as shown below

$$w = c(a_s) + 1 \tag{44}$$

$$a_x = \frac{f_x}{w(\eta^2 + 2\eta)} a_e \tag{45}$$

$$a_s^{-k} - a_e^{-k} = \frac{2k\alpha(\sigma - 1)}{k - 1} \times \frac{(\eta^2 + 2\eta)a_x^{-k+1} + a_e^{-k+1}}{a_e} \tag{46}$$

$$1 - a_s^{-k} = \frac{2k(1 - \alpha)(\sigma - 1)w}{k - 1} \times \frac{(\eta^2 + 2\eta)a_x^{-k+1} + a_e^{-k+1}}{a_e} \tag{47}$$

where (44) characterizes the cutoff ability of schooling; (45) depicts selection to exporting; (46) and (47) comes from the labor market clearing conditions. For algebra convenience, let $T = (\eta^2 + 2\eta)^k / f_x^{k-1}$, the above system of equations reduces to

$$a_x = \left[\frac{\alpha\kappa Tw^{k-1} + \alpha\kappa + 1}{Tw^k} f_x \right]^{1/k} a_s \tag{48}$$

$$a_e = \left[\alpha\kappa Tw^{k-1} + \alpha\kappa + 1 \right]^{1/k} a_s \tag{49}$$

$$a_s = \left[\frac{\alpha\kappa Tw^{k-1} + \alpha\kappa + 1}{(1 - \alpha)\kappa Tw^k + \alpha\kappa Tw^{k-1} + (1 - \alpha)\kappa w + \alpha\kappa + 1} \right]^{-1/k} \tag{50}$$

$$w = c(a_s) + 1 \tag{51}$$

where κ is a constant defined as $\kappa = \frac{2k(\sigma - 1)}{k - 1}$.

Proof of Proposition and Corollary

Proposition 1

As $c(a)$ is continuous and strictly decreasing, $w \leq 1 + c(1)$ and there exists a inverse function $a_s = c^{-1}(w - 1)$. Define $H(w) = c^{-1}(w - 1) - a_s(w)$. It can be shown that

$$\frac{da_s}{dw} = \frac{1}{k} a_s^{k+1} \frac{(1 - \alpha)\kappa[\alpha\kappa T^2 w^{2k-2} + (2\alpha\kappa + k)Tw^{k-1} + (\alpha\kappa + 1)]}{[...]^2} > 0$$

One can easily derive the below limiting result:

$$\lim_{w \to 1^+} H(w) = +\infty$$

$$\lim_{w \to c_1 + 1} H(w) = 1 - a_s(c_1 + 1) < 1 - a_s(1) < 0$$

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where the first result comes from $\lim_{a \to +\infty} c(a) = 0$ and $c'(a) < 0$, and the second comes from the property $a_s'(w) > 0$ which is shown above. Therefore, there is a fixed point $w^* \in (1, c(1) + 1]$ such that $H(w^*) = 0$, which confirms existence. On the other hand,

$$H'(w) = 1/c'(w-1) - a_s'(w) < 0$$

and it confirms that the equilibrium is unique.

Proposition 2

By definition $T = \frac{(\eta^2 + 2\eta)^k}{f_x^{k-1}}$, trade liberalization (larger η or smaller f_x) increases T. According to (50),

$$\frac{da_s(w)}{dT} = \frac{1}{k} a_s^{k+1} \frac{(1-\alpha)\kappa w^k}{[...]^2} > 0$$

Applying implicit function theorem to $H(w^*, T) = 0$, one can derive

$$\frac{dw^*}{dT} = -\frac{H_T}{H_w} = \frac{da_s(w^*)/dT}{H_w} < 0$$

On the other hand

$$\frac{da_s^*}{dT} = \frac{1}{c'(w^* - 1)} \frac{dw^*}{dT} > 0$$

where the equality comes from $a_s^* = c^{-1}(w^* - 1)$.

In sum, trade liberalization decreases skill premium and increases skilled labor cutoff a_s (increases college dropout rate among the low ability group of people).

Corollary 2

As production function is in form of Cobb-Douglas,

$$\frac{H^S}{L^S} = \frac{H^D}{L^D} = \frac{\alpha}{1-\alpha} \frac{1}{w^*}$$

According to Proposition 2 ($dw^*/dT < 0$), it is immediately that $\frac{dH^S/L^S}{dT} > 0$. On the other hand, substituting $H^S = G(a_e^*) - G(a_s^*)$ and $L^S = G(a_s^*)$ in

$$\frac{H^S}{L^S} = \frac{H^D}{L^D} = \frac{\alpha}{1-\alpha} \frac{1}{w^*}$$

One can derive

$$G(a_e^*) = G(a_s^*) + \frac{\alpha}{1-\alpha} \frac{G(a_s^*)}{w^*}$$

$a_x = \left[\frac{T w^k / f_x}{(1-\alpha)\kappa T w^k + \alpha \kappa T w^{k-1} + (1-\alpha)\kappa w + \alpha \kappa + 1} \right]^{-1/k}$ Since $G'(a) > 0$ and trade liberalization (higher T) increases a_s^* and decreases w^* (Proposition 1), it is immediately that $da_e^*/dT > 0$

