CAPITAL AND LABOR DISTORTIONS, FIRMS' HETEROGENEITY AND EXPORT BEHAVIOR

A Thesis

Presented to the Faculty of the Graduate School

of Cornell University

In Partial Fulfillment of the Requirements for the Degree of

Master of Science

by

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August 2019

ABSTRACT

A firm-level input price distortion is integrated into a firm's market selection decision model. We conclude that a firm facing more capital and labor costs, as measured by input price wedges at the firm level, is more likely to export and have a higher export intensity. The assumption is that the domestic market in China is more competitive for manufacturing sectors. Moreover, my model suggests that firm-level input price wedges have less of an effect on firms with higher productivity. Empirically, I show that total factor productivity for exporting firms is lower than that for firms that only sell domestically. I use two-stage Heckman regressions to verify empirically my theoretical model. I also find that the distortions have greater impact on non-State-Owned Enterprises, and the results remain consistent in export-oriented cities in which firms are heavily subsidized for exports, and in sectors who have a relatively high ratio of China to United States prices.

BIOGRAPHICAL SKETCH

Hongxiao Chen is a current Master student in Cornell University, studying Applied Economics and Management. He obtained his bachelor's degree in economics in Central University of Finance and Economics, China.

ACKNOWLEDGEMENTS

I would first like to thank my thesis advisor Professor Chau of The Dyson School of Applied Economics and Management at Cornell University. The door to Prof. Chau office was always open whenever I ran into a trouble spot or had a question about my research or writing. She consistently allowed this paper to be my own work but steered me in the right the direction whenever she thought I needed it.

I would also like to acknowledge Professor de Gorter of The Dyson School of Applied Economics and Management at Cornell University as the minor in my committee, and I am gratefully indebted to his/her for his/her very valuable comments on this thesis, as well as his valuable instructions through the study in his class.

Finally, I must express my very profound gratitude to my parents and to my friend Xinran Xu for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them. Thank you.

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U: Utility

Q_s: Consumption of each sector

P_s: Price index of each sector

σ: Elasticity of substitution across goods

φ: Firm's productivity

$\mu_m(\varphi) = T_m \varphi^{-z}$: Potential firms in country m and sector s with at least productivity φ

z: a constant term across countries and sectors
T_m: The technology level in country m.

α_s: Labor share of each sector

β_s: Capital share of each sector

$c_i(\varphi)$: Unit variable cost for each firm

$p_{id}(\varphi)$: Price of a firm's good for within country trade

$p_{ix}(\varphi)$: Price of a firm's good for selling abroad

t: a summation of transportation cost and tariff

$\rho = \frac{\sigma-1}{\sigma}$

$r_{id}(\varphi)$: Revenue from selling to domestic market

$r_{ix}(\varphi)$: Revenue from selling abroad

γ_s: Sector share of the whole market.

X_x: Total expenditure in international market

X_d: Total expenditure in the market within domestic country

P_{sd}: Price index in domestic market for sector s

P_{sx}: Price index in foreign market for sector s.

f_{id}: Fixed cost required to enter domestic market

f_{ix}: Fixed cost required to enter international market

$\pi_{id}(\varphi)$: Profit from selling domestically

$\pi_{ix}(\varphi)$: Profit from selling to international market

φ_x^*: Productivity cutoff for selling to international market

φ_x^*: Productivity cutoff for selling to domestic market

τ_{Kit}: Capital distortion

τ_{Kit}: Labor distortion

I. Introduction

The key issue I address is the relationship between a countries' trade pattern and domestic input subsidies/taxes for individual firms. For example, how subsidies for capital and labor affect exports? Usually, industry-oriented support policies are taken as a threat to a fair international trade environment by governments of importing countries who may retaliate with import tariffs. In the past, these policies, for instance, includes Japan's state reduced-rate loans and loan guarantee, which fostered its key industries in 1980s, EU's subsidy to Airbus, and China's new energy subsidy policy in 2010, which caused an initiation of an investigation under section 301 of US trade law. More recently, China's "made in China 2025" strategy which uses government subsidies, mobilize state-owned enterprises, and pursue intellectual property acquisition has raised political opposition in many importing countries, especially the United States. The main question of this thesis is, however, do distortions in input prices for firms, which mainly serves for supporting domestic industries, really encourage export and hurt foreign firms?

Before empirically studying this question, I need to overcome the limitation of input-specific subsidy data. Such information is not available in a typical firm-level survey. In the manufacturing sector, for example, direct subsidies can be observed in China's industry data, but the precise way in which different inputs of production are targeted is unclear. More specifically, a firm takes all of the subsidy received, which includes governments' subsidy paid for the loss from operation on policy-related commodities like tap water, vegetables and meat, into one accounting subject. Also, subsidies supporting key industries, like those in "made in China 2025", are also recorded in this account subject.

Furthermore, the observed subsidy may be endogenous to a firm's export. For example, some firms may obtain a tax rebate only after they export. Moreover, some types of implicit subsidies, like low cost credit in the form of loans, are not considered in this accounting framework. Hence, researchers may mistakenly take some heavily subsidized firms as non-subsidized, which may cause a misspecification. Because of the limitation in China's subsidy data, there is no paper systematically study subsidies using firm-level data in China, and empirically determine its relation to exports.

The contribution of my thesis includes the following. First, by using the method of Hsieh (2009) in specifying firm level wedges, I apply China's firm-level data to identify indirectly the input subsidies of each firm. Second, in the identification of firm level distortions, I use my own estimate of labor and capital shares for each sector in China instead of using sector shares of the US (as Hsieh (2009) assumed). Empirically, I find that the lower the input subsidy distortions are, the higher will be the likelihood of export. This result runs counter to the literature where input subsidies are deemed to lead firms to export more. The mechanism for why I come to this conclusion is as follows: since most manufacturing sector is labor-intensive in China, while at the same time China has an international advantage with lower labor costs, prices for manufacturing goods are much lower in China's domestic market. This leads to the fact that for manufacturing sectors in China, the domestic market is more competitive than the international market. Moreover, the domestic market in China is more fragmented, since local provincial officials enact policies that help local firms to grow, which makes other firms from other provinces pay a higher fixed cost to enter the market. Lastly, based on the model structure of Melitz (2003), I integrate distortions and trade into one model to explain why this counter-intuitive relationship could exist.

The rest of the paper is arranged as follows: Part II reviews the literatures. Part III summarizes some common input distortions in China and their sources. Part IV provides a theoretical structure supporting my analysis. Part V explains how I process my data and identification process. Part VI shows the empirical results and further discussions In part VII I run several robustness check. Part VIII concludes.

II. Literature Review

II.1 Estimation of distortion

Many scholars and organizations have tried to estimate distortions based at an aggregate level. Anderson (2008) together with the World Bank introduced an indicator named Nominal Rate of Assistance (NRA) to measure distortions which does not only capture information on various kinds of subsidies but also on import tariffs and quotas in agricultural sectors of different countries. Similarly, OECD provide an estimate called Producer Support Estimate (PSE), which captures most subsidies based on both input and output in agricultural sectors of OECD and several non-OECD countries. The estimated distortions mentioned above, however, have their own shortcomings. First, indicators like the PSE are country-sector level data, which does not allow distortions among households or firms to be observed. Moreover, because of the limitation of observations, these indicators are not appropriate for empirical models that require a number of observations for consistent estimates. Survey data that captures household behavior and has a many observations helps solve the deficiencies of country level data. Nevertheless, the main limitation of survey data is that it is difficult for one dataset to capture all forms of distortion.

