Skill-biased Imports and Demand for Skills in China*

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[Preliminary and comments welcome]
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Abstract

Importing capital equipment and machinery is crucial for a developing country to acquire advanced technology and achieve economic growth. In this paper we show that imported capital goods also drive up demand for skills because foreign technology is skill complementary. As a result, skill premium rises where more machines and equipment are imported. Using micro level data from China, we find that about 46% of the increase in skill premium and 21% of increase in skilled labor share could be explained by capital imports.

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1. Introduction

Widening wage gap between skilled versus unskilled workers is a well-documented observation, in both developed and developing countries for the past several decades (Goldberg and Pavcnik, 2007). This striking observation, accompanied with the contemporaneous increase of the relative supply of skilled workers, implies rising demand for skills. Skill-biased technical changes (Berman et al., 1994; Acemoglu, 2003), and global offshoring (Feenstra and Hanson, 1996, 1999), are proposed as two separate (and competing) driving forces. Skill-biased technologies, however, are often embodied in capital goods such as computers and machines.[1] Therefore, importing capital goods has been an effective way for transferring knowledge (Eaton and Kortum, 2001), a crucial mechanism for developing countries to acquire advanced technology (Coe and Helpman, 1995), and an important engine for growth (Grossman and Helpman, 1991).

In this paper, we show that importing capital goods also drives up demand for skills in developing countries. Since developing countries lack the ability for original innovation, they import foreign technology through trade, while imported machines are more skill-complementary than those using indigent technologies. As a result, skill premium increases where more machines and equipment are imported, as assumed in the theoretical work by Burstein, Cravino, and Vogel (2013) and Parro (2013). Meanwhile, regions with more capital imports should also have more skilled labors, which is less-explored in the literature.

To examine the causal effects, we employ exchange rate movements as instruments. Exchange rates between RMB and foreign currencies affect import volumes while their movements are plausibly exogenous to China's local labor markets. The regional variation of the instrument comes from the facts that different regions have different major sourcing countries and are exposed to various exchange rate shocks.

Our empirical findings combine evidence on both firm level and household level

[1] Katz and Autor (1999) document a positive correlation between use of computer-based technologies and employment of skilled labor within industries, firms, and plants. Also see Acemoglu and Autor (2011) and Van Reenen (2011) for literature reviews on wage inequality.

datasets from China. China is an important case to study due to its sheer size. More importantly, there is a substantial and simultaneous increase in both employment share of skilled labor and the relative wage premium of skilled workers during last two decades, as illustrated in Figure 1.[2] During 1998-2009, skilled labor share increases from about 20% to more than 40%, while college premium increases from about 25% to about 45%. There are substantial variations in trade and labor market outcomes across different regions (Han et al., 2012). Our work shows the importance of imported technology in driving up both demand and wage premium for skill.

[INSERT FIGURE 1 HERE]

We have several novel findings. First, using a panel of Chinese manufacturers, we estimate a Cobb-Douglas production function, augmented with firms' capital goods import share. The result shows that capital goods imports increase the productivity of skilled workers but decrease that of unskilled workers, so imported capital goods are skill-biased. This finding confirms the capital-skill complementarity documented in Griliches (1969), Goldin and Katz (1998), and Krusell et al. (2000). Furthermore, within the same industry and city, firms that import capital goods have higher labor productivity, pay higher wages, and hire more workers with college degree or above. This is consistent with the idea that imported machines are favoring more educated workers. The novel part of our paper is that we focus on the impact of imported capital good on labor. Existing studies mostly study the impact of imported inputs on firm productivity (Fernandes, 2007; Kasahara and Rodrigue, 2008; Halpern, Koren & Szeidl, 2015).[3]

Importantly, capital goods imports affect relative demand for skilled workers and their relative wages. In particular, workers in different regions of China are exposed differently to the impact of imported machinery, resulting in variations in their relative demand and wage premium for skills. To obtain causal effects, we utilize the household surveys across cities in China and employ the city-specific exchange rate movements

[2] We follow Autor and Katz (1999) and define skilled workers as those who hold college degree or above.

[3] A few studies, including Harrison and Hanson (1999) and Crino (2012), show that imported inputs increase employment of high-skill workers.

as instruments. Exchange rates between RMB and foreign currencies affect value of imports while their movements are plausibly exogenous to local labor markets. Furthermore, different regions across trade with different set of countries and therefore experience different exchange rate shocks. More specifically, we find that 10 percentage points increase in local penetration of capital imports increases skill premium by 1.7 percent and the employment share of skilled workers by 0.7 percent. This means that about 46% of the increase in skill premium and 21% of increase in skilled labor share could be explained by capital imports.

Trade may affect employment and wage of workers through other channels. Firstly, import competition may induce domestic firms to employ more skilled workers (Attanasio et al., 2004; Lu and Ng, 2013; Bloom et al., 2015). Secondly, increasing access to foreign market may encourage exporters to upgrade skills (Zhu and Trefler, 2005; Yeaple, 2005; Verhoogen, 2008; Bustos, 2011b). Thirdly, offshoring and foreign direct investment (FDI) may affect demand for different types of workers (Feenstra and Hanson, 1997, 1999; Chen et al., 2013). Fourthly, rising skilled labor supple due to the college expansion policy since 1999 may also affect relative demand for skills. After controlling for these concurrent effects, capital goods import remains an important driving factor on skill premium.

Furthermore, the composition of capital goods imports also matter. First, technology advances, in the form of R&D and equipment & machinery production, are highly concentrated in a handful of industrial economies (Eaton and Kortum, 2001; Alfaro and Hammel, 2007; Burstein et al., 2013).[4] We find machinery imports sourced from major R&D countries exert stronger impacts in raising skill demand and premium. Secondly, R&D intensity varies across capital goods. Consistent with what is found in Reveh and Reshef (2015), R&D intensive capital equipment are more skill-complementary than others, therefore have larger impact in raising skill premium.[5]

Our paper is closely related to recent research attention on international trade in

[4] Those countries include France, Germany, Italy, Japan, South Korea, United Kingdom and United States.

[5] Note that Reveh and Reshef (2015) find that the level of capital imports does not affect skill premium, only the composition of capital imports does. The difference between our finding and theirs might be because they provide cross-country evidence while we focus on a panel of cities in China.

capital equipment. First of all, the growth literature focuses on the impact of capital goods imports on growth and productivity. The idea dates back to the product life cycle theory in Grossman and Helpman (1995): Innovation happens in the North, thus the lagged South countries acquire advanced technologies through capital goods imports (Coe et al., 1997). Navaretii and Tarr (2000), and Blalock and Veloso (2007) provide evidence that importing is a source of international technology transfer. Lee (1995) and Mazumdar (2001) confirm that imported capital goods lead to higher growth, while Hasan (2002) shows that imports of technology improves firms' productivity. Besides technology spillover, access to imported capital equipment also lowers down investment prices in low-income countries, which stimulates growth. Eaton and Kortum (2001) document that about 25% of cross-country productivity differences are attributed to variation in the relative price of equipment, about half of which is due to trade barriers. Santacreu (2015), in a recently work, shows that about 65% of embodied growth in developing countries can be explained by foreign innovations.

Secondly, based on the enormous evidence on the complementarity between capital and skill (Acosta and Gasparini, 2007; Katz & Murphy, 1992), several recent studies suggest that skill-biased technologies can be transferred through trade. This is feasible particularly through imports with high R&D content (Attanasio et al., 2004; Reveh and Reshef, 2015; Fracasso and Marzetti, 2015). Notably, Burstein et al. (2013) provide a tractable framework to evaluate the impact of capital goods trade on skill premium. Using the Hungarian employer-employee surveys, Koren and Csillag (2011) directly link machinery imports and skill premium. They find that operators of imported machines have higher wages and the effect is stronger for operators with higher education. In comparison, our paper uses the urban household survey data that covers workers across sectors. This is because imported technologies are likely to result in skill upgrading throughout the economy. For example, it also increases demand for skilled labor to fulfill tasks such as maintenance, monitoring, repair, and training. Imported machines may also exert its impact on skill premium by substituting unskilled labor.

Because of our focus on capital imports and skill premium, our paper contributes to understanding the impact of globalization on wage inequality, which has been reviewed by Goldberg and Pavcnik (2007). Among those studies, Harrison and Hanson (1999) assess the impact of import on human capital accumulation. They find that Mexican firms that import machinery and materials tend to have higher share of skilled workers compared to other firms within the same sector. Crinò (2012) examines a sample of firms across 27 transition countries and finds that importing inputs significantly increases the employment of skilled workers. Other supporting studies include Acosta and Gasparini (2007) on Argentina, Sanchez-Paramo and Schady (2003) on Argentina, Chile, Colombia and Mexico[6]

Finally, our paper also contributes to understanding the dynamics of wage structure and human capital accumulation in China, which has received increasing attention from researchers (Xie and Zhou, 2014). Ge and Yang (2014) document the changes of wage structure in China and emphasize the rise of basic wage and the rising returns to skill. Han et al. (2012) study the impact of trade on China's wage inequality. They find that regions that are exposed more to trade experienced larger increase in wage inequality after trade reform. Based on their findings, we further explore the channels about how trade increases China's skill premium. Sheng and Yang (2011) find that liberalization on FDI and better contract environment attract more skill-intensive production by foreign-owned firms and therefore raise skill premium.

The rest of the paper is organized as follows. Section 2 introduces the background for our research, and describes our data in details. Sections 3 show the skill-complementarity of capital imports and its impacts on firm's relative demand for skills, technology adoption, wage and productivity. Section 4 show the direct impacts of capital imports on regional wage inequality and human capital accumulation. We conclude in Section 5.