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Proposition 3

To study the effect of trade liberalization, a_x can be written in form of $a_x(f_x, T(f_x), w(T(f_x)))$ as shown

$$a_x = \left[\frac{Tw^k/f_x}{(1-\alpha)\kappa Tw^k + \alpha\kappa Tw^{k-1} + (1-\alpha)\kappa w + \alpha\kappa + 1}\right]^{-1/k}$$

Applying the Chain Rule, one can derive

$$\frac{da_x}{df_x} = \underset{(+)}{\frac{da_x}{df_x}} + \underset{(-)}{\frac{da_x}{dT}}\underset{(-)}{\frac{dT}{df_x}} + \underset{(-)}{\frac{da_x}{dw}}\underset{(-)}{\frac{dw}{dT}}\underset{(-)}{\frac{dT}{df_x}}$$

The net effect of reducing fixed cost seems to ambiguous. However, one can rewrite

$$\frac{dw}{dT} = \frac{dc(a_s)}{dT} = \frac{da_s}{dT}c'(a_s) = -\frac{da_s}{dT}|c'(a_s)|$$

The sign of da_x/df_x depends crucially on the shape of education cost $c(a)$. Specifically, when $|c'(a)|$ is sufficiently small (equal zero in the limiting case), it is immediate that reducing fixed cost f_x decreases ability cutoff of exporter ($da_x/df_x > 0$); when $|c'(a)|$ is sufficiently large in the other extreme (infinitely large in the limiting case), reduction of fixed cost f_x increases ability cutoff of exporter ($da_x/df_x < 0$).

Similarly, the effect of trade cost τ on a_x is derived as

$$\frac{da_x}{d\tau} = \left(\underset{(-)}{\frac{da_x}{dT}} - \underset{(-)}{\frac{da_x}{dw}}\underset{(+)}{\frac{da_s}{dT}}|c'(a_s)|\right)\underset{(-)}{\frac{dT}{d\tau}}$$

when $|c'(a)|$ is sufficiently small (equal zero in the limiting case), reduction of trade cost τ decreases ability cutoff of exporter ($da_x/d\tau > 0$); when $|c'(a)|$ is sufficiently large in the other extreme (infinitely large in the limiting case), reduction of trade cost τ increases ability cutoff of exporter ($da_x/d\tau < 0$).

Proposition 4

$da_s/d\tau < 0$ and $dw/d\tau > 0$ is confirmed by Proposition 2, and $da_x/d\tau > 0$ when $|c'(a_s)|$ is small is confirmed by Proposition 3. This part will prove $d\pi_d(a)/d\tau > 0$ and $d\pi_x(a)/d\tau < 0$.

Firstly, I show trade liberalization (decreases τ) decreases the income of small median (domestic) firms $d\pi_d(a)/d\eta < 0$ while increases income of large (exporting) firms [36] $d\pi_x(a)/d\eta > 0$. According to (15),

$$\pi_d(a) = \frac{w}{a_e}a, \quad \pi_x(a) = \frac{(1+\eta)^2}{a_e}a - f_x$$

As $dw/d\eta = dw/dT \times dT/d\eta < 0$ and $da_e/d\eta = da_e/dT \times dT/d\eta > 0$ by Proposition 2, the slope of profit function of domestic firms get smaller, i.e., $\frac{d(w/a_e)}{d\eta} < 0$. The the slope of profit function for

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[36]By definition $\eta = \tau^{1-\sigma}$, smaller τ implies larger η.

the marginal firm (cutoff a_e) is w, which is smaller after a rise in economy openness. Therefore, trade liberalization by reducing per-unit trade cost decreases small medium firms' profit $d\pi_d(a)/d\eta < 0$.

Next, I show trade liberalization (decreases τ) increases exporting firm's profit. Let $h(\eta) = (1 + \eta)/a_e^{1/2}$ denote the slope of exporting firms' profit, which can be expressed as

$$\frac{dh(\eta)}{d\eta} = a_e^{-\frac{1}{2}}[1 - \frac{1}{2}a_e^{-1}(\eta+1)\frac{da_e}{d\eta}] \tag{52}$$

On the other hand,

$$a_e = \left[(1-\alpha)\kappa Tw^k + \alpha\kappa Tw^{k-1} + (1-\alpha)\kappa w + \alpha\kappa + 1\right]^{\frac{1}{k}}$$

and therefore[37],

$$\frac{da_e}{d\eta} = \frac{da_e}{dT} \times \frac{dT}{d\eta} + \frac{da_e}{dw} \times \frac{dw}{d\eta} = 2a_e^{1-k} \times \frac{(\eta+1)}{\eta^2+2\eta}[(1-\alpha)\kappa Tw^k + \alpha\kappa Tw^{k-1}] + \frac{da_e}{dw} \times \frac{dw}{d\eta}$$