To estimate properly firm level input distortions, I follow a method that takes all forms of capital and labor input distortions into consideration, and estimate the input distortions for each firm. According to Hsieh and Klenow (2009), the distortion is referred to the inconformity between firm's marginal productivity and its marginal cost. Specifically, in their paper, the distortion in capital input is defined as the ratio of marginal productivity of capital to its cost of capital, $\frac{\mathrm{MPK}}{\mathrm{r}}$. The idea behind this identification is that, under the assumption of profit maximization, MPK should be equal to r, and when these two factors are not equal, a distortion exists. Following the same logic, I can define the labor input distortion as the ratio of the marginal productivity of labor to its wage, $\frac{\mathrm{MPL}}{\mathrm{w}}$. One flaw of their research is that in their simulations, they take each sector's labor and capital elasticity in the US as a reference for China's sector labor and capital share. My thesis solves these two shortcomings. First, I obtain Total Factor Productivity (TFP) of each firm and factor elasticity of each two-digit sector in China. Then, I employ data of firms in the manufacturing sectors in China to identify each firm's labor and capital price distortion.

II.2 Firm's heterogeneity model

Melitz (2003)'s model incorporates firm-level productivity and its export decision, and he points out firms with different productivity can coexist in an industry because at the very beginning firms do not observe their productivities, and after firms gain knowledge on their productivity, they will choose whether to export or not. However, some assumptions in his model may be inapplicable to China's situation. First, as pointed out by Lu (2010), because of a relatively lower wage in China, price of goods in manufacturing sectors which are labor intensive should be lower than the price in the international market. Also, in my research, I provide evidence on how the fixed cost faced by firms for selling domestically is higher than the fixed cost for selling in the international market, which also runs counter to Melitz's assumption.

When applying the firm's heterogeneity model into the empirical model, correctly estimating the productivity level for each firm is important. Several issues may lead to a biased estimation of TFP. For instance, firms are able to observe their productivities, and thus these firms will adjust their inputs of labor and capital based on their individual productivity level (Olley and Pakes, 1996). As a result, the residual term is correlated with labor input and capital input, leading to endogeneity when estimating TFP. This is known as a simultaneity bias. Another problem is that firms with higher capital stock are more likely to survive in the market when facing economic shocks, even when they have relatively low productivity. This issue creates an inverse relationship between the residual term and firms' capital input, which is known as selectivity bias. Olley and Pakes (1996) introduced a way of estimating TFP that eliminates simultaneity bias and selectivity bias. Besides, Levinsohn and Petrin (2002) use intermediate inputs as a proxy variable that overcomes a shortcoming of Olley and Pakes (1996) method in which net investment of a firm should always be positive, and positively related to total output as well, while in reality the net investment could be negative. However, these two methods have not taken the distortions of input into consideration, which may result in a biased estimation of firms' "real" TFP. In my thesis, I eliminate the distortion terms in TFP that are estimated by either Olley and Pakes (1996) or Levinsohn and Petrin (2002) methods, leading to a more accurate estimation of a firm's TFP.

II.3 Misallocation and international trade

When looking at the relationship between trade and misallocation, most literature focus on how trade affects misallocation which refers to that capital and labor are not able to flow freely in the market to make firms' MRPL and MRPK equal to their marginal labor and capital cost and realize their maximized profit, because of the existence of distortions in input prices. As a result, whether misallocation will be mitigated when a country joins the international market remain ambiguous. Behrens & Murata(2012) constructed a general equilibrium model of monopolistic competition that includes the effect of promoting competition to study the influence of trade on the efficiency of resource allocation. Holmes (2014) develops an index measuring allocative efficiency that depends on the distribution of mark-ups, which is similar to the one in Chau and Grosskopf (2003). In his model, trade will help increase allocation efficiency by changing costs of goods, and thus increasing the welfare.. When it comes to China's issue, argument exists as well. Bai, Jin and Lu (2018) argues that trade liberalization may induce larger misallocation and TFP loss, since firms with lower distortions exit the market.

These papers show that the relationship between misallocation and international trade remains ambiguous,but do not point out how misallocation will affect firm's export, since it is hard to find a variable measuring firm level distortion, while in my thesis, I presented a model and empirical results to reveal the relationship between firm's export and distortions a firm face.

III. Distortion and trade in China

Having grown rapidly over the past 40 years, the development of China seems to be successful. However, such success is out of various kind of "distortions" in the market. The distortions in China originate from the strategy of heavy industry priority development, which aims at concentrating most capital into industrial sector, and finally leads to a 30-year long planned economy. To achieve this aim, Chinese government has created various policies to suppress the exchange rate, interest rates, and the price of labor and intermediate inputs in order to support capital-intensive industries to develop. To support the living of residents in cities, the food price is also suppressed, and people living in rural areas were not allowed to migrate to cities, so that farmers were extremely poor. As a result, the needs of workers living in cities, who are having a suppressed income, can be satisfied (Lin and Chen, 2016).

All these distortions lead to many abnormal phenomena in recent years (Aziz and Cui, 2007; Lin and Chen, 2016): consumptions to GDP's ratio keeps decreasing, while the ratios of investment and net export to GDP are both increasing; the distribution of national income has been shifting from residents to enterprises and governments; the growth of labor remuneration falls behind the growth of labor productivity; urbanization lags behind industrialization; employment growth is far behind the pace of economic growth. These abnormal phenomena is a result of distortions rather than some special preference of residence in China (like they are more willing to save more in bank).

International trade has contributed a lot to China's development. After the reform in 1978, China switched its trade policy from a Catch-up Strategy to a comparative advantage strategy. Still, however, the distortions exist, and China's huge amount of exports has so much to do with these distortions. On the one hand, the over development of capital-intensive industries made the rate of employment growth far behind the pace of economic growth, together with suppressed income. Thus, household consumption and the demand of consumers on import is constrained by slow growth of income, which results in continuous increase in trade surplus. On the other hand, because of the distortions assigned to firms by Chinese government, like suppressed labor wage, suppressed exchange rate, subsidies to firms, China's firms do not have to be very productive to survive in the international market.

III.1 Capital distortion

Incomplete financial market contributes a lot in misallocations in capital. Financial sectors serve as blood vein of the whole economy, and blood obstruction will slow down the pace of economic growth. For example, if firms cannot obtain funding from banks, then they cannot operate normally. Finance and risk capitals are key sources which may be needed by firms, and with better financial infrastructure like that in US will help financial resource be allocated more efficiently. As a comparison, banking sectors is China are dominated by badly managed and slowly progressive public banks which are ineffective in enforcing credits to private firms, and the stock market in China is also known for its inefficiency and plenty of regulations (Banerjee and Moll, 2009). For instance, short selling is not allowed, and derivatives markets are underdeveloped. In fact, the incomplete financial market is a phenomenon of financial suppression that exists in many developing countries (McKinnon, 1973). The form of financial suppression includes both restrictions on deposit and lending rates and capital account controls (Bai, 1999). Garnaut (2001) found that the official interest rate is lower than market interest rate by at least 50%, and most low-interest loans are assigned to State-owned enterprises. Given an official interest rate that is fixed, a cheaper credit will lead to a lower capital distortion, since the cheaper credit is representing a lower marginal product of capital.

A second form of capital distortion is soft budget constraint faced by SOEs (Kornai, 2003). Since local economy development is closely related to local state-owned enterprises, which contributes a lot on tax income and creates job position for local residents, local governments need to play roles as supporting organizations to make sure SOEs can survive in the market, even SOEs with lower productivity. As a result, since SOEs are not constrained by their capital inputs, they can apply more capital than they originally need, thus creating a much lower MPK.