2. Research Background and Data Construction

2.1 Imports of Capital Goods

China's embracement of globalization started in early 1980s. At the onset, one of

[6] However, Pavcnik (2003) finds that foreign technology does not explain the increased relative demand for white-collar workers by Chilean plants in early 1980s.

the main objectives of China "opening up" was to "bring in advanced foreign technology". *Quid Pro Quo*, a policy that requires multinational firms to transfer technology capital for market access, has remained active and effective in China (Holmes et al., 2015). For its convenience and transparency, import capital equipment became a widely adopted practice in transferring technology. Furthermore, both central and local governments strongly encourage importing critical equipment and intermediate inputs to "strengthen domestic firms' international competitiveness" (the State Council of China, 1994). For this purpose, imported capital equipment has received preferential tax and tariff treatment or even exemption (the State Council of China, 1997). The average tariffs for capital goods dropped from 28% in 1992 to 8% in 2009.

Consequently, there has been a surge of imports in capital goods in recent years. Capital goods are defined based on the International Standard Industrial Classification (ISIC-rev.3) and Broad Economic Classification (BEC), following the literature (Burstein, et al. 2013). More specifically, capital goods include the ISIC industry codes 29-33, but are also classified as capital goods and parts by the BEC (i.e., BEC 41 and 42). Our results remain if we experiment with alternative definitions of capital goods, such as that in Reveh and Reshef (2015). Figure 2 shows that: firstly, from 1998-2009, capital goods imports into China increased by seven-fold, from 51 billion to 397 billion dollars.[7] Secondly, around 35% of non-fuel imports were capital goods in 1998, while the proportion in 2006 increased to about 50% and decreased a bit after then. Thirdly, capital import intensity, defined as the ratio of imported capital stock over total industrial fixed assets, has also risen rapidly until 2008.

[INSERT FIGURE 2]

There are also substantial variations across regions in their exposure to imports of capital equipment. The coastal areas, as the center for China's manufacturing, attracted

[7] Note that China is also one of the major producers of capital goods. However, more than 50% of Chinese exports in capital goods are processing trade, implying the actual technology created within China is small. For one particularly important exporting sector, the computers industry, processing exports account for over 95% of total sectoral exports. Furthermore, exports from industrial countries appear to be higher quality than from developing countries such as China (Schott, 2007).

most of capital goods imports and experienced steady growth in capital goods import share, while the inland areas are left far behind. As shown in Figure 3, capital goods import account for about 38%, 41%, and 35% of total non-fuel imports in 1998, for eastern (coastal), central, and western provinces respectively. While in 2009, only the eastern (coastal) areas see steady increase in the proportion of capital goods in total non-fuel imports.

[INSERT FIGURE 3]

2.2 Rising Skill Premium

Drastic changes occurred to China's labor market due to globalization in the past decades (Han et al. 2012). Li et al. (2012) documented the fast-rising wages for both skilled and unskilled workers. For example, in 2010, an average urban worker earned an annual salary of about 37,000 RMB ($5,500 in U.S. dollars), increasing by five times than that in 1993. Ge and Yang (2014) further examine the change in wage structure by education, gender, ownership type, industry, and geographic region. They also emphasize the rising wage inequality and associate it with increasing returns to education and to state-sector employees.

In Figure 1, we show the sharp rise in skill premium. Skilled workers are defined as those who hold college degree or above, following the literature (Katz and Autor, 1999). In 1998, skilled workers earned 26% more than unskilled workers. The skill premium, however, soared to 45% in 2009. Relative supply of skilled worker also increased: the share of college graduates increased from 23% to 41% during the same time.

To show relative wage changes over time, we specify a Mincer-type wage regression function (Mincer, 1974):

$$\ln w_i^{jt} = \beta_1^{jt} S_i^{jt} + \beta_2^{jt} E_i^{jt} + \beta_3^{jt} \left(E_i^{jt}\right)^2 + \beta_4^{jt} M_i^{jt} + \mu_m + \mu_n + \varepsilon_i^{jt}, \qquad (1)$$

where $\ln w_i^{jt}$ is individual i's log value of deflated wage for city j at year t. S_i^{jt} is the indicator for skill (S_i^{jt} = 1 if the worker holds a college degree or above, and = 0 otherwise). E_i^{jt} represents the working experience, calculated as the difference between the current year (survey year) and the year that she/he received her/his first job. $E^{2\,jt}_{i}$ is included to capture the non-linear part of the impact of experience. M_i^{jt} is a dummy variable for male. We also control for ownership fixed effects μ_m, where m indicates state, collective or private ownership. μ_n are dummy variables for sector, where l refers to 16 sectors based on NBS classification, including agriculture, mining, manufacturing, construction and services. Note essentially we run the Mincer regression for each city in each year separately. The estimated coefficient for skill dummy, β_1^{jt}, uncover the skill premium for city j at year t.

Figure 4 shows the patterns for regional skill premium, both of which were increasing in both coastal and inland China. On average, skilled workers earned 29%, 21%, and 24% more than those unskilled workers in 1998, for cities in the east, central, and the west, respectively. In 2009, the skill premium soared to 49%, 41% and 40% in three regions respectively. On the other hand, share of skilled labor has been growing and almost doubled for all the regions.

[INSERT FIGURE 4]

The positive coefficients b_2 and b_4 indicate that experienced workers and male workers on average are paid more, *ceteris paribus*. Furthermore, in the appendix (Figures A1 and A2), we show that skill premium and skilled labor share were increasing for both experienced and unexperienced workers, and for both male and female workers. It would be interesting to examine whether imported technology favors certain group of workers, classified by their experience or gender, which we will discuss later in the paper.

Figure 5 scatterplots the relationship between capital goods import and skill demand. The left panel shows the cities with more capital goods imports tend to have higher skill premium, while the right panel shows the cities with more capital goods imports tend to hire relatively more skilled workers.

[INSERT FIGURE 5]

2.3 Data Sources

To construct the data series as described above, we rely on several data sources. The import and export data are collected by the General Administration of Customs of China (GACC). The dataset provide detailed annual transaction information for each firm and product at six-digit HS classification from 2000-2006 and detailed annual transaction information for each city and product at six-digit HS classification from 1997-2009. With information on firms' total stock of assets, we then construct firm-specific import intensity, and city-specific capital import intensity by aggregation. To construct capital goods import intensity, we use accumulated capital imports, assuming annual depreciation rate at 10 percent and 1997 as the base year.[8]

Firm level and city level capital stock data is generated using the Annual Surveys of Industrial Production (ASIP, 1998-2007), which include all SOEs and non-state enterprises with annual sales above 5 million RMB, in mining, manufacturing, and public utility sectors. Provided by the National Bureau of Statistics of China (NBSC), this dataset forms the basis for the reported industrial output in National statistical yearbooks. Firms included in the annual surveys account for 91% of total gross output, 71% of employment and 97% of export (Brandt et al., 2012). For all years, we have information on the number of employees and total wage bill. However, only in 2004, the census year, the data contains information on number of workers by education level. In addition, we also know the number of computers for each firm, which also reflects the technology level of the firm.

To construct city level skill premium, and number of skilled workers relative unskilled workers, we utilize the Urban Household Surveys (UHS) from 1998-2009, conducted by the NBSC. The UHS provides a detailed record of demographic, employment and income information for household members. To ensure the representativeness, the NBSC adopts a probabilistic sampling and stratified multistage approach and replaces one third of the sample each year. Because of our focus on workers, we focus on individuals with labor earnings and between the ages of 16 and 60. We have access to data for 97 cities across nine provinces. The sample has good

[8] In the appendix, we describe how we construct the series for capital stock.

variations in terms of geographical location and of average income level. It includes Beijing, Liaoning, Zhejiang, and Guangdong, which are typically classified as Eastern-Coastal provinces. It also includes Anhui and Hubei, which are Central provinces, and Sichuan, Shanxi, and Gansu, which belong to Western region. Descriptive statistics of key variables using this sample are comparable with those using the national sample, further ensuring the representativeness of our data.

Finally, we collect data for macro variables from the following sources. Bilateral exchange rates are collected from The Penn World Table (PWT 7.0, 1998-2009). Data on city-level GDP, city-level capital stock for industrial enterprises above designated size, and provincial-level FDI, consumer price (CPI) number of college graduates, and population are collected from China Statistical Year Book (1998-2009).

2.4 Descriptive Statistics of Key Variables

Table 1 presents the summary statistics for the main variables of interest. Panel A describes the statistics for city-level variables based on the UHS data. College workers are on average paid 32% more than workers without college degree. Capital goods import takes about 43% of total manufacturing capital stock. Across regions, eastern regions had the highest average skill premium. At the same time, east regions are also mostly to imported technology.

Panel B and C describe and compare several key variables between firms that import capital goods and those that do not. Firstly, capital importers are minority, which account for about 7% of all manufacturing firms. Secondly, capital goods importers had higher non-capital import intensity and higher export intensity. Thirdly, capital importers employed higher rate of college workers. Fourthly, capital goods importers also employ more computers per worker. Computerization has played an important part in innovation and in skill upgrading based on evidence from the US (Berman, Bound, and Griliches, 1994). Fifthly, capital goods importers also pay more to their workers. Lastly, capital goods importers tend to have higher labor productivity and capital intensity.

[Insert Table 1 Here]

3. Capital Goods Imports and Firm Characteristics

Our empirical examination is carried out in two steps. In this section, we will use firm level production data to investigate the association between capital goods imports and firms' characteristics. In the next section, we will utilize city level variations in wage and employment to examine the causal effect of capital imports on skill premium and skilled labor share.