Substituting to (52), one can derive

$$\frac{dh(\eta)}{d\eta} = a_e^{-\frac{1}{2}}\left\{1 - a_e^{-k}\frac{(\eta+1)^2}{\eta^2+2\eta}[(1-\alpha)\kappa Tw^k + \alpha\kappa Tw^{k-1}]\right\} - \frac{1}{2}a_e^{-\frac{3}{2}}(\eta+1)\frac{da_e}{dw} \times \frac{dw}{d\eta}$$

$$= a_e^{-(\frac{1}{2}+k)}\left\{(1-\alpha)\kappa Tw^k + \alpha\kappa Tw^{k-1} + (1-\alpha)\kappa w + \alpha\kappa + 1 - \frac{(\eta+1)^2}{\eta^2+2\eta}[(1-\alpha)\kappa Tw^k + \alpha\kappa Tw^{k-1}]\right\} \tag{53}$$

$$- \frac{1}{2}a_e^{-\frac{3}{2}}(\eta+1)\frac{da_e}{dw} \times \frac{dw}{d\eta}$$

$$= a_e^{-(\frac{1}{2}+k)}\left\{(1-\alpha)\kappa w + \alpha\kappa + 1 - \frac{(1-\alpha)\kappa Tw^k}{\eta^2+2\eta} - \frac{\alpha\kappa Tw^{k-1}}{\eta^2+2\eta}\right\} - \frac{1}{2}a_e^{-\frac{3}{2}}(1+\eta)\frac{da_e}{dw} \times \frac{dw}{d\eta} \tag{54}$$

As $a_x = \frac{f_x}{w(\eta^2+2\eta)}a_e$, we have $(\eta^2+2\eta)w/f_x < 1$ due to selection effect. This inequality can be further written[38] as $\frac{Tw^k}{\eta^2+2\eta} < w$ or $\frac{Tw^{k-1}}{\eta^2+2\eta} < 1$. Applying these inequality to 53 and $\frac{da_e}{dw} \times \frac{dw}{d\eta} < 0$, it is immediately that

$$\frac{dh(\eta)}{d\eta} > a_e^{-(\frac{1}{2}+k)} > 0$$

Therefore $d\pi_x/d\eta > 0$.

Proof of Proposition 5

Aggregate nominal output $\mathcal{E}$ consist of two part [39]$(\mathcal{E} = C + M)$, and the real output is defined by $\mathcal{E}/P$. The total consumption is given by

---

[37]$dT/d\eta = T \times 2k(\eta+1)/(\eta^2+\eta)$ and $da_e/dT = a_e^{1-k}\left[(1-\alpha)\kappa w^k + \alpha\kappa w^{k-1}\right]/k$

[38]Jointly use the definition of T as well as the fact that $(\eta^2+2\eta)^{k-1}w^{k-1}/f_x^{k-1} < 1$.

[39]C is aggregate consumption and M is firm's service purchase.

$$C = 1 - a_s^{-k} + w(a_s^{-k} - a_e^{-k}) + \int_{a_e}^{a_x} \pi_d(a)dG(a) + \int_{a_x}^{+\infty} \pi_x(a)dG(a)$$

$$= \kappa(Tw^k + w)a_e^{-k} + \frac{k}{k-1}\frac{w}{a_e}[(\eta^2 + 2\eta)a_x^{-k+1} + a_e^{-k+1}] - f_x a_x^{-k}$$

$$= \left[(\kappa + \frac{1}{k-1})Tw^k + (\kappa + \frac{k}{k-1})w\right]a_e^{-k} \tag{55}$$

where the derivation uses $wH/L = \alpha/(1-\alpha)$, $a_x = \frac{f_x}{(\eta^2+2\eta)w}a_e$ and $T = (\eta^2 + 2\eta)^k/f_x^{k-1}$. Similarly, one can derive the aggregate nominal firm service purchase as

$$M = \int_{a_e}^{+\infty} \frac{\lambda z(a)^2}{2a}dG(a) + \int_{a_x}^{+\infty} f_x dG(a)$$

$$= \frac{k}{k-1}(Tw^k + w)a_e^{-k} + f_x a_x^{-k}$$

$$= \left(\frac{2k-1}{k-1}Tw^k + \frac{k}{k-1}w\right)a_e^{-k}$$

where the derivation uses $a_x = \frac{f_x}{(\eta^2+2\eta)w}a_e$ and $T = (\eta^2 + 2\eta)^k/f_x^{k-1}$. Given C, M and $\kappa = \frac{2k(\sigma-1)}{k-1}$, the aggregate nominal output is expressed as

$$\mathcal{E} = (\frac{2k}{k-1} + \kappa)(Tw^k + w)a_e^{-k}$$

$$= \frac{2k\sigma}{k-1}\frac{Tw^k + w}{(1-\alpha)\kappa Tw^k + \alpha\kappa Tw^{k-1} + (1-\alpha)\kappa w + \alpha\kappa + 1} \tag{56}$$

On the other hand, using (17) and definition of $A = P^\beta \mathcal{E}^{1-\beta}$ one can derive the real output as

$$\frac{\mathcal{E}}{P} = \left[\frac{\kappa_\pi^2}{2\lambda}\right]^{\frac{1}{2(\sigma-1)}} w^{-\frac{1+2\alpha(\sigma-1)}{2(\sigma-1)}} \mathcal{E}^{\frac{\sigma}{\sigma-1}} a_e^{\frac{1}{2(\sigma-1)}} \tag{57}$$