III.2 Labor distortion

Labor distortion in China mainly comes from the so-called "Hukou" system, which is referred to household registration system in China. Each individual has their own Hukou status, and most people's Hukou status inherited from their parents, even though it is possible for them to change the status in the future. Hukou system in today's China is complicated. After its creation in 1958, China began to connect various policies affecting labor market to Hukou. The first attribute of Hukou is that each person is registered in a location, while this location may not be this person's real physical location. The second attribute of Hukou is that labor still has mobility under the structure of household registration system, so that there are many people working in places that do not correspond to their Hukou origin Fields & Song (2013) pointed out there are hundreds of millions of migrants in China working in different job positions in cities while still remaining their rural, or agricultural Hukou status. There are several reasons for the inconformity of individuals' real physical locations and Hukou locations. For example, in some cities only high-skilled and well-educated workers can be registered.

Many papers in the literature suggest that rural Hukou holders are facing labor market discrimination when working in cities. The first type of discrimination is wage discrimination, in which most studies have investigated. It is defined as workers who have same productivity receiving different wages. Lee (2012) showed that local workers with urban Hukou has more than 30% hourly wage than rural Hukou holders with China Urban Labor Survey in 2005, and 28% of the difference cannot be explained by observable variables. Song (2013) used Rural-Urban Migration survey data in China collected in 2008 and investigated how differently rural Hukou holders working in cities are discriminated in SOEs and private firms. He found that for workers with same personal characteristics, urban Hukou holders have over 50% more income than rural Hukou holders in SOEs, while this percentage number is only 5% in private firms. If we assume workers in SOEs and private firms are having a similar marginal product of labor, a higher wage paid to the SOEs will lead to a lower $\frac{\mathrm{MPL}}{\mathrm{w}}$, which is a lower distortion.

Also, in our data we find that SOEs are having a lower MPL, which leads to an even lower labor distortion.

The second type of discrimination is called hiring discrimination, which is defined as workers with same level productivity having different access to identical jobs. (Bertrand & Mullainathan, 2004). Several literatures support the existence of hiring discrimination based on Hukou exist. Zhao and Howden (2010) employed a household survey conducted in Beijing in 2006 and found that number of employed people in a household have a significantly negative relationship with rural Hukou status. Chen and Hoy (2011) used survey data on 21 manufacturing companies in Shanghai and found that workers working in urban area while with rural Hukou accounts for only a small portion in State-owned enterprises that have higher wage level, while in private companies there are a higher share of workers with rural Hukou status. Thus, firms hiring more people with city Hukou status, like SOEs, wage, and will have a lower labor distortion $\frac{\text{MPL}}{\text{w}}$.

Zhao (2005) also demonstrates that rural Hukou holders working in cities have more difficulties in accessing to jobs covered by social insurance programs, since private firms are only required to pay social insurance only for local residents. Gagnon et al. (2011) found that, migrant workers with urban Hukou registered in other provinces are 17% less likely to find formal job, and this gap cannot be explained without considering it as a discrimination based on Hukou registered location. Thus, hiring more people with Hukou registered in rural area or other provinces may help firms have a lower real labor cost that is represented by MPL, and thus a lower $\frac{\text{MPL}}{\text{w}}$.

From the above analysis, we can see a Hukou status's effect on labor distortion is ambiguous. For example, a city Hukou status can increase not only wage *w*, but also increase the real cost MPL by covering employees with insurance. But it still needs to be admitted Hukou system is a main source of labor distortion.

Another source for labor distortion is surplus rural labor force. As a country transfer from an agricultural to an industrial economy, the demand in labor supply in non-agricultural sectors increases greatly, while most people are still remaining in rural areas. When these people began to move from rural areas to cities to find job, the industrial sector can expand without raising wages, which resulted in an underestimated wage level for workers. Also, as Lewis depicts, the turning point is attained when the marginal productivity of labor in the traditional sector is equal to that of the modern sector. This finally leads to a lower wage level but a high MPL, thus creating the deviation of MPL from wage. There has been a lot of arguments on whether China has passed Lewis (1954) point, which refers to the situation where all surplus rural labor force has moved to industrial sectors, and wages begin to increase. Zhang Xiaobo (2011) used primary surveys of wage rates to show a rising trend of real wages in 2003, indicating that there is no more surplus labor in agricultural sectors. However, Jane Golley (2011) argued that even though there is a significant rising in wage of unskilled workers between 2000 and 2009, such rising has no significant relationship with unskilled labor shortage, so that China still has abundant surplus labor force in rural areas. Fung Kwan et al. (2018) also argued that official data has over reported agricultural labor statistics, so they derived a dataset including labor's participation in agriculture sectors and production cost and revenue. They compared the estimated required labor requirement and actual observed labor requirement and concluded that the surplus drops from 18% in 2001 to 12% in 2013, suggesting that even though China has reduced redundant labor, it still has a long way to go before passing Lewis point. As long as some industries are hiring workers with a suppressed wage, in a dynamic process MPL will always be greater than wage level.

A last form of labor distortion can be shown by the facts that SOEs in China have high labor redundancy. It is known in China that many jobs in SOEs are referred as the "Iron bowl" which means a secure job, and many employees will not be fired, so that many of the employees are not fully devoted to their jobs. Another example is that in many private firms, employees are facing a larger burden than those in SOEs. Many employees in private firms need to work for more than 10 hours every day, while employees in SOEs only need to work for 8 hours which includes their noon rest. With these burdens, it is very likely for private firms to create more value added and have a higher MPL, which is verified in the data. In my dataset, I also find the wage level for employees in SOEs and private firms are quite similar. Given a similar wage, a private firms' higher marginal product revenue of labor will suggest a higher labor distortion.

The table below summaries different representations of capital and labor distortions.

Capital distortion	**MPK**	**r**	**MRK/r**
Lower price of credits	↓	-	↓
Soft budget constraint	↓	-	↓
Labor distortion	**MPL**	**w**	**MPL/w**
Surplus rural labor force	↑	↓	↑
Hukou-fail to cover social insurance	↓	-	↓
Hukou-wage discrimination	-	↓	↑
"Iron bowl"- A secured job in SOEs	↓	-	↓

The literature above mainly focuses on distortions based on inputs or production factors, while in reality there are many other forms of distortions including different types of subsidies, tariffs, import quotas and so on which is beyond the research scope of this paper.

IV. Theoretical model

IV.1 Setup

To begin, I follow Lu (2010)'s method, which incorporate Melitz (2003) and Bernard (2007)'s model, to build the setup of the model. Assume there are two countries $m \in \{US, CN\}$, that using capital and labor as inputs for production. I use *d* to represent CN, which is the domestic market, or within country trade, and *x* to represent US, which is the exported or importing country. In both countries, s is used to denote sectors, and each sector has a share of $\gamma_s \in (0,1)$, with a Cobb-Douglas Utility function, where i denotes each firm.

$$U = \prod (Q_s)^{\gamma_s}$$

$$Q_s = \left[\int q_s(\varphi)^{\frac{\sigma-1}{\sigma}} d\mu(\varphi)\right]^{\frac{\sigma}{\sigma-1}}$$

$$P_s = \left[\int p_s(\varphi)^{\frac{\sigma-1}{\sigma}} d\mu(\varphi)\right]^{\frac{\sigma}{\sigma-1}}$$

where $\sigma > 1$is the elasticity of substitution across goods, and $\mu_m(\varphi) = T_m \varphi^{-z}$, which measures potential firms in country m and sector s with at least productivity φ. Assume z is a constant term across countries and sectors, and T_m determines the technology level in country m.

Assume firms in each sector have heterogeneous productivity, φ. Using i to denote each firm, the production function for a firm within one sector is $y_i(\varphi) = \varphi_i L_i^{\alpha_s} K_i^{\beta_s}$, where α_s is the labor share of each sector. The unit variable cost for each firm is $c_i(\varphi) = \left(\frac{1}{\alpha}\right)^{\alpha} \left(\frac{1}{\beta}\right)^{\beta} \frac{w^{\alpha_s} r^{\beta_s}}{\varphi}$.