3.1. Skill Complementarity of Capital Goods Import

We begin by testing whether imported capital goods are skill-biased. The idea of technology-skill complementarity dates back to Griliches (1969). Since then, a large body of literature has shown that physical capital and skill are relative complements (Goldin and Katz, 1998). Notably, Krusell et al. (2000) have built a neoclassical framework in which the elasticity of substitution between capital equipment and unskilled labor is higher than that between capital equipment and skilled labor.

In comparison, we hypothesize that the capital-skill complementarity is more pronounced for imported capital equipment. We test this hypothesis using the following specification:

$$y_i = \beta_1 S_i + \beta_2 L_i + \beta_3 K_i + \left(\beta_4 S_i + \beta_5 L_i + \beta_6 K_i\right) \times \frac{K_i^m}{K_i} + \mu_j + \gamma_k + \varepsilon_i \qquad (2)$$

where y_i is log value added of firm i; $\frac{K_i^m}{K_i}$ is capital import intensity, defined as the share of imported capital stock out of firm's total capital stock; K_i is log value of capital stock; S_i is log employment of skilled workers and L_i is log employment of unskilled workers. We also include μ_j and γ_k, the city and industry level fixed effects respectively to control for any city- or industry-specific factors.

To capture the distinct effect of imported capital goods relative to domestic ones, we interact three types of factor inputs (namely capital stock, unskilled labor inputs, and skilled labor inputs) with imported capital goods intensity. We expect a positive coefficient β_4 for the interaction between skilled labor input and capital goods import intensity, due to the skill complementarity of imported capital goods. It is also interesting to check the sign of β_5, which indicates whether imported equipment complements or substitutes unskilled workers. Finally, given the presumption that imported capital equipment is superior to domestic equipment, we expect β_6 to be positive.

Besides the skill-complementarity of capital goods imports, it is also interesting to examine whether firms with higher capital imports intensity exceed other firms in various measures of firm performance, such as employment of skilled labors, average wage, computer usage, productivity, and capital-labor intensity. The economic specification is as follows:

$$y_i = \beta_1 \frac{K_i^m}{K_i} + X_i \delta + \mu_j + \gamma_k + \varepsilon_i \qquad (3)$$

For the dependent variable, y_i, we use the employment share of skilled workers, log numbers of computers per worker, log average wage, log labor productivity, log capital-labor ratio of firm i. For the explanatory variables, $\frac{K_i^m}{K_i}$ is capital import intensity of firm i; X is a vector of covariates that control for share of non-capital import to total input, share of export to total sales, and log employment; μ_j controls for city fixed effects and γ_k controls for 4-digit industry fixed effects.

3.2. Empirical Results

Table 2 reports the empirical results for imported capital-skill complementarity as specified in equation (2). In column (1) we run a benchmark regression for a typical Cobb-Douglas production function with capital and two types of labor as inputs. All three factors contribute substantially to value-added growth. Column (2) considers the superiority of imported capital goods. Firms with larger foreign capital intensity tend to have larger output. Column (3) considers the complementarity of imported capital goods with different factors of inputs. We include interactions of capital import intensity with capital, skilled labor employment and unskilled labor employment. The coefficient of interaction term between capital import intensity and skilled labor employment is positive and significant, suggesting that foreign capital is complementary towards skill and make skilled labor more productive. In contrast, foreign capital substitutes unskilled workers. In addition, the interaction between total capital stock and import capital intensity also plays positive effect on value-added, suggesting that imported technology is superior in quality.

In Column (4), we exclude firms in machinery and equipment sector. Machinery and equipment sector tends to import a substantial amount of capital goods, partly due to its deep involvement in global value chain. Excluding this sector relieves the concern of importing capital goods as components of final output. However, Column (4) shows that the complementarity between imported capital goods and skilled labor still hold outside this sector.

Table 3 examines the relationship between firm performance and capital import intensity, as specified in equation (3). Column (1) shows that firms with higher capital import intensity tend to have higher share of skilled workers (as measured by the share of workers with college degree or above). While the coefficient on imported input intensity is also positive, the effect is more pronounced for capital goods imports. Export intensity, however, has negative association with share of college workers, consistent with the observation that Chinese manufacturers' comparative advantage is labor intensive.

Column (2) further shows firms with higher capital import intensity also use more computers per worker. More specifically, increasing capital import intensity by 10 percentage points is associated with 1.4 percentage points' increase of computer use per worker. A large body of literature has used computerization of the US firms as reflecting skill-biased technology change (Berman, Bound, and Griliches, 1994; Autor, Levy, and Murnane, 2003).

If using imported capital goods leads to larger employment share of skilled workers, as shown in Column (1), then we would also expect it leads to higher average wage and higher labor productivity. This is confirmed by Columns (3) and (4): Firms with higher capital goods import intensity pay higher average wage, and have higher value of value-added per worker. This is consistent with findings by Bernard (1995) and Revenga (1994), who show that more capital-intensive plants hire a higher proportion of skilled workers and offer higher wages.

Interestingly, export share of total revenue turns out to have no correlation with average wage, but is negatively associated with labor productivity of the firm. This is consistent with the finding of Lu (2015) that Chinese exporting firms tend to less productive than non-exporting firms. Finally, using more imported capital goods is also associated with higher capital intensity, as shown in Column (5).

Note in all specifications of Table 3, we controlled for firm size using total employment, and for city- and industry-specific factors. Although with a cross-section of firms, we cannot identify the causal relationship between capital goods import and demand for skills. The results in Table 2 and Table 3 are indicative of skilled-biased imported technology.

4. Capital Import Intensity and City Level Skill Premium

4.1. Capital Import Intensity and Relative Demand for Skills

To estimate the causal effect of capital goods imports on wages, we utilize the panel data in the urban household survey data. We exploit the fact that regions differ in their exposure to imported technology and equipment and in their changes in skill premium over time, as described in Section 2. We use a two-stage least square estimation, with the second stage specified as follows:

$$y_{it} = \beta_1 \frac{K_{it}^m}{K_{it}} + X_{it}\delta + \mu_i + \gamma_t + \varepsilon_{it}, \qquad (4)$$

where y_{it} is the skill premium of city i in year t, W_H/W_L, which we estimated from the Mincer regression (1), or the employment share of skilled workers in city i in year t, $E_H/(E_H + E_L)$. $\frac{K_{it}^m}{K_{it}}$ is the city-specific import intensity for capital goods. X_{it} includes a set of covariates that might also affect demand for skill and the wages. μ_i controls for city fixed effects and γ_t controls for year fixed effects which capture common macro shocks such as business cycles.

The parameter of interest is β_1, which captures the impact of imported technology on relative demand for skills. Since capital goods imports embody skill-biased technology, more such imports lead to higher demand for skilled labor and drive up skill premium. So we expect the coefficient β_1 to be positive.

Relative wage premium and employment share of skilled labor, however, may also exert impacts on the demand for imported capital goods. For example, a city with relatively higher skill premium may have stronger incentive to introduce more low-skill-biased technology and import less capital equipment since low-skilled workers are cheaper. On the other hand, there may exist other factors of demand, which can affect both skill premium and demand for imported capital goods simultaneously. So both the reverse causality and the omitted variable may bias our estimation. To cope with such endogneity concerns, we employ an instrumental variables strategy, using exchange rate as instrumental variables. Exchange rate movements affect trade flow of capital goods. Furthermore, the value of RMB against other currencies is plausibly unrelated to the regional labor market in China. The same empirical strategy using exchange rate movements as instruments has been adopted by Revenga (1994), Park et al. (2010), and Brambilla et al. (2012).

The variation for the identification comes from the fact that regions had different sourcing countries and were exposed to different exchange rates movements. During our sample period (1998-2009), exchange rates between RMB and other currencies varied widely. There were substantial variations of RMB against major trading partners.[9] For instance, real exchange rate of RMB against Korea depreciated by 5% while RMB against Japan Yen, U.S. dollars and Euro appreciated by 5%, 8% and 22% respectively from 1998 to 2009. Since changes of exchange rate vary substantially across different source countries, similar cities may face different shocks if they imported capital goods from different sources.

[9] Figure A3 in the appendix shows the movements of RMB against currencies of China's major trading partners, measured as RMB per foreign currency.

To examine the impact of exchange rates on imports of capital goods, we specify the first stage as follows:

$$\frac{K_{it}^{m}}{K_{it}} = \beta_1 REER_{it}^{1} + \beta_2 REER_{it}^{2} + \mu_i + \gamma_t + \varepsilon_{it} \qquad (5)$$

where $\frac{K_{it}^{m}}{K_{it}}$ is the city-specific import intensity for capital goods; $REER_{it}^{1}$ and $REER_{it}^{2}$ are log real effective exchange rates for capital imports, where the weights are lag-one-year capital import share and capital import share in 1998, the starting year of the sample. Larger $REER_{it}$ means depreciation of city i's relative purchasing power. As before, μ_i controls for city fixed effects and γ_t controls for year fixed effects.

The city-specific exchange rate $REER_{it}^{1}$ for capital import is constructed as the weighted average of bilateral real exchange rate of city i against each of its source countries,

$$REER_{it}^{1} = \sum_{c} \varphi_{i,c,t-1} \times \ln RER_{ct} \qquad (6)$$

where i, c and t refers to city, source country and year respectively, $\ln RER_{ct}$ is the log real exchange rate, using nominal exchange rates adjusted by China and source country' price indices. $\varphi_{i,c,t-1}$ is country c's import share of capital goods imports by city i in year $t-1$. We lag the import share by one year so that the weights won't be affected by the current exchange rates. Because capital is a stock variable, we follow the literature to use accumulated stock of capital goods imports over the firm's total capital stock, with depreciation rate set at 10 percent.