According to (56), $\mathcal{E} = \mathcal{E}(w(T), T)$, therefore, when $|c'(a_s)|$ is sufficiently small

$$sign\left(\frac{d\mathcal{E}(w(T), T)}{dT}\right) = sign\left(-\frac{d\mathcal{E}}{dw}\frac{da_s}{dT}|c'(a_s)| + \frac{d\mathcal{E}}{dT}\right) \approx sign\left(\frac{d\mathcal{E}}{dT}\right) > 0$$

where the last inequality comes from the fact that

$$\frac{d\mathcal{E}}{dT} = \frac{2k\sigma}{k-1}\frac{w^k}{[(1-\alpha)\kappa Tw^k + \alpha\kappa Tw^{k-1} + (1-\alpha)\kappa w + \alpha\kappa + 1]^2} > 0$$

The real output is also improved by showing

$$\frac{d(\mathcal{E}/P)}{dT} = \underbrace{\frac{d(\mathcal{E}/P)}{dw}\frac{dw}{dT}}_{(+)} + \underbrace{\frac{d(\mathcal{E}/P)}{da_e}\frac{da_e}{dT}}_{(+)} + \underbrace{\frac{d(\mathcal{E}/P)}{d\mathcal{E}}\frac{d\mathcal{E}}{dT}}_{(+)} > 0$$

Therefore, both nominal and real output increases with trade liberalization (smaller f_x or τ).

Next we study the impact of trade liberalization on real consumption. According to (55) and (57),

$$
\begin{aligned}
\frac{C}{P} &= \left[(\kappa + \frac{1}{k-1}) T w^k + (\kappa + \frac{k}{k-1}) w \right] a_e^{-k} \times \left[\frac{\kappa_\pi^2}{2\lambda} \right]^{\frac{1}{2(\sigma-1)}} w^{-\frac{1+2\alpha(\sigma-1)}{2(\sigma-1)}} \mathcal{E}^{\frac{1}{\sigma-1}} a_e^{\frac{1}{2(\sigma-1)}} \\
&= \left[\frac{\kappa_\pi^2}{2\lambda} \right]^{\frac{1}{2(\sigma-1)}} \times \left[(\frac{1}{k-1} + \kappa) T w^k + (\frac{k}{k-1} + \kappa) w \right] \\
&\quad \times \left[(1-\alpha)\kappa T w^k + \alpha\kappa T w^{k-1} + (1-\alpha)\kappa w + \alpha\kappa + 1 \right]^{-\left[\frac{1}{2k(\sigma-1)} + \frac{1}{\sigma-1} + 1 \right]} \\
&\quad \times w^{-\frac{1+2\alpha(\sigma-1)}{2(\sigma-1)}} \left(T w^k + w \right)^{\frac{1}{\sigma-1}}
\end{aligned}
$$

Trade liberalization affects the real consumption through directly channel T as well as the indirect channel w. The net outcome is crucially determined by degrees of love of variety. One can easily show that under some finite values of σ, $\dfrac{dC/P}{dT} < 0$, i.e., trade liberalization decreases the real consumption. This is mostly due to over-selection effect, and price index increase due to the loss of variety. However, when consumers care less on varieties, we can show that trade liberalization also increases the real consumption. To prove this, we consider the extreme case $\sigma = +\infty$ and applying L'hopital rule,

$$
\lim_{\sigma \to +\infty} \frac{C}{P} = \frac{w^{1-\alpha}}{(1-\alpha)w + \alpha} \tag{58}
$$

Real consumption of the limiting case (58) decreases with w. Recalling that $dw/dT < 0$, this confirms the proof that reduction in unit trade cost τ or fixed exporting cost f_x (increases T) increases real consumption.