Firm's price is a markup over variable cost. Selling abroad requires each firm to pay transportation cost and tariff t>0. Here I assume the tariff for each firm in each sector is flat. The price for within country trade is $p_{id}(\varphi) = \frac{\sigma}{\sigma-1} c_i(\varphi)$, and the price for trading in international market is $\mathrm{p_{ix}}(\varphi) = (1+\mathrm{t})\frac{\sigma}{\sigma-1}\mathrm{c_i}(\varphi)$, where t includes tariff rate and extra transportation cost, subscript d denotes domestic market and subscript x denotes foreign markets.

For simplicity, define $\rho = \frac{\sigma-1}{\sigma}$. The potential revenue for a firm in country w, x in sector s is:

$$\mathrm{r_{id}}(\varphi) = \gamma_s X_d \left(\frac{\rho P_{sd}\varphi}{\left(\frac{1}{\alpha}\right)^{\alpha}\left(\frac{1}{\beta}\right)^{\beta} w_d^{\alpha_s} r_d^{\beta_s}} \right)^{\sigma-1} = \gamma_s X_d \left(\frac{p_{id}(\varphi)}{P_{sd}}\right)^{1-\sigma} \tag{1}$$

$$\mathrm{r_{ix}}(\varphi) = \gamma_s X_x \left(\frac{\rho P_{sx}\varphi}{\left(\frac{1}{\alpha}\right)^{\alpha}\left(\frac{1}{\beta}\right)^{\beta} (1+t) w_d^{\alpha_s} r_d^{\beta_s}} \right)^{\sigma-1} = \gamma_s X_x \left(\frac{p_{ix}(\varphi)}{P_{sx}}\right)^{1-\sigma}$$

where $\mathrm{r_{id}}(\varphi)$ and $\mathrm{r_{ix}}(\varphi)$ defines each firm's revenue from within country trade and international market respectively. γ_s is the sector share of the whole market. X_x is the total expenditure in international market, and X_d is the total expenditure in the market within domestic country. P_{sd} represents the price index in domestic market for sector s. P_{sx} defines the price index in foreign market for sector s.

Assume that f_{id}, f_{ix}, to be the fixed cost that is required to enter the within country market and international market. Profits for a firm with productivity φ are:

$$\pi_{id}(\varphi) = \frac{r_{id}(\varphi)}{\sigma} - f_{id} \tag{2}$$

$$\pi_{ix}(\varphi) = \frac{r_{ix}(\varphi)}{\sigma} - f_{ix}$$

IV.2 Productivity cutoff

For simplicity, it is assumed that f_{id} of each firm is identical and can be represented as f_d. Same for f_{ix}, which is defined as f_x below. To stay in the market, a firm needs to have a profit that is at least $\pi(\varphi^*) = 0$, so the productivity cutoff for selling domestically and export is:

$$r_{id}(\varphi_d^*) = \sigma f_d$$

$$r_{ix}(\varphi_x^*) = \sigma f_x$$

Using the productivity cutoff equations (2) and formula (1), the relationship between productivity cutoffs for selling domestically and exporting can be derived:

$$\frac{\varphi_x^*}{\varphi_d^*} = (1+t)\left(\frac{P_{ds}}{P_{xs}}\right)\left(\frac{\mathrm{X_d} f_x}{X_x f_d}\right)^{\frac{1}{\sigma-1}} \quad (3)$$

In Melitz(2003)'s model, it is assumed that the ratio of price indexes in two countries, $\frac{P_{ds}}{P_{xs}}$, is equal to one, since two countries are symmetric. As a result, because of the existence of tariffs and the transportation cost, the productivity cutoff for exporting, φ_{x}^*, is greater than the one for selling domestically, φ_d^*. However, when comparing a developed country to a developing country, the ratio of price indexes $\frac{P_{ds}}{P_{xs}}$ can be less than one.

Also, note that trading within one country includes trading in the firm's own province in which this firm pays a lower fixed cost, as well as trading to other provinces in the same country, in which a firm needs to pay a higher fixed cost, due to local protectionism in China. The latter can be defined as market fragmentation. In both cases, equation (3) may give us that $\varphi_x^* < \varphi_d^*$, even though I do not assume any difference between price indexes of the two countries.

First, if trading within one country is dominated by trading across the country, selling domestically may incur an increase in fixed costs due to market fragmentation between provinces. $f_{\mathrm{di}} = f_0 + \lambda * S_k$, where f_0 represents the cost that a firm has to pay in order to sell in a local area, and S_k represents the degree of market segment of one province. Therefore, $\lambda * S_k$ represents the extra cost a firm needs to pay if it wants to sell to other provinces. Moreover, because of the existence of market segmentation among provinces in China, it is likely $f_d > f_x$. Therefore, it is possible the cutoff for selling domestically is greater than the one for exporting, which is $\frac{\varphi_x^*}{\varphi_d^*} < 1$, where *d* refers to a developing country and *x* refers to a developed country. On the other hand, if trading within one country is dominated by trading in the local province, the domestic market size faced by one firm, X_d, would be very small. In the last section of this chapter, I find empirical evidence for these assumptions.

Figure 1 where $\varphi_d > \varphi_x$ exhibits the pattern discussed above. The *x* axis exhibits the range of firms' productivity, and the *y* axis represents firms' revenue. The Blue line represents firms' revenue from both international market and within country trade, while the red line shows the revenue from only the international market. When firm's productivity is greater than φ_d, it will choose to both export and within country trade, and when its productivity lies between φ_d and φ_x, it will only export.

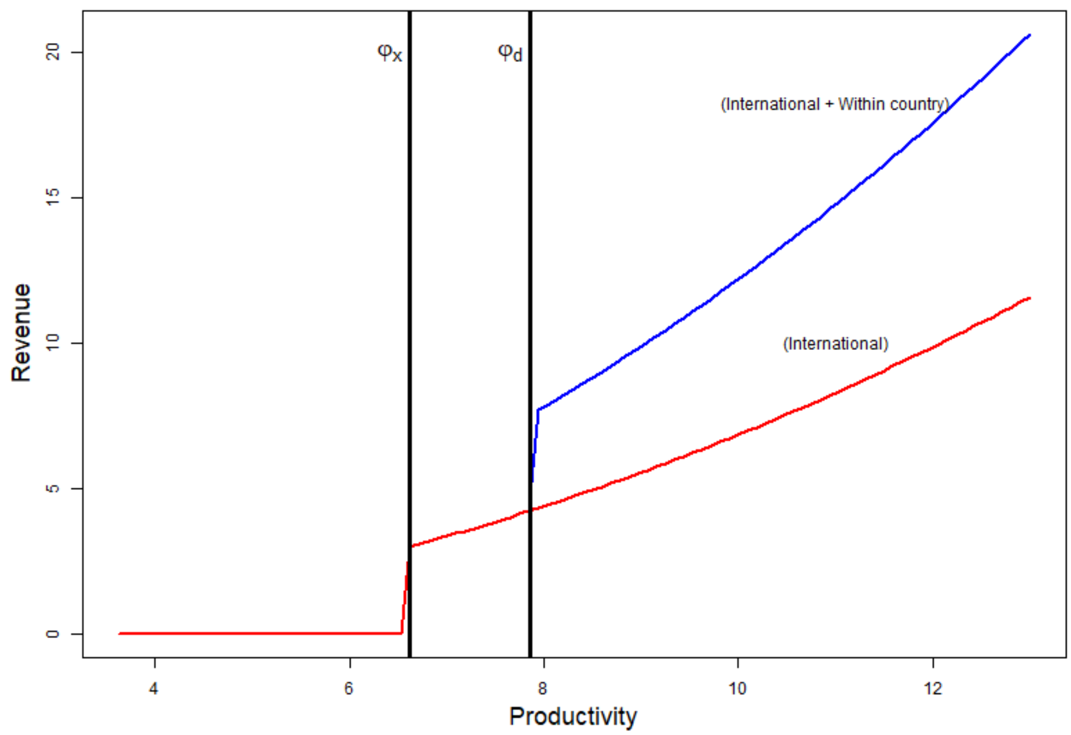

Figure 1

IV.3 Distortion's effect

Then I allow input and output distortions in the model. I follow Hsieh's (2009) method to summarize capital input and labor inputs by defining them as,