Similarly, $REER_{it}^{2}$ is constructed using $\varphi_{i,c,98}$ as weights. Since exchange rate movements also affect export, we construct corresponding weighted log real effective exchange rates for exports. As for trade openness, we use non-capital import share weighted log real effective exchange rate and export share weighted log real effective exchange rate as its instrumental variables.

4.2.Benchmark Results

Table 4 reports the main results for the 2SLS estimation. In the odd columns, we report the impact of capital goods imports on skill premium, while the even columns are for the impacts on the employment share of skilled workers. First of all, Column (1) shows that an increase of ten percentage points in the capital import intensity will increase the skill premium by 1.7 percentage points. Column (2) then examines the impact of capital goods imports on city's share of skilled workers: an increase of ten percentage points in the capital import intensity will increase the skill premium by 0.7 percentage points.

The impact of capital goods is indeed strikingly large. Multiplied by the actual increase in import share of capital goods stock from 1998-2009, it indeed explains about 46% of the increase in the skill premium and 21% of the increase in employment share of skilled workers.[10]

In panel B of Table 4 we report the corresponding first-stage regression results. City-level exchange rate depreciation significantly reduces capital imports. The *F*-statistics for excluded instruments is 9 and the statistics for under-identification test is 22, both are significant at 1%. This suggests good explanatory power for the endogenous variable in the first-stage estimation.

Columns (3) and (4) analyze the impacts of non-US and non-HK capital imports on relative demand for skills. Since RMB was pegged to U.S dollars before the exchange regime reform since late 2005, the exchange rate between RMB and USD might be endogenously decided. To address this concern, we delete capital imports from the United States and Hong Kong whose currency has been pegged to U.S dollars and calculate corresponding capital import intensity and instrumental variables. As shown in Columns (3) and (4), the impacts of capital import become slightly bigger.

Table 5 deals with the concerns that the effects of capital goods imports may capture the effect of other confounding factors. Increasing access to foreign market encourages exporting firms to upgrade skills (Yeaple, 2005; Verhoogen, 2008; Bustos,

[10] From 1998-2009, the actual increase in import share of capital goods stock was 36 percentage points; the total increase in skill premium was 13 percentage points, the total increase in the employment share of skilled workers was 12 percentage points.

2011a). To address this concern, we control for export intensity which is measured as the ratio of export to GDP. Indeed, export intensity does increases skill premium but has little impact on human capital accumulation. As for capital import intensity, the impacts remain to be robust.

Columns (3) and (4) control for the openness to foreign trade in each city *i*, where openness is measured as sum of non-capital goods import and exports relative to city GDP. This measure of openness accounts for not only enlarged export market access, but also imported inputs. Imports of intermediate inputs may also change the demand for different types of workers. Increase in imports of intermediate inputs may drive up the demand for unskilled workers since firms need workers to process those inputs. On the other hand, consider the quality superiority of imported inputs, to processing with those inputs may require more skilled workers and therefore drive up demand for skilled workers (Crinò, 2012; Verhoogen, 2008). Our main results hold robust while trade openness has only positive impact on wage inequality.

The first stage results are shown in Column (1) to (4) of Table 5 Panel B. They have two implications: first, a city's trade exposure indeed responds to the movement of exchange rates. The depreciation of RMB against foreign currencies encourages export. Second, trade exposure is unlikely to bias our benchmark estimation since our instrument variables for capital import intensity have little explanatory power for export intensity and trade openness. The over-identification tests (Hanson J Statistics) further indicate that our instruments are not statistically correlated with the error terms. The combined pieces of evidence indicate that the estimation results in Column (1) and (2) of Table 4 are unlikely driven by trade openness.

Our IV strategy remains valid in this case because capital goods and intermediate inputs were often imported from different source countries. 80% of the world's capital equipment production occurred in just eight countries in the year 2000 (Burstein et al., 2013), while a large share of China's imported inputs comes from the surrounding Asian economies such as Malasia, Indonesia, Korea, and Taiwan.

4.3. Robustness Checks

Apart from non-capital import and export, there are concerns that our identification may be biased by other confounding factors accompanied with trade liberalization. One possible threat is foreign direct investment (FDI). The inflow of FDI may influence relative demand for skills through two channels. Firstly, FDI is closely related with outsourcing activities which can increase relative demand for skills in developing countries. The fragmentation of the global value chain enables developed countries to outsource their less skill-intensive parts of production to developing countries. Those tasks, however, may still be skill-intensive compared with the domestic production in the developing countries, which drives up demand for skills in both countries (Feenstra and Hanson, 1996, 1997, 1999). Secondly, it may bring in new technology and drive up the demand for skilled workers (Zhu and Trefler, 2005). As Sheng and Yang (2011) points out that the rising college premium in China is partly due to the lessening of policy restrictions on FDI.

To rule out the alternative mechanism, we augment the regression by including FDI in Table 6. Since we do not have detailed region-country-year FDI information and thus cannot construct corresponding instrumental variable, we directly include provincial share of FDI stock out of GDP into the regression. The first and third columns show that after including FDI intensity as an additional control, the impacts of capital import intensity on skill premium and skilled labor share become slightly bigger compared with benchmark regression in Table 4. The effects of FDI itself on relative demand for skills are positive. Although we cannot directly rule out the possibly that FDI violates our results, evidence suggests that our estimation strategy is less likely to be driven by FDI.

Another threat to our identification is the rising supply of skilled labor. In 1999, China launched a massive college expansion program. As a result, China's college admission has increased from 1.1 million in 1998 to 6.4 million in 2009. Such large-scale expansion in supply of skilled labor exerts a downward force to drive down skill premium. However, one insight from the seminal work of Acemoglu (1998) argues that the increasing supply of skilled workers induces skill-biased technology changes due to a "market size" effect. Considering the above two aspects, the impacts of skilled labor supply are ambiguous.

To capture the impact of increasing skilled labor supply owning to college expansion, we further include the share of college graduates out of working population into the regression. Column (2) and (4) of Table 6 confirm that the upward strength of college expansion on relative demand for skills dominates the downward force, since the coefficient of college expansion proxy is positive and the coefficient of capital import intensity becomes slightly bigger compared with Table 4.

To sum up, we find that the skill-complementary capital imports consistently exert positive impact on the college premium and college labor share, implying the SBTC is embodied in imports of capital goods. The results are robust in presence of controls for other channels through which trade and other confounding factors may affect skill premium.

In Table 7, we conduct falsification tests. Although exchange rates between RMB and foreign currency are quite exogenous to local labor market, the corresponding weights may be endogenous. Since imports of fuel such as crude oil should not affect relative demand for skills, we address this concerns by regressing fuel import intensity on skill premium and skill labor share respectively and construct corresponding instruments for it. If our instruments for capital import intensity happen to be correlated with other omitted factors which affect relative demand for skills, the coefficient of fuel import intensity should be significant. As shown in Table 7, fuel exerts no impacts neither on skill premium nor human capital accumulation.

In Table 8, we test the heterogeneous impacts of capital import intensity. Based on the Mincer regression in Section 2, we calculate skill premium for male and female. The patterns of skill premium and skilled labor share by gender are displayed in Figure 1 of the Appendix. Skill premium was higher for female and share of skilled labor was higher for male. In 1998, female workers with college degree earned 29% higher than those without college degree while this number was 25% for male workers. In 2009, skill premium has rose to 46% and 43% for female and male workers respectively. As for human capital accumulation, men generally received higher education than women. To show the impact of capital import on relative demand for skills, we replicated the regressions in Table 4 and second stage results are presented in Table 8 Column (1) and (2). Capital import intensity exerts similar positive effects on human capital accumulation for workers with different gender, while it has much more significant impact on skill premium for male.

Capital imports also have heterogeneous impacts in terms of worker's working experience. In Figure 2 of the Appendix, we display the patterns of skill premium and skilled labor share by working experience. Workers with less than 5 years working experience are classified as unexperienced workers and skill premium is lower among these beginners in job market. As shown in the Appendix, skill premium rose faster among experienced workers and skilled labor share were increasing faster for unexperienced workers. In Table 8 Column (3) and (4), we show that capital import intensity increases skill premium for experienced workers more while has greater positive impact on share of skilled labors for unexperienced workers.

Besides, we also try alternative definitions for skilled labor. In Column (5), we change the definition for skilled labor to those with senior high school degree or above. In Column (6), we refer skilled labor to those with university degree or above. As expected, the impact of capital import intensity has larger impact on university premium. As for human capital accumulation, capital import intensity has greater impact on high school labor share since university is much harder to enter.

In Table 9, we try two alternative definitions for capital goods. Capital goods from developed countries are thought to be more skill-biased since these countries are skill-abundant and machines produced are thus more skill-complementary. In Column (1) and (2), we regression skill premium and skilled labor share on capital import intensity, where capital import are limited to seven R&D intensive sourcing countries. These seven countries include the France, Germany, Italy, Japan, Korea, United Kingdom and United States. As expected the coefficient of capital import intensity is significant and positive. Compared with Table 4, the coefficient is much bigger, implying the impact on relative demand for skills is stronger for capital goods imported from developed countries.

In Column (3) and (4), we follow the definition of Caselli and Wilson (2004) and

Raveh & Reshef (2016) and regress skill premium and skilled labor share on R&D-intensive capital import intensity, since R&D-intensive capital equipment is more skill-complementary. As shown in Column (3) and (4), the coefficients of capital import intensity is significant and positive, and as expected are greater than the coefficients in Column (1) and (2) in Table 4 Panel A.