Empirical Appendix

We use three nationally representative surveys in section 2. The first survey is China Household Income Project (CHIP) for 1995, 1999, 2002, 2007 and 2008. The urban survey covered 11, 6, 12, 9 and 9 provinces, autonomous regions, or municipalities, which also covers a wide variety of regions regarding geography and economic development. The second data is China Household Finance Survey (CHFS) launched in 2012 that is unique for detailed information on family's wealth including financial asset and debts, housing asset, and the asset for household production and business activities whose detailed introduction can be found in Gan, Yin, Jia, Xu, Ma, and Zheng (2013). Finally, a third dataset is the China Health Nutrition Survey (CHNS), which include years of 1997, 2000, 2004, 2006, 2009 and 2011. Due to limited access, the regression doesn't include the dummy variable indicating the minor ethnicity in the Mincery regression for CHNS. The point estimations are shown in the Figure 11. The downward pattern on skill premium is also observed in CHNS. For robustness, we replicate the several exercises, as discussed in section 2, using CHIP. We still find labor market polarization (Figure 13) and the rise of business income among the top households (Figure 13).
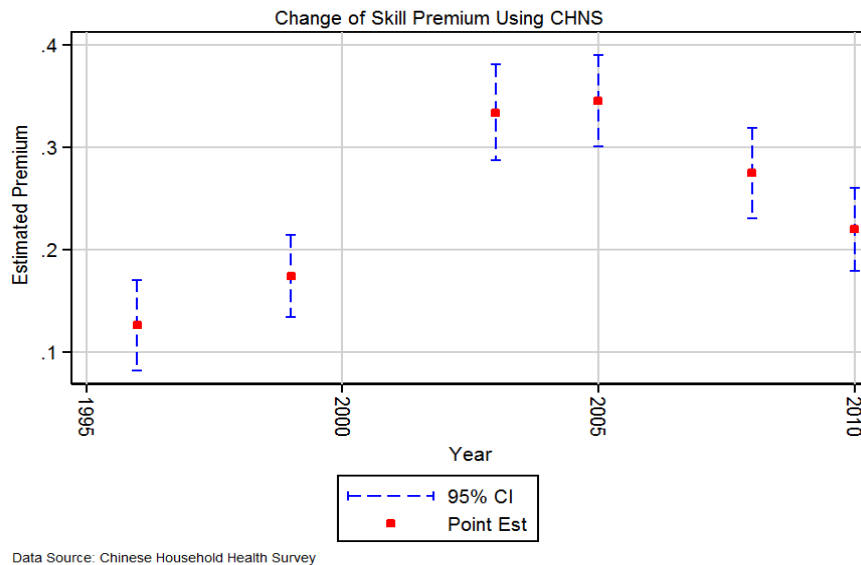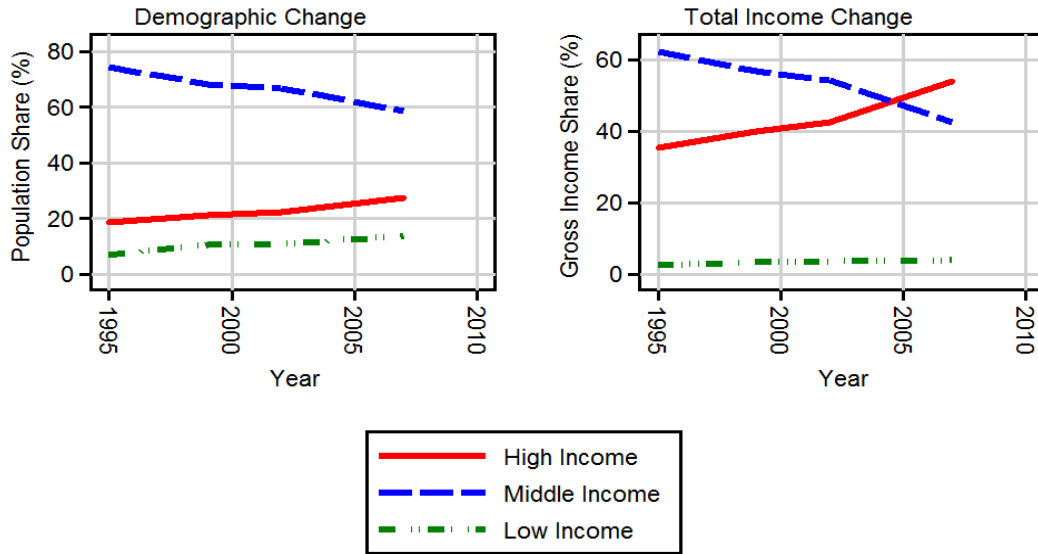

Figure 11: Estimated Skill Premium of CHNS

Income Polarization in China
1995-2007

Demographic Change

Total Income Change

—	High Income	
– –	Middle Income	
·–·–	Low Income	

Data source:CHIP;
Low-income: Households with less than 50 percent of median income;
Middle-income: Households with 50-150 percent of median income;
High-income: Households with more than 150 percent of median income.

Figure 12: Income Polarization

Decomposition of the Annual Total Society Income
1995-2007
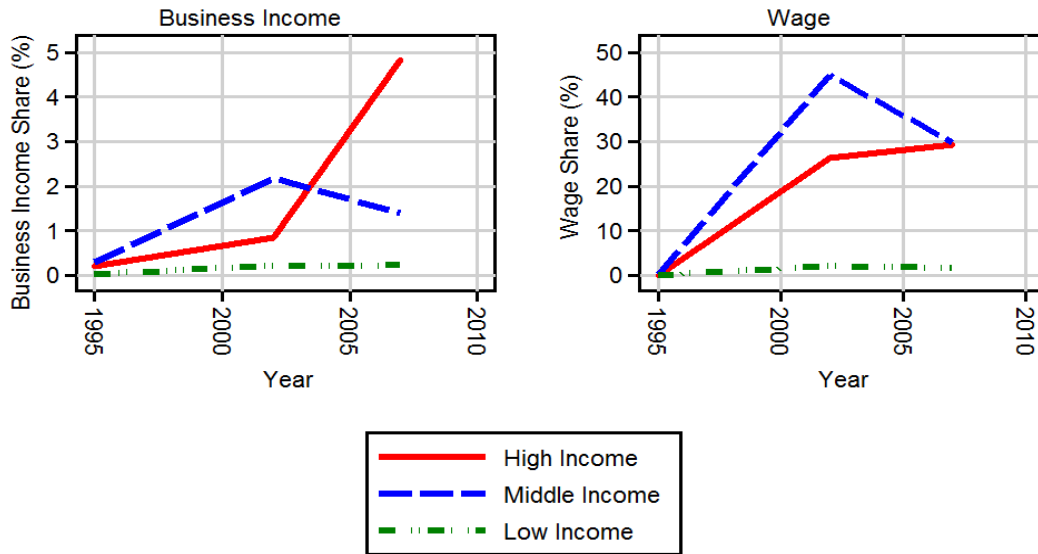
Business Income

Wage

—	High Income	
– –	Middle Income	
·–·–	Low Income	

Data source:CHIP;
Low-income: Households with less than 50 percent of median income;
Middle-income: Households with 50-150 percent of median income;
High-income: Households with more than 150 percent of median income.