Distortions on capital:

$$1 + \tau_{Kit}$$

Distortions on labor:

$$1 + \tau_{Lit}$$

With the profit function:

$$\pi_{it} = P_s Y_{it} - (1 + \tau_{Lit}) w L_{it} - (1 + \tau_{Kit}) r K_{it}$$

The capital and labor distortions are also named as "wedges" of capital and labor by Hsieh (2009). There are many forms of capital and labor distortion. For example, firms with lower capital wedges may have access to lower cost credits or may receive subsidies to purchase a large amount of fixed assets. Firms with lower labor wedges may hire people without the local household register, or in the form of signing dispatch labor contract, so that they do not have to pay these people for their social insurance and house funds (Hertel, 2006). Besides, since 2007, China has not yet passed the Lewis point; firms that hire people from rural areas may also face a low labor wedge. With distortions, the unit variable cost becomes:

$$\mathrm{c}_{\mathrm{it}}(\varphi) = \frac{(1+\tau_L)^{\alpha_s} w^{\alpha_s} (1+\tau_K)^{\beta_s} r^{\beta_s}}{\varphi} = \mathrm{c}_{\mathrm{i}}\left(\varphi^{obs}\right) = \frac{w^{\alpha_s} r^{\beta_s}}{\varphi^{obs}}$$

from which I defined the observed productivity, φ^{obs}, as a function of firm's real productivity φ and distortion terms:

$$\varphi_{it}^{obs} = \frac{\varphi_{it}}{(1+\tau_{Lit})^{\alpha_s}(1+\tau_{Kit})^{\beta_s}} \tag{4}$$

When the distortion terms $1+\tau_{Kit}$ and $1+\tau_{Lit}$ are greater than 1, the productivity that can be observed will be lower than a firm's potential, or real productivity, which may result in firm's productivity falling below the threshold for within country trade. Figure 2 shows the effect of distortions. The dashed vertical line marked with φ_{real} points out where a firm's productivity could originally be, and the dashed line marked with φ_{obs} shows the observable productivity after distortions. In this case, this firm will only export, and the firm's revenue from within market trade drops to 0, suggesting a 100% export intensity.

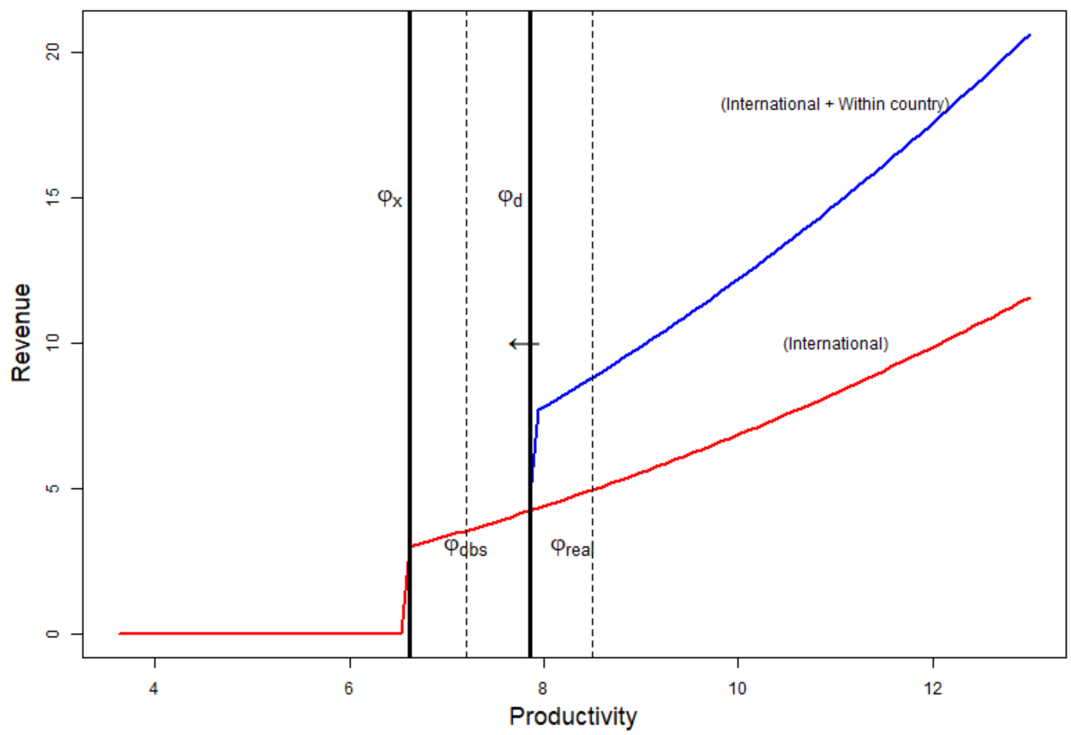

Figure 2

Nevertheless, based on this model, it can also be found that firms with a higher potential productivity are less affected by the distortions. Figure 3 presents firms with a higher potential productivity, and it can be seen that for these firms, a lower observed productivity does not affect their export selection and export intensity.