5. Concluding Remarks

In this paper, we present evidence suggesting that increased imported capital goods can have substantial effect on the demand for skilled labor. We first show that imports of capital goods are complementary to skills. Besides, we also find out that firms with higher capital import intensity tend to hire more college workers, use computer more intensively, have higher labor productivity and pay higher wages.

We then directly examine the impact of capital import intensity on regional relative demand for skills. Regions that have relatively larger imports of capital goods have higher return to schooling and higher skilled labor share. We confirm the causal relationship by employing IV method and using a large-scale household survey data for China from 1998 to 2009. An increase of capital import intensity by 10 percentage points drives up skill premium by 1.7 percentage points and increases share of skilled labors by 0.7 percentage points. Such impact is particularly important for developing countries since importing capital goods is one of the major ways to adopt advanced technology. This finding lends support to the skill-capital complementarity models proposed by Krusell et al. (2000) and Burstein et al. (2013), and echoes a few recent empirical studies using firm data, such as Koren and Csillag (2011).

Our empirical work is related to the growing literature exploring the effect of imports on skilled labor demand in developing countries. We contribute to the literature by directly testing the causal impact of capital imports on relative demand for skills from the perspective of skill-biased technology change. In addition, our paper also contributes to a growing interest in studying rising wage inequality in China, the world's largest developing country and trading nation.

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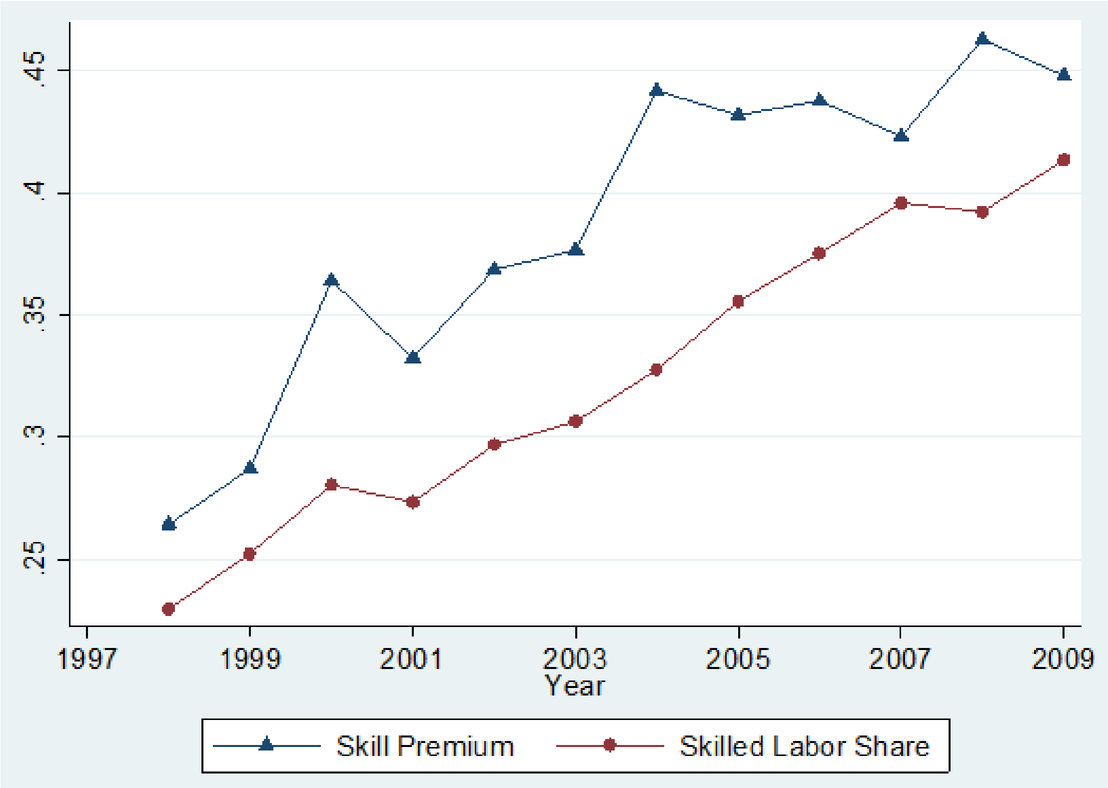
Figures and Tables

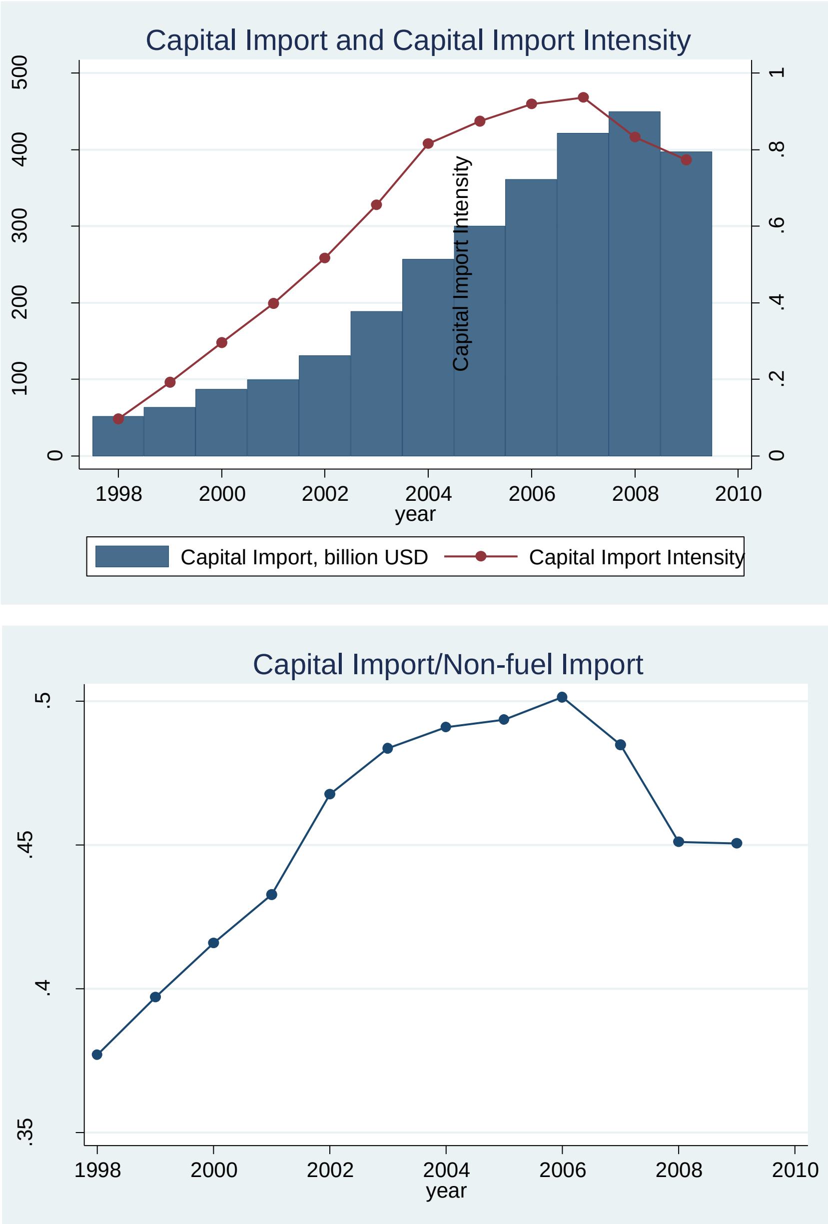
Figure 1: College Premium and Skilled Labor Share



Data: Urban Household Survey: 1998-2009

Note: College premium is calculated based on Mincer-style OLS regression, controlling for gender, age, age square, experience, province and industry dummies.

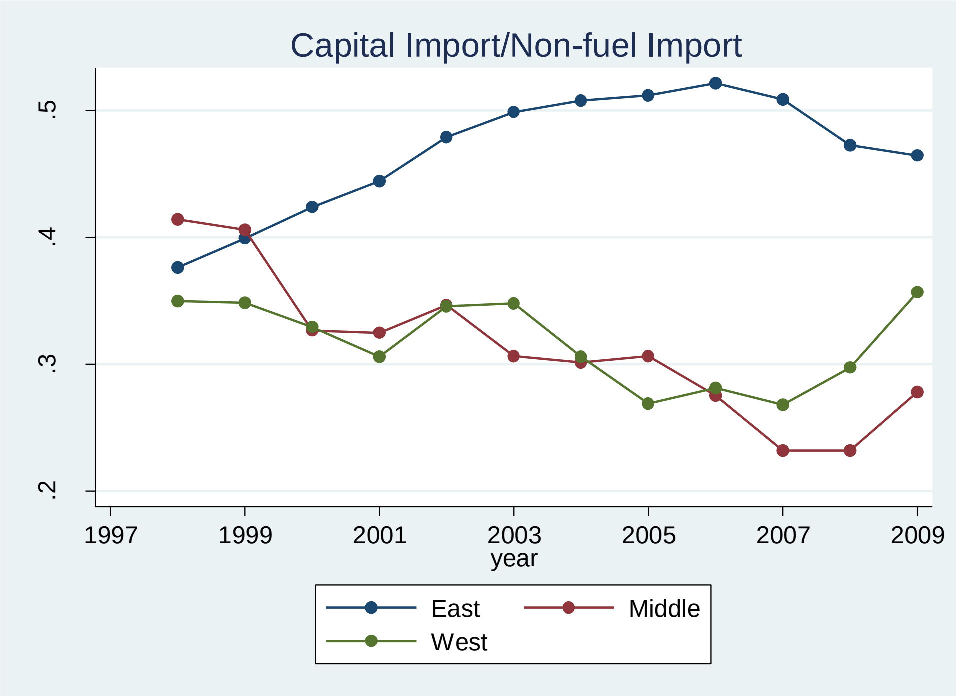
Figure 2: China's Import of Capital Goods, 1998-2009



Source: China General Administration of Customs, various years of China Statistical Year Book.