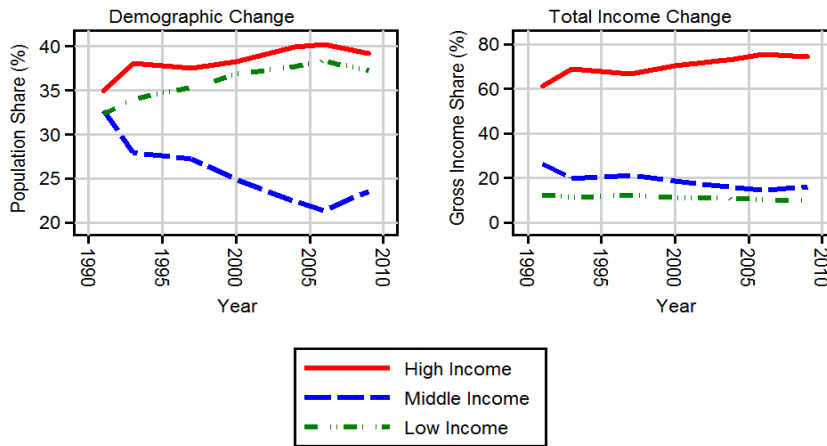Figure 13: Decomposition of Annual Total Society Income

Income Polarization in China (60% - 225%)
1990-2010
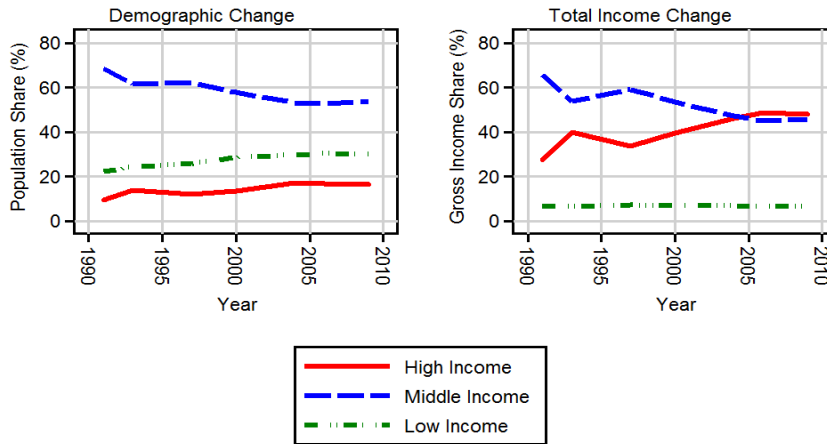
Demographic Change | Total Income Change

(a) Alternative Measure: 60-225% of Median

Income Polarization in China (75% - 125%)
1990-2010

Demographic Change | Total Income Change

(b) Alternative Measure: 75-125% of Median

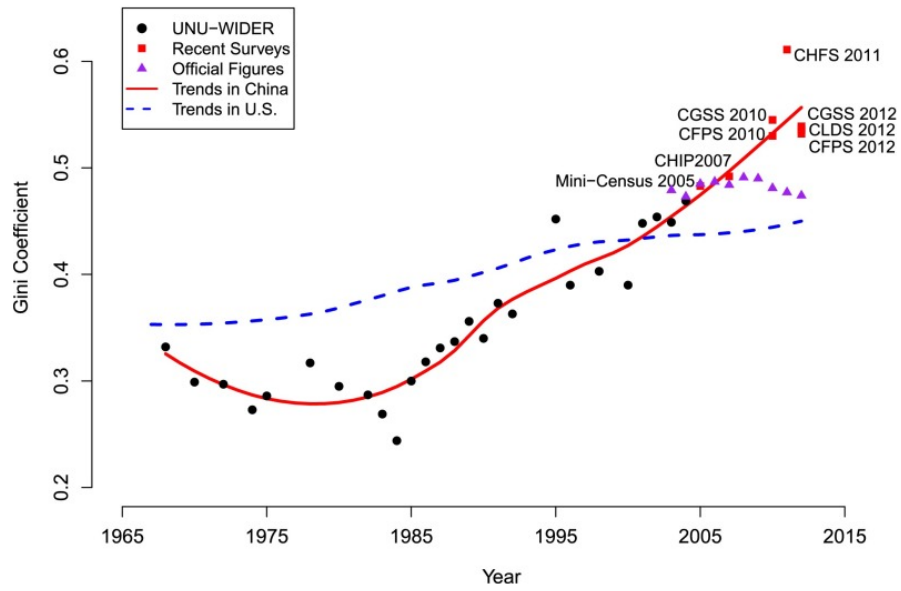Figure 14: Income Polarization: Alternative middle income Definitions