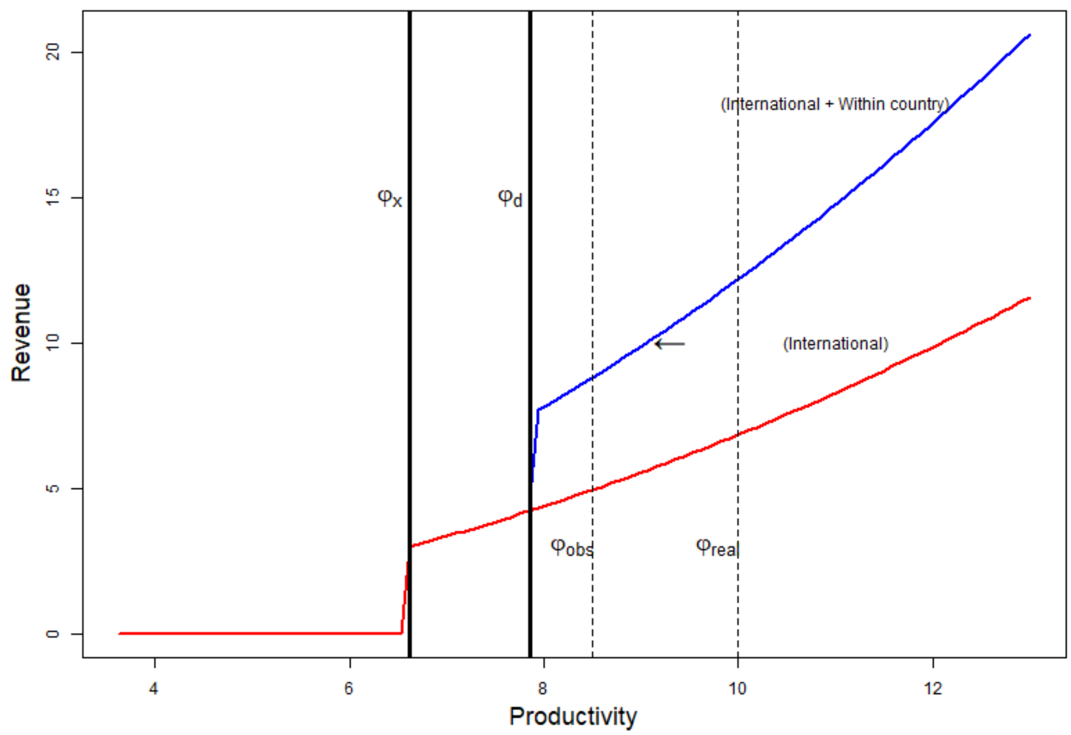

Figure 3

Another conclusion from this model is that firms in sectors with higher capital and labor shares are more likely to be affected by distortions. Equation (4) tells us, given the same level of distortions τ_{kit}, τ_{Lit}, and potential productivity φ, the larger the labor and capital elasticities are, the lower the value of observed productivity is. Using this result, I can compare the effect of distortions on various types of firms. For example, table 1 exhibits the sector share of SOEs and private firms, and from table 1, we can observe the estimated capital and labor shares to be almost identical for SOEs and private firms. Thus, I assume that the distortions may not have significant different effects between SOEs and private firms, and this conclusion should be verified in empirical parts.

Table 1

	SOEs	Private firms
Capital share	0.186	0.184
Labor share	0.132	0.143

Source: Annual Survey of Industrial Firms in China

IV.4 Verification of assumptions

Assumption 1: When $\frac{w_{cn}}{r_{cn}} < \frac{w_{us}}{r_{us}}$, I will have $P_{CN} < P_{US}$.

To begin with, I demonstrate the wage level, interest rate level, and price level of two countries at a first glance. I select the 10-year Treasury bond yield rate in China and US as the interest level to be compared. From figure 4, I can see that the interest rates of two countries does not strictly follow which one is larger. Especially from the period of year 2002 to 2007 which is covered by my sample data, the gap between two interest rates exhibited a waning and waxing pattern.

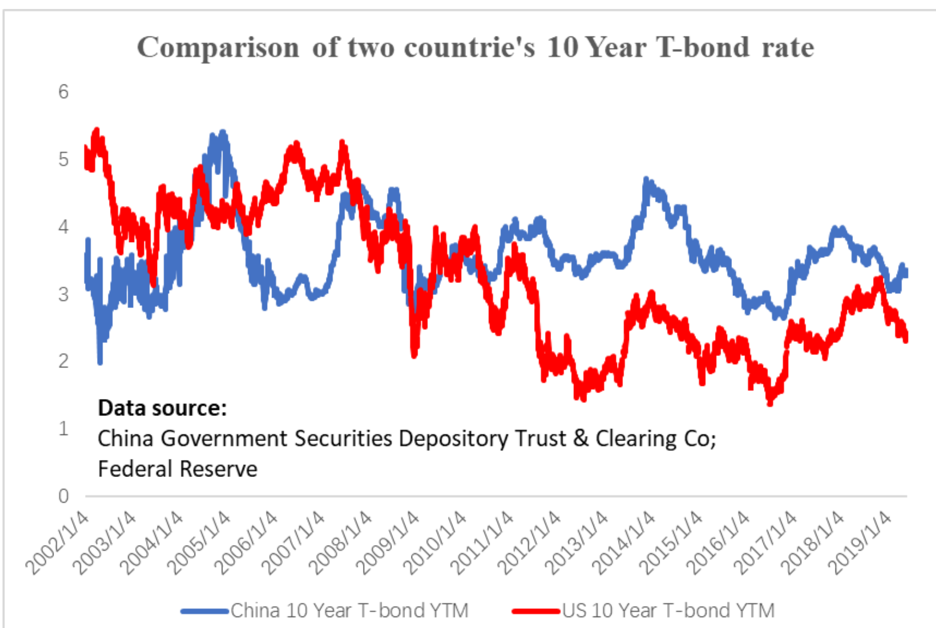

Figure 4

However, the wage level does vary a lot between these two countries. Table 2 displays the annual average wage income per person in the manufacturing sector, and both incomes' units are US dollars. In table 2, the average income level of China in manufacturing sectors is far lower than in the US.

Table 2

Year	China personal income	US personal income
2013	6921	50646
2014	7874	51610
2015	8175	52527
2016	8110	54071
2017	8795	55295

Data source: US Bureau of labor statistics; National Bureau of statistics of People's Republic of China
Unit: US dollar

In figure 5, I use the export unit price of 4-digit level products in manufacturing sectors to show the probability of a lower price in China. My data sample comes from International Trade Center (ITC), and in my final sample, there are 623 4-digit sectors in total. Numerically, the probability of China having lower prices in manufacturing sectors is 78.3%. I firstly define the unit price ratio of each 4-digit sector as $\frac{P_{CN}}{P_{US}}$, then I take the mean of 4-digit level unit price ratio into 2-digit sectors. Figure 6 exhibits the average price ratio in 29 2-digit manufacturing sectors, from which one can notice that in most sectors the average price ratio is smaller than 1. Moreover, figure 6 also indicates that sectors with a higher standardized labor share are more likely to have a lower price in China.

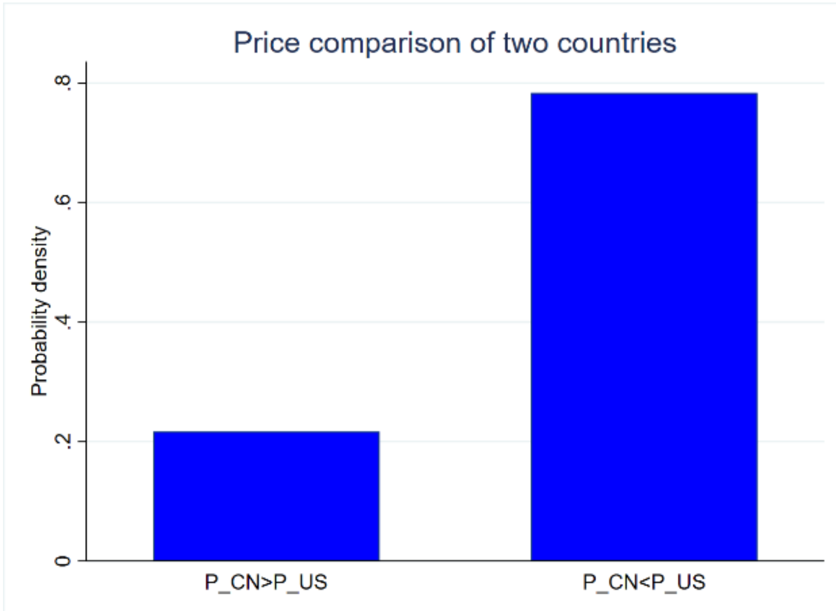

Figure 5

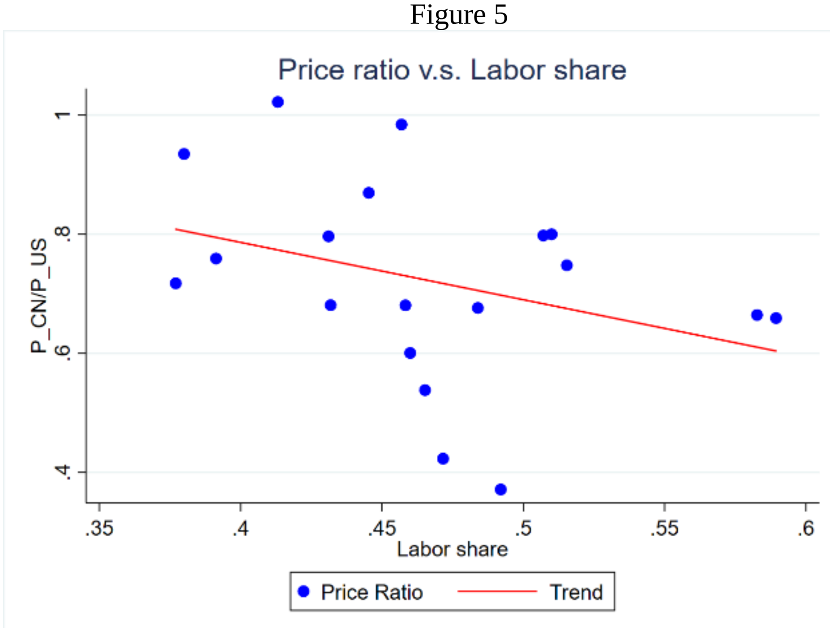

Figure 6

In this part, I prove the pattern suggested in above graphs. Following Eaton and Kortum (2002)'s model, the price index of each sector can be defined as:

$$\mathrm{P_{CN}} = \gamma\left[\mathrm{T_{CN}}\left(\left(\frac{1}{\alpha}\right)^{\alpha}\left(\frac{1}{\beta}\right)^{\beta} w_{CN}^{\alpha} r_{CN}^{1-\alpha}\right)^{-\theta} + \mathrm{T_{US}}\left(\left(\frac{1}{\alpha}\right)^{\alpha}\left(\frac{1}{\beta}\right)^{\beta} w_{US}^{\alpha} r_{US}^{1-\alpha}(1+t)\right)^{-\theta}\right]^{-\left(\frac{1}{\theta}\right)}$$

$$\mathrm{P_{US}} = \gamma\left[\mathrm{T_{US}}\left(\left(\frac{1}{\alpha}\right)^{\alpha}\left(\frac{1}{\beta}\right)^{\beta} w_{US}^{\alpha} r_{US}^{1-\alpha}\right)^{-\theta} + \mathrm{T_{CN}}\left(\left(\frac{1}{\alpha}\right)^{\alpha}\left(\frac{1}{\beta}\right)^{\beta} w_{CN}^{\alpha} r_{CN}^{1-\alpha}(1+t)\right)^{-\theta}\right]^{-\left(\frac{1}{\theta}\right)}$$

where $\mathrm{T_{CN}}$ and $\mathrm{T_{US}}$ state technology in two countries, $\theta > 1$ represents the trade elasticity of two countries. $\gamma = \left[\Gamma\left(\frac{\theta+1-\sigma}{\theta}\right)\right]^{\frac{1}{1-\sigma}}$ and Γ is the Gamma function. For simplicity, I drop the subscript s which denotes each sector. I then divide $\mathrm{P_{CN}}$ to $\mathrm{P_{US}}$ which gives us:

$$\frac{P_{CN}}{P_{US}} = \left[\frac{T_{CN}\left(w_{CN}^{\alpha} r_{CN}^{1-\alpha}\,(1+t)\right)^{-\theta} + T_{US}(w_{US}^{\alpha} r_{US}^{1-\alpha})^{-\theta}}{T_{CN}(w_{CN}^{\alpha} r_{CN}^{1-\alpha})^{-\theta} + T_{US}\left(w_{US}^{\alpha} r_{US}^{1-\alpha}\,(1+t)\right)^{-\theta}}\right]^{\frac{1}{\theta}}$$

Define $\mathrm{K} = \frac{w_{cn}/r_{cn}}{w_{us}/r_{us}}$ which is less than 1 as I have previously assumed, so that

$$P_{CN} - P_{US} \propto \left[AK^{-\alpha\theta} - B\right]\left[d^{-\alpha\theta} - 1\right]$$

where $\mathrm{A} = \mathrm{T_{CN}} r_{CN}^{-\theta}$, $\mathrm{B} = \mathrm{T_{US}} r_{US}^{-\theta}$. Since $\left[d^{-\alpha\theta} - 1\right] < 0$, and $\left[AK^{-\alpha\theta} - B\right]$ is monotonously increasing with α. As a result, if α is large enough, $P_{CN} - P_{US}$ is possible to be greater than 0, suggesting that $\mathrm{P_{CN}} < \mathrm{P_{US}}$. Moreover, since that $P_{CN} - P_{US}$ is decreasing with an increasing α, I can also conclude that in sectors that are more labor-intensive, $\frac{\mathrm{P_{CN}}}{P_{US}}$ is much lower than in capital-intensive sectors.

Assumption 2: $f_x < f_d$ in China.

In my model, another assumption that determines the inverse relationship between two productivity cutoffs is that firms usually face a higher fixed cost when trading within China. Poncet (2003) uses data for 1987, 1992 and 1997 and finds that during the period of 1987 to 1997 inter-provincial trade flow intensity is decreasing while involvement in international market is gradually increasing. Poncet (2005) observes a reduction in provincial market integration between 1992 and 1997 as well, after calculating the boarder effect of each province. How could it be so? Local protectionism of each province is the main source for a high fixed cost of within country trade. In the 1980's decentralization reforms, provincial governments are placed with more regulatory responsibility, ownership of firms, and economic and financial powers. As a result, to assist local economy, local government uses these given powers to implement discriminatory product and heal certification standards, and subsidies to local businesses in purchase of locally produced products in order to reduce competition with inter-provincial products and to maintain employment and competitiveness in local enterprises. (China economic research,1993; World bank,1994; Development research center, 2003). Poncet (2005)'s empirical results verify that provinces' domestic trade protection mainly serves for social-economic stability preservation and fiscal revenues maximization. The phenomenon of local protection finally leads to a higher cost for a firm that wants to sell to another province.

Assumption 3: Trading only in local province results in smaller market size.

I use GDP of each province as a proximity of market size. Table 3 shows the $GDP_p/\sum GDP_{-p}$ of each province in 2006, where $\mathrm{GDP_p}$ defines the GDP of province p, and $\sum \mathrm{GDP_{-p}}$ defines the sum the GDP of all other provinces which does not include province p.

Table 3 suggests that, for almost each provinces, the relative GDP ratio is less than 5%, and for the province that accounts for the largest amount of GDP, the relative GDP ratio is only 13%.

Table 3

Province	GDP	$GDP_p/\sum GDP_{-p}$
Beijing	811.78	4%
Hebei	1146.76	5%
Liaoning	930.45	4%
Shanghai	1057.22	5%
Jiangsu	2174.21	10%
Zhejiang	1571.85	7%
Shandong	2190.02	10%
Henan	1236.28	6%
Hubei	761.75	3%
Hunan	768.87	3%
Guangdong	2658.78	13%
Sichuan	869.02	4%
Chongqing	390.72	2%
Tianjin	446.27	2%
Shanxi	487.86	2%
Inner Mongolia	494.42	2%
Jilin	427.51	2%
Heilongjiang	621.18	3%
Anhui	611.25	3%
Fujian	758.39	3%
Jiangxi	482.05	2%
Guangxi	474.62	2%
Hainan	106.57	0%
Guizhou	233.90	1%
Yunnan	398.81	2%
Tibet	29.08	0%
Shaanxi	474.36	2%
Gansu	227.74	1%
Qinghai	64.85	0%
Ningxia	72.59	0%
Xinjiang	304.53	1%

V. Data and Descriptive Analysis

V.1 Data

a. Data description

Data used in this paper is Annual Survey of Industrial Firms in China, which is collected and published by National Bureau of Statistic in China. The samples in this data are mainly derived from the quarterly and annual reports submitted by the sample enterprises to the local statistics bureau. The full name of this data is called "Database of all SOE and above-scale non-SOE industrial enterprises", whose sample scope is all state-owned industrial enterprises and non-state-owned industrial enterprises above a certain size, and whose statistical unit is an enterprise legal person. The industrial firms here includes firms in "extractive industry", "manufacturing industry" and "power, gas and water production and supply industry" in the "national economic industry classification", which mainly includes manufacturing industry (accounting for more than 90%). "Above scale" requires the annual main business income (that is, sales) of the enterprise to be 5 million yuan or more, in 2011, the standard was changed to 20 million yuan or The database based on the above statistical method has been collected since 1998, and the industrial enterprise database used by most scholars is from 1999 to 2007.