Note: This figures show the pattern of Chinese total capital imports (unit: 1 billion US$), capital import intensity and share of capital import to non-fuel import. Capital Import Intensity is the share of the accumulated capital imports out of total capital. Following Eaton and Kortum (2001) and Burstein et al. (2013), we define equipment commodities to be the sum of ISIC Rev. 3 codes 29-33 and exclude those that are not belong to Broad Economic Classification (BEC) industry 41 (capital goods) and BEC industry 42 (Parts and accessories of capital goods).

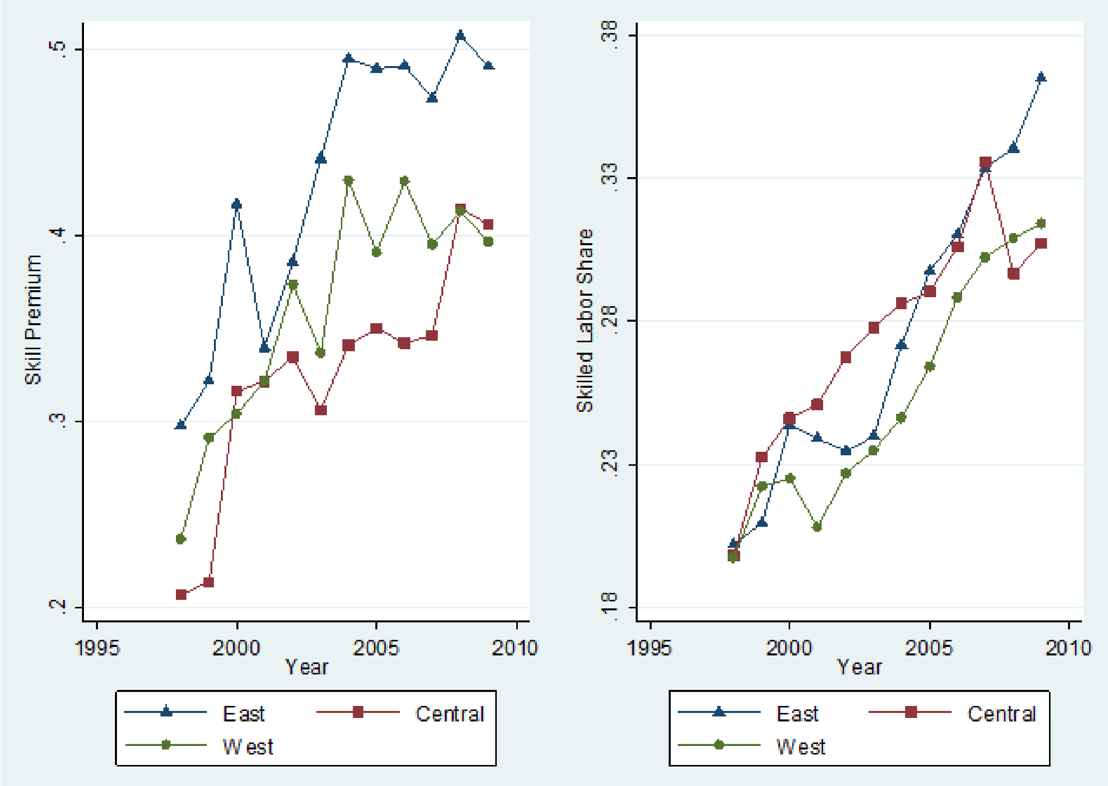
Figure 3: Share of Capital Imports to Total Non-fuel Imports by Region



Source: China General Administration of Customs

Note: Among the nine provinces in our sample, east regions include Beijing, Liaoning, Zhejiang, and Guangdong; central regions include Anhui and Hubei; and the west include Shaanxi, Sichuan, and Gansu.

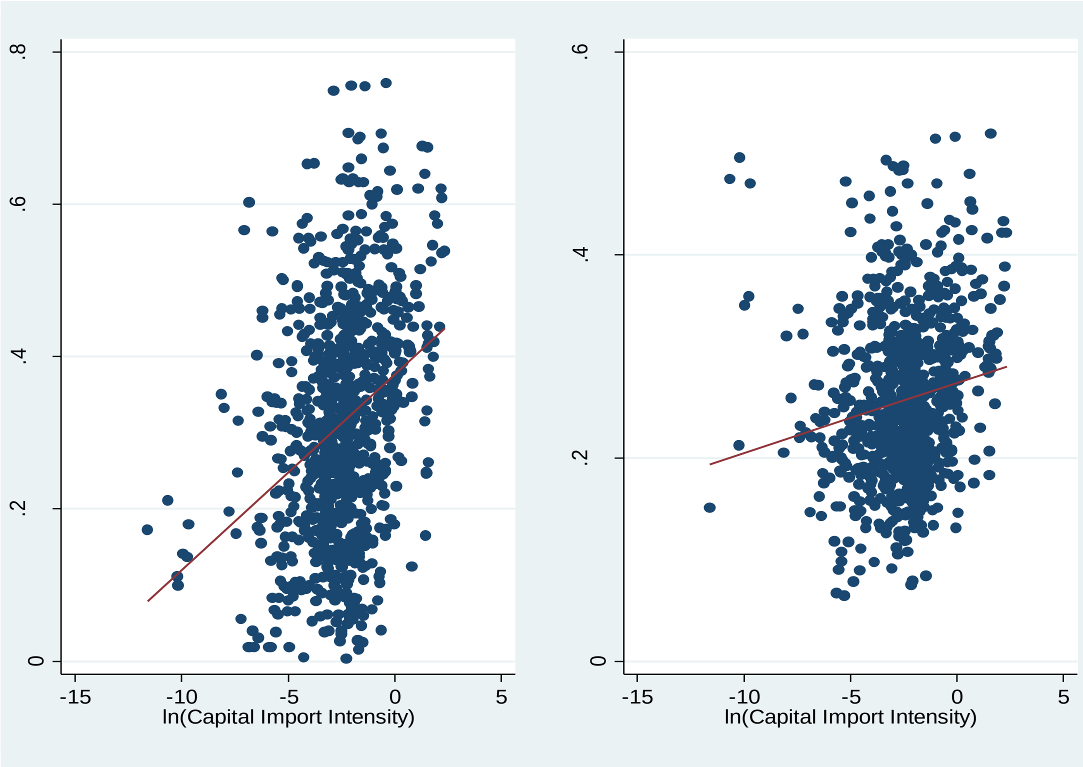
Figure 4: Capital Import Intensity and College Premium



Data: Urban Household Survey

Note: College premium is calculated based on Mincer-style OLS regression, controlling for college education, gender, experience, experience square, ownership, province and industry dummies.

Figure 5: Capital Import Intensity and College Premium



Source: China General Administration of Customs, Urban Household Survey

Table 1: Summary Statistics

Variable	Mean	sd	Median	N
Panel A: 1998-2009 UHS (City-level Data)				
College Premium	0.31	0.15	0.31	864
Share of College Workers	0.27	0.08	0.26	864
Accumulated Capital Import Intensity	0.44	1.17	0.11	864
Non-capital Import/GDP	0.19	0.50	0.06	857
Export/GDP	0.43	1.15	0.15	857
Panel B: Capital Importer (2004 Firm Survey)				
Capital Import Intensity	0.14	0.21	0.05	16,153
Non-capital Import/Input	0.16	0.23	0.04	16,153
Export/Sales	0.45	0.42	0.35	16,153
Share of College Workers	0.18	0.19	0.12	16,153
Number of Computer per Worker	0.16	0.18	0.10	16,153
Ln(Average Wage per Worker)	2.85	0.56	2.80	16,153
Ln (Value-added per Worker)	4.22	0.99	4.13	16,153
Ln(K/L)	4.26	1.27	4.27	16,153
Panel C: Non-capital Importer (2004 Firm Survey)				
Non-capital Import/Input	0.01	0.07	0.00	200,779
Export/Sales	0.16	0.33	0.00	200,779
Share of College Workers	0.11	0.15	0.06	200,779
Number of Computer per Worker	0.07	0.11	0.03	200,779
Ln(Average Wage per Worker)	2.42	0.47	2.41	200,779
Ln (Value-added per Worker)	3.92	0.91	3.83	200,779
Ln(K/L)	3.37	1.32	3.45	200,779

Source: Urban Household Survey and 2004 Surveys of Industrial Production.