Figure 15: Change of Income Inequality with Trade Liberalization (Source: Xie and Zhou (2014))

Table 2: Trade Shock and Skill Premium Change (CHIP)

Dep. ln $Wage$	Export Shock				IV: $\widehat{Export\ Shock}$			
	(1)OLS	(2)FE	(3)FE	(4)FE	(5)2SLS	(6)FE	(7)FE	(8)FE
$College_{ict}$	0.441***	0.445***	0.392***	0.388***	0.451***	0.454***	0.397***	0.392***
	(0.025)	(0.025)	(0.021)	(0.021)	(0.028)	(0.027)	(0.021)	(0.021)
$College_{ict} \times Export\ Shock_{ct}$	-0.005***	-0.005***	-0.002*	-0.002*	-0.007***	-0.007***	-0.003**	-0.003**
	(0.002)	(0.002)	(0.001)	(0.001)	(0.003)	(0.002)	(0.002)	(0.001)
$Export\ Shock_{ct}$	0.031***	0.025***	0.003		0.037***	0.030***	0.003	
	(0.003)	(0.004)	(0.002)		(0.005)	(0.005)	(0.003)	
Observations	19,330	19,330	19,330	19,330	19,330	19,330	19,330	19,330
R-squared	0.321	0.347	0.430	0.140	0.318	0.339	0.430	0.140
City FE	NO	YES	YES	YES	NO	YES	YES	YES
Year FE	NO	NO	YES	YES	NO	NO	YES	YES
City-Year FE	NO	NO	NO	YES	NO	NO	NO	YES

Notes: The dependent variable is individual log wage. Besides the key variables reported in the table, each regression also controls marriage status, gender, minor ethnicity, working experience as well as the squared term of working experience. Robust standard errors are clustered at city-year level and reported in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Trade Liberalization and the Extensive Margin of Business Activity

Dep. Var:	CHNS				CHIP			
	Export Shock		IV:$\widehat{Export\ Shock}$		Export Shock		IV:$\widehat{Export\ Shock}$	
$\mathbf{1}$(Involved in Business Activity)	Logit	Probit	Logit	Probit	Logit	Probit	Logit	Probit
$Export\ Shock_{ct} \times High_{ict}$	-0.049	-0.027	-0.107***	-0.061***	-3.791***	-2.151***	-6.574***	-3.723***
	(0.030)	(0.017)	(0.037)	(0.021)	(0.044)	(0.023)	(0.046)	(0.027)
$Export\ Shock_{ct} \times Middle/Low_{ict}$	-0.100***	-0.059***	-0.167***	-0.098***	-3.934***	-2.227***	-6.688***	-3.787***
	(0.009)	(0.006)	(0.012)	(0.007)	(0.018)	(0.005)	(0.027)	(0.007)
Number of Obs.	2,549	2,549	2,549	2,549	11,593	11,593	11,593	11,593
Class FE	YES	YES	YES	YES	YES	YES	YES	YES
Region-Year FE	YES	YES	YES	YES	YES	YES	YES	YES

Notes: The dependent variable is the dummy variable that equals unity if the household is involved in business activity. Robust standard errors are clustered at province-year level and reported in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Trade Shock and the Intensive Margin of Business Activities

Dep. Var:	CHNS		CHIP	
ln(*Business Income*)	*Export Shock*	*IV:Export Shock*	*Export Shock*	*IV:Export Shock*
Export Shock$_{rt}$ × *High$_{irt}$*	0.125***	0.079***	0.045***	0.047***
	(0.010)	(0.011)	(0.005)	(0.006)
Export Shock$_{rt}$ × *Middle/Low$_{irt}$*	0.105***	0.055***	0.042***	0.045***
	(0.004)	(0.005)	(0.002)	(0.002)
Number of Obs.	1,661	1,661	1,036	1,036
R-squared	0.387	0.387	0.512	0.512
Class FE	YES	YES	YES	YES
Region-Year FE	YES	YES	YES	YES

Notes: The dependent variable is the business income of household in nature log. Robust standard errors are clustered at province-year level and reported in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Trade Shock and Labor Market Polarization (CHIP)

Panel (A): Demographic Change and Trade Liberalization

Dep. ln $Population\ Share_{ict}$, $i \in \{H, M, L\}$	Export Shock				IV: $\widehat{Export\ Shock}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Export\ Shock_{ct} \times High\ Income\ Group$	0.011***	0.013***	0.009**	0.009**	0.012***	0.014***	0.009**	0.009**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
$Export\ Shock_{ct} \times Middle\ Income\ Group$	-0.005***	-0.004	-0.008*	-0.007*	-0.005***	-0.004	-0.009	-0.008*
	(0.001)	(0.002)	(0.004)	(0.004)	(0.001)	(0.003)	(0.005)	(0.005)
$Export\ Shock_{ct} \times Low\ Income\ Group$	0.014***	0.015***	0.011***	0.011***	0.016***	0.018***	0.013***	0.013***
	(0.004)	(0.004)	(0.003)	(0.002)	(0.005)	(0.004)	(0.002)	(0.002)
Number of Obs.	230	230	230	230	230	230	230	230
R-squared	0.862	0.869	0.870	0.870	0.862	0.869	0.870	0.870
Class FE	YES	YES	YES	YES	YES	YES	YES	YES
Province FE	NO	YES	YES	YES	NO	YES	YES	YES
Year FE	NO	NO	YES	YES	NO	NO	YES	YES
City Controls	NO	NO	NO	YES	NO	NO	NO	YES

Panel (B): Income Distribution and Trade Liberalization

Dep. ln $Income\ Share_{ict}$, $i \in \{H, M, L\}$	Export Shock				IV: $\widehat{Export\ Shock}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Export\ Shock_{ct} \times High\ Income\ Group$	0.014***	0.015***	0.013***	0.013**	0.015**	0.017***	0.014***	0.015**
	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$Export\ Shock_{ct} \times Middle\ Income\ Group$	-0.008***	-0.007**	-0.010*	-0.009**	-0.009***	-0.008*	-0.010*	-0.009*
	(0.002)	(0.003)	(0.004)	(0.004)	(0.003)	(0.004)	(0.005)	(0.005)
$Export\ Shock_{ct} \times Low\ Income\ Group$	0.008*	0.009**	0.007*	0.008**	0.011**	0.012***	0.010***	0.011***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)
Number of Obs.	230	230	230	230	230	230	230	230
R-squared	0.932	0.935	0.935	0.935	0.932	0.935	0.935	0.935
Class FE	YES	YES	YES	YES	YES	YES	YES	YES
Province FE	NO	YES	YES	YES	NO	YES	YES	YES
Year FE	NO	NO	YES	YES	NO	NO	YES	YES
City Controls	NO	NO	NO	YES	NO	NO	NO	YES

Notes: The dependent variable is logarithmic population share for Panel (A) and logarithmic income share for Panel (B). City controls include regional average wage level and population of total labor force. Robust standard errors are clustered at city-year level and reported in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Trade Shock and Skill Premium Change (CHNS)

Dep. ln $Wage$	Export Shock				IV: $\widehat{Export\ Shock}$			
	(1) OLS	(2)FE	(3)FE	(4)FE	(5)2SLS	(6)FE	(7)FE	(8)FE
$College_{ipt}$	0.401***	0.401***	0.372***	0.383***	0.405***	0.412***	0.386***	0.396***
	(0.034)	(0.033)	(0.035)	(0.035)	(0.033)	(0.033)	(0.035)	(0.037)
$College_{ipt} \times Export\ Shock_{pt}$	-0.006*	-0.007**	-0.006**	-0.007*	-0.007*	-0.010***	-0.009**	-0.010*
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)
$Export\ Shock_{pt}$	0.043***	0.016*	-0.018		0.052***	0.016	-0.013	
	(0.003)	(0.009)	(0.012)		(0.004)	(0.010)	(0.010)	
Observations	5,255	5,255	5,255	5,255	5,255	5,255	5,255	5,255
R-squared	0.292	0.307	0.331	0.154	0.285	0.307	0.331	0.155
Province FE	NO	YES	YES	YES	NO	YES	YES	YES
Year FE	NO	NO	YES	YES	NO	NO	YES	YES
Province-Year FE	NO	NO	NO	YES	NO	NO	NO	YES

Notes: The dependent variable is individual log wage. Besides the key variables reported in the table, each regression also controls marriage status, gender, age as well as the squared term of age due to limited data information. Robust standard errors are clustered at province-year level and reported in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Trade Shock and Labor Market Polarization (CHNS)

	Demographic Change				Income Distribution			
	Export Shock	Export Shock	IV: Export Shock	IV: Export Shock	Export Shock	Export Shock	IV: Export Shock	IV: Export Shock
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Export\ Shock_{ct} \times High\ Income\ Group$	0.018*	0.022**	0.021*	0.027**	0.022**	0.027**	0.026**	0.034***
	(0.009)	(0.009)	(0.010)	(0.010)	(0.008)	(0.009)	(0.009)	(0.010)
$Export\ Shock_{ct} \times Middle\ Income\ Group$	-0.012*	-0.008	-0.013*	-0.007	-0.026***	-0.021**	-0.031***	-0.023*
	(0.006)	(0.008)	(0.007)	(0.009)	(0.007)	(0.009)	(0.008)	(0.011)
$Export\ Shock_{ct} \times Low\ Income\ Group$	0.017	0.022	0.016	0.022	0.007	0.012	0.002	0.010
	(0.019)	(0.019)	(0.022)	(0.023)	(0.022)	(0.022)	(0.025)	(0.026)
Number of Obs.	81	81	81	81	81	81	81	81
R-squared	0.864	0.876	0.862	0.874	0.945	0.952	0.945	0.951
Class FE	YES	YES	YES	YES	YES	YES	YES	YES
Province FE	NO	YES	NO	YES	NO	YES	NO	YES

Notes: The dependent variable is logarithmic population share for demographic change and logarithmic income share for income distribution. Robust standard errors are clustered at province-year level and reported in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

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