Table 2: Capital Import Intensity and Firm Productivity, 2004

Dependent Variable:	(1)	(2)	(3)	(4)	(5)	(6)
Ln (Value-added)	Manufacture		Delete Equipment Manufacture	Manufacture		Delete Equipment Manufacture
Definition for Skill	College or above			Having Technical Title		
Ln(Skill)	0.236***	0.232***	0.227***	0.168***	0.167***	0.162***
	(106.70)	(104.80)	(92.60)	(72.90)	(72.52)	(63.45)
Ln(Unskilled)	0.391***	0.393***	0.397***	0.461***	0.460***	0.465***
	(132.30)	(133.19)	(122.74)	(142.68)	(142.36)	(130.19)
Ln(Capital)	0.219***	0.218***	0.221***	0.236***	0.235***	0.238***
	(109.45)	(109.15)	(99.83)	(107.78)	(107.45)	(98.00)
Ln(Skill)*Capital Import Intensity		0.660***	0.730***		0.392**	0.457***
		(3.77)	(3.97)		(2.41)	(2.76)
Ln(Unskilled)*Capital Import Intensity		-1.199***	-1.151***		-1.095***	-0.867***
		(-8.48)	(-7.36)		(-5.52)	(-4.19)
Ln(Capital)*Capital Import Intensity		0.934***	0.845***		1.114***	0.887***
		(7.93)	(6.49)		(7.89)	(5.88)
City Fixed Effects	Y	Y	Y	Y	Y	Y
Industry Fixed Effects	Y	Y	Y	Y	Y	Y
Observations	202,230	202,230	165,936	169,142	169,142	137,286
R-squared	0.524	0.527	0.525	0.541	0.544	0.542

Note: Capital import intensity is defined as the share of capital import out of capital. In Column (3) and (6), we delete firms that belong to equipment manufacture industries (CIC industry 35, 36 and 37). City fixed effects, CIC 4-digit industry fixed effects are controlled. Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 3 Capital Import and Firm Characteristics, 2004

Dependent Variable	(1) College Share	(2) Computer per Worker	(3) Ln(Wage)	(4) Ln(Value-added per Worker)	(5) Ln(K/L)
Capital Import Intensity	0.103***	0.139***	0.480***	0.901***	1.574***
	[0.00641]	[0.00678]	[0.0181]	[0.0311]	[0.0422]
Non-capital Import/Inputs	0.0604***	0.0744***	0.347***	0.453***	1.442***
	[0.00360]	[0.00352]	[0.0116]	[0.0217]	[0.0311]
Export/Sales	-0.0119***	0.00134	0.00358	-0.116***	-0.255***
	[0.000962]	[0.000819]	[0.00316]	[0.00607]	[0.00976]
log(Employment)	-0.00668***	-0.0127***	0.0263***	-0.149***	0.0120***
	[0.000342]	[0.000279]	[0.00103]	[0.00203]	[0.00286]
City Fixed Effects	Y	Y	Y	Y	Y
Industry Fixed Effects	Y	Y	Y	Y	Y
Observations	216,932	216,932	216,932	216,932	216,932
R-squared	0.255	0.254	0.296	0.216	0.185

Note: Skilled worker is defined as people with a college degree or above. Capital import intensity is defined as the share of capital import out of capital. City fixed effects, CIC 4-digit industry fixed effects are controlled. Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 4 Capital import and Relative Demand for Skills

Panel A: Second Stage	(1)	(2)	(3)	(4)
			Deleting US and HK 1998-2006	
Dependent Variable	W_H/W_L	Skill share	W_H/W_L	Skill share
Capital Import Intensity	0.170***	0.0706**	0.256**	0.0693*
	(0.0592)	(0.0278)	(0.106)	(0.0362)
Panel B: First Stage	(1)	(2)	(3)	(4)
Dependent Variable	Capital Import Intensity	Capital Import Intensity	Capital Import Intensity	Capital Import Intensity
Ln(Exchange Rate)$_{Kstock}$	-0.0970***	-0.0970***	-0.0300***	-0.0300***
	(0.0231)	(0.0231)	(0.00907)	(0.00907)
Ln(Exchange Rate)$_{Kstock98}$	-1.383***	-1.383***	-1.549***	-1.549***
	(0.420)	(0.420)	(0.588)	(0.588)
City Fixed Effects	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y
Under-identification	22.15***	22.15***	12.95***	12.95***
Hansen J Statistic	3.350*	0.267	0.0822	0.0518
Observations	864	864	495	495

Note: Capital Import Intensity is the share of the accumulated capital imports out of capital. ln(Exchange Rate)$_{Kstock}$ and ln(Exchange Rate)$_{Kstock98}$ are log weighted exchange rates, where the weights are one-year's lag of accumulated capital import share and capital import share in 1998, the starting year of the sample. The instrumental variables for capital import intensity and trade openness in Column (3) and (4) are corresponding instrumental variables where imports/exports from/to US and Hong Kong are not included in the import/export share. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 5 Capital import and Relative Demand for Skills

Panel A Second Stage Dependent Variable	(1) W_H/ W_L	(2) Skill share	(3) W_H/ W_L	(4) Skill share
Capital Import Intensity	0.253***	0.0854**	0.281***	0.0735**
	(0.0922)	(0.0367)	(0.0985)	(0.0347)
Export/GDP	0.202**	0.0521		
	(0.0971)	(0.0368)		
Trade Openness			0.137**	0.0277
			(0.0666)	(0.0231)

Panel B First Stage Dependent Variable	(1) Capital Import Intensity	(2) Export Intensity	(3) Capital Import Intensity	(4) Trade Openness
Ln(Exchange Rate)$_{Kstock}$	-0.101***	0.0178	-0.109***	0.0428
	(0.0243)	(0.0337)	(0.0245)	(0.0500)
Ln(Exchange Rate)$_{Kstock98}$	-1.326***	0.608	-1.286***	1.032*
	(0.426)	(0.478)	(0.393)	(0.575)
Ln(Exchange Rate)$_{Export}$	-0.0160	0.0653**	-0.0172	0.101**
	(0.0197)	(0.0285)	(0.0205)	(0.0423)
Ln(Exchange Rate)$_{Export98}$	-1.137***	1.721**	-1.208***	2.708**
	(0.407)	(0.752)	(0.425)	(1.108)
Ln(Exchange Rate)$_{Non\text{-}K}$			0.00893	-0.0336
			(0.0113)	(0.0206)
Ln(Exchange Rate)$_{Non\text{-}K98}$			-0.510*	0.698
			(0.290)	(0.871)
City Fixed Effects	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y
Under-identification	7.876***	7.876***	9.821***	9.821***
Hansen J Statistic	0.841	0.433	0.104	1.424
Observations	857	857	848	848

Note: Capital Import Intensity is the share of the accumulated capital imports out of capital. ln(Exchange Rate) $_{Kstock}$, Ln(Exchange Rate)$_{Export,}$ and Ln(Exchange Rate)$_{Non\text{-}K}$ are log weighted exchange rates, where the weights are one-year's lag of accumulated capital import share, export share and non-capital import share. ln(Exchange Rate) $_{Kstock98}$, ln(Exchange Rate)$_{Export98,}$ and ln(Exchange Rate)$_{Non\text{-}K98}$ are log weighted exchange rates, where the weights are accumulated capital import share, export share and non-capital import share in 1998, the starting year of the sample. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 6 Robustness Checks for Capital import and Relative Demand for Skills

	(1)	(2)	(3)	(4)
Dependent Variable	W_H/ W_L	Skill share	W_H/ W_L	Skill share
Capital Import Intensity	0.274***	0.0763**	0.275***	0.0758**
	(0.0929)	(0.0332)	(0.0924)	(0.0327)
Trade Openness	0.0804	0.0121	0.0817	0.0119
	(0.0754)	(0.0233)	(0.0721)	(0.0216)
FDI Stock/GDP	0.0876	0.0366	0.0847	0.0372
	(0.165)	(0.0587)	(0.157)	(0.0554)
College Graduate/			1.666	-0.803
Working Population			(7.701)	(3.077)
City Fixed Effects	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y
Observations	848	848	848	848
Hansen J Statistic	0.0688	1.042	0.0604	1.025

Note: The instrumental variables for capital import intensity and trade openness in Column (1)-(4) are the same as those in Table 5. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 7: Counter-factual Tests

	(1)	(2)	(3)	(4)
Dependent Variable	W_H/ W_L	Skill share	W_H/ W_L	Skill share
Fuel Import/GDP	-0.215	0.346	-0.586	0.0983
	(0.491)	(0.224)	(0.385)	(0.151)
Capital Import Intensity			0.149***	0.0386**
			(0.0529)	(0.0181)
Trade Openness			0.0588*	0.0145
			(0.0341)	(0.0122)
City Fixed Effects	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y
Under-identification	14.25***	14.25***	14.48**	14.48**
Hansen J Statistic	0.290	1.790	1.022	7.428
Observations	547	547	547	547

Note: The instrumental variables for capital import intensity and trade openness are the same as those in Table 5. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 8: Heterogeneous Impacts of Capital Imports on Relative Demand for Skills

	(1)	(2)	(3)	(4)	(5)	(6)
					Alternative Definition for Skilled Labor	
	Male	Female	Junior	Senior	High School	University
Panel A: W_H / W_L						
Capital Import Intensity	0.373***	0.0521	0.270	0.273***	0.240**	0.263**
	(0.129)	(0.108)	(0.519)	(0.105)	(0.102)	(0.116)
Trade Openness	0.174**	0.0207	-0.130	0.172**	0.118*	0.190**
	(0.0864)	(0.0726)	(0.396)	(0.0761)	(0.0651)	(0.0899)
City Fixed Effects	Y	Y	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y	Y	Y
Under-identification	9.821*	9.861*	9.517*	9.821*	9.821*	9.821*
Hansen J Statistic	2.955	5.538	4.547	1.151	7.796*	1.579
Observations	848	847	844	848	848	848
Panel B: Skill share						
Capital Import Intensity	0.0773*	0.0694**	0.224**	0.0304	0.0898**	0.0452**
	(0.0416)	(0.0331)	(0.0886)	(0.0346)	(0.0425)	(0.0208)
Trade Openness	0.0407	0.0154	0.134**	-0.00113	0.0408	0.0265*
	(0.0282)	(0.0225)	(0.0582)	(0.0260)	(0.0269)	(0.0141)
City Fixed Effects	Y	Y	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y	Y	Y
Under-identification	9.821*	9.821*	9.821*	9.821*	9.821*	9.821*
Hansen J Statistic	3.367	0.935	6.210	1.194	2.463	4.065
Observations	848	848	848	848	848	848

Note: The instrumental variables for capital import intensity and trade openness are the same as those in Table 5. Robust standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 9 Alternative Definition for Capital Import

	(1)	(2)	(3)	(4)
Definition for Capital Import	Capital Import from Seven Countries		R&D-intensive Capital Goods	
Dependent Variable	W_H/ W_L	Skill share	W_H/ W_L	Skill share
Capital Import Intensity	0.859***	0.221**	0.506***	0.135**
	(0.253)	(0.105)	(0.189)	(0.0674)
Trade Openness	0.0231	-0.00219	0.118*	0.0237
	(0.0427)	(0.0163)	(0.0624)	(0.0226)
City Fixed Effects	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y
Under-identification	9.466*	9.466*	10.19*	10.19*
Hansen J Statistic	1.702	2.057	0.754	1.279
Observations	848	848	848	848

Note: Capital Import Intensity in Column (1) and (2) is the ratio of the accumulated capital goods imported from seven developed countries to capital. Capital Import Intensity in Column (3) and (4) is the ratio of accumulated capital goods imported to capital, where capital is R&D intensive goods defined according to Raveh & Reshef (2016). The instrumental variables for capital import intensity and trade openness are the same as those in Table 5. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Appendix: Construction of Capital Import Intensity

To construct capital import intensity, we rely on several data sources to provide information on imported capital and capital stock. The import data are collected by the General Administration of Customs of China (GACC). The dataset provide detailed annual transaction information for each firm and product at six-digit HS classification, from 1997-2009. The firm-specific capital stock data is provided by the Annual Surveys of Industrial Production (ASIF, 2004). We are then able to obtain the city-specific capital stock by aggregation.

The firm-specific capital import intensity is specified as follows:

$$Kintensity_j = \frac{Kimport_j}{Capital_j}$$

where $Kimport_j$ is capital import of firm j at year 2004; $Capital_j$ is firm j 's stock of capital at year 2004.

To construct city-specific imported capital stock, we employ the perpetual inventory method:

$$Kimport_{it}^{stock} = Kimport_{it} + Kimport_{it-1}^{stock}(1-\delta)$$

where $Kimport_{it}^{stock}$ is the stock of imported capital in city i at year t; $Kimport_{it}$ is capital goods imported by city i at year t; $Kimport_{it-1}^{stock}$ is the stock of imported capital in city i at year $t-1$; δ denotes the rate of depreciation, set at 10 percent (Kydland and Prescott, 1982). Because city-level capital import data from the GACC were available since 1997, we set 1997 as the start year to calculate imported capital stock. By doing so, we impose the assumption that capital import before 1997 is neglectable. This assumption is reasonable since China's international trade soared after entering WTO and import volume before 2002 was relatively small[11].

The city-specific capital import intensity is constructed as the ratio of cumulative capital imports to capital stock:

$$Kintensity_{it} = \frac{Kimport_{it}^{stock}}{Capital_{it}}$$

[11] Total import in 1992 was 18% of that in 2002 and total import in 1997 was 48% of that in 2002.

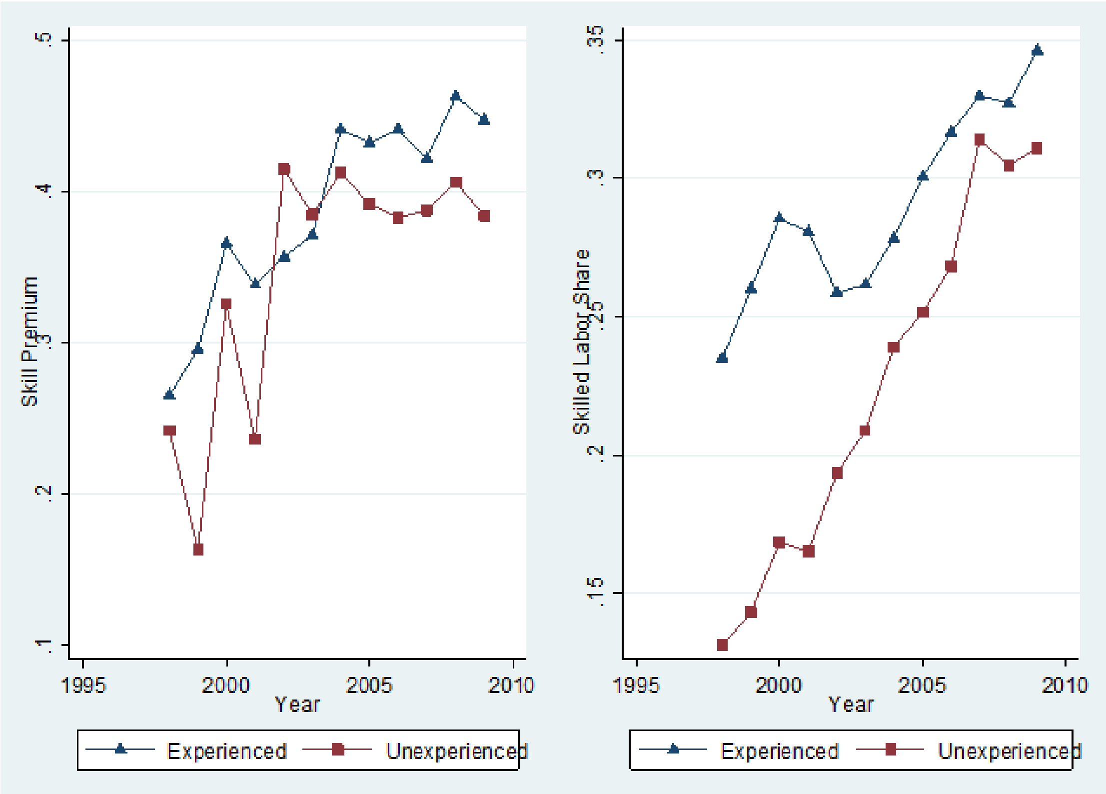
where $Capital_{it}$ is capital stock in city i at year t by aggregating firm-level capital stock; $Kimport_{it}^{stock}$ is stock of imported capital in city i at year t. The capital import intensity reflects the relative importance of foreign capital imports to domestic capital for city i at year t.

Appendix Figure A1: College Premium and Skilled Labor Share-by Gender

Data: Urban Household Survey

Note: College premium is calculated separately for male and female workers based on Mincer-style OLS regression, controlling for college education, experience, experience square, ownership, province and industry dummies.

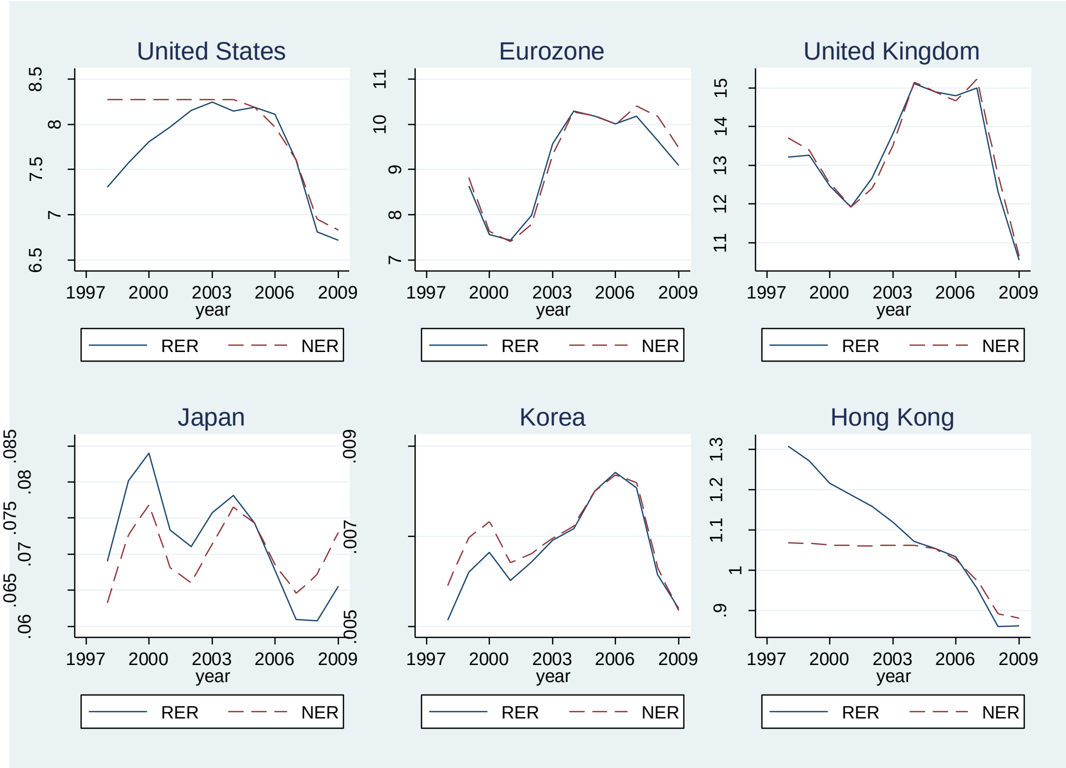
Appendix Figure A2: College Premium and Skilled Labor Share-by Experience



Data: Urban Household Survey

Note: College premium is calculated separately for experienced and unexperienced workers based on Mincer-style OLS regression, controlling for college education, gender, experience, experience square, ownership, province and industry dummies. Experienced people are those with more than five years working experience.

Appendix Figure A3: China's bilateral exchange rates against Major Trading Partners



Data: The Penn World Table (PWT 7.0, 1998-2009)
Note: NER refers to nominal exchange rate and RER refers to real exchange rate. Both are measured as RMB per foreign currency.