As the main component of the database is manufacturing enterprises, the statistical standard of the database is relatively consistent with the industrial classification of other countries, and some variables (such as capital, R&D input and export delivery value) are easier to measure.

The statistical method of the manufacturing industry includes 30 categories (double-digit industries), including agricultural and sidelines-food processing industry, food manufacturing industry, handicrafts and other manufacturing industries, waste resources and waste materials recycling and processing industry, corresponding to the national economy industry classification and code (GB/t4754-2002) code 13 ~ 43(excluding 38).

In order to maintain the integrity of enterprise samples and to be comparable with existing studies, I took all state-owned and non-state-owned industrial enterprises above the scale from 1999 to 2007 as the main samples for my analysis of the database.

From 1999 to 2007, China's industrial enterprise database included more than 2 million observations. The number of sample enterprises increased from about 160,000 in 1999 to about 330,000 in 2007. In the nine-year sample period, there are about 550,000 enterprises in total. Obviously, this is an unbalanced panel data. Due to the closure, restructuring of enterprises and other reasons, only over 46,000 enterprises (about 8% of the total number of enterprises in the sample) appeared continuously in the whole sample period.

The database includes two types of information about the enterprise: one is the basic information of the enterprise, and the other is the financial information of the enterprise. The basic information of an enterprise includes: code of legal person, name of enterprise, legal person representative, contact number, postal code, specific address, industry to which it belongs, type of registration (ownership), affiliation, year of operation, number of employees and other indicators. Enterprise's financial data includes current assets, accounts receivable, long-term investments, fixed assets, accumulated depreciation, intangible assets, current liabilities and long-term liabilities, paid-in capital, advocate business income, advocate business cost, operating expenses, management fees, financial costs, operating profit, total profit tax, advertising, research and development fee, the total amount of total wages, welfare funds, value-added tax, industrial intermediate input, such as gross value of industrial output and export delivery value indicators. The total number of indicators is about 130.

Table 4 describes the total number of enterprises and the share changes of state-owned, collective, private and foreign-funded enterprises (including Hong Kong, Macao and Taiwan enterprises) from 1999 to 2007. It can be seen that the proportion of state-owned and collective enterprises has been significantly reduced from 2/3 in 1999 to less than 1/10 in 2007, while the proportion of private enterprises has rapidly increased from less than 30% to over 70%. This table reflects the drastic change of structure of Chinese market economy from one perspective.

Table 4

Year	State-owned enterprises(%)	private firms(%)	foreign firms(%)
1998	62.8	27.18	10.02
1999	57.53	31.59	10.88
2000	49.21	39.32	11.47
2001	35.45	53.03	11.52
2002	28.59	60.53	10.88
2003	23.98	64.96	11.06
2004	16.4	72.21	11.39
2005	10.9	78.59	10.51
2006	13.14	67.45	19.41
2007	10.79	70.18	19.03

Identification of Misallocations

Assume each firm's production are in Cobb-Douglas forms:

$$Y_{si} = A_{si} K_{si}^{\beta_s} L_{si}^{\alpha_s}$$

Define τ_{lit} and τ_{kit} are firm-level distortions, the profit maximization problem is:

$$\max\left(\pi_{it} = PY_{it} - \left(1 + \tau_{it}^{L}\right)\overline{w}L_{it} - \left(1 + \tau_{it}^{K}\right)\bar{r}K_{it}\right)$$

The first order conditions give that

$$\frac{\partial \pi}{\partial \mathrm{L}} = 0$$

$$\frac{\partial \pi}{\partial \mathrm{K}} = 0$$

Then the firm-level distortions in capital and labor input prices can be identified as:

$$\left(1+\tau_{it}^{L}\right)=\frac{\alpha_s[PY]_{it}}{\overline{w_{st}}L_{it}}=\frac{\mathrm{MPL_{it}}}{\overline{w}_{st}}$$

$$\left(1+\tau_{it}^{K}\right)=\frac{\beta_s[PY]_{it}}{\overline{r_{st}}K_{it}}=\frac{\mathrm{MPK_{it}}}{\overline{r_{st}}}$$

In estimation, I use the yearly average industry wage and interest rate, $\overline{w}$ and $\bar{r}$, to identify the firm-level distortion in order to see the effect of any deviation from average wage and interest rate levels.

b. Other key variables:

Export: The dataset summarizes the values of the goods a firm export. For firms that do not export, the value of this variable is 0. So, aside from knowing about the amount of goods a firm export, I can also determine whether a firm export or not.

Value added: The value added is not reported in 2001, 2002, and 2004. However, based on accounting standards, I can use the following equation to generate added value:

$$\begin{aligned}&Industrial\ added\ value\\&\quad = Industrial\ total\ output - Intermediate\ input + value\ added\ tax\end{aligned}$$

In year 2004, neither added value nor industrial total output is reported. To generate added value, U used another equation:

$$\begin{aligned}&Industrial\ added\ value\\&\quad = operating\ revenue + other\ revenue - intermediate\ input\\&\quad\quad + value\ added\ tax\end{aligned}$$

Capital: Original value of fixed assets is the foundation of how I identify firms' capital input. Since under accounting standards, book value but not real value of fixed assets is reported each year, the value of fixed assets will be underestimated as year passes by (assuming under inflation situation). Thus, it is important to convert the value of fixed assets to the real one. Firstly, I assume the book value of fixed assets in the year in which firms appears in the dataset for the first time, as the real value of a firm's fixed assets. Secondly, I deflate the real value of fixed assets to 1998's baseline. The investment deflator is constructed by Brandt and Rawski (2008), and since the value for 2007 is missing, I use fixed asset price investment index published by NBS for instead. Lastly, as suggested by Brandt (2012), I assume a 9% depreciation rate for firm. Thus, aside from the initial value of fixed assets, the one for the following years can be calculated by the following formula:

$$Capital_{it} = 0.91 \times Capital_{it-1} + (FA_{it} - FA_{it-1}) \times 100/BR\_deflator$$

where FA_{it} represents the book value of fixed assets of firm i in year t. It is admitted that this method of estimating firms' real capital level might generate a downward estimation of firms' capital. Since the data set only counted in one firm when this firm reached the required revenue level, say, 5 million RMB, so that the first time when a firm appeared in the data set is not equal to the year when the firm is set up, so the book value of fixed asset appearing in the first year may still differ from its real value.

Employment: Firms in each year report the number of employees who are included in the wage bill. Besides, the total wage that is paid to employees are also reported in a firms' financial statements.

Interest rate: Interest rate each firm faces is calculated as:

$$interest\ paid_{it}/(long\ term\ debt_{it} + short\ term\ debt_{it})$$

Labor and capital shares: There are multiple ways of estimating labor shares. As previously said, there are 29 sectors in the sample. The first method I use is to define labor share as $\alpha = \frac{\text{labor income}}{labor\ income + total\ profit + depreciation + value\ added\ tax}$. The denominator on the RHS is the income-based value added. In the second way, the labor share is still below the level implied by the national income data. So I blow up the labor share in each sector by 25% to match the labor share implied by NBS. The capital share would be $1 - \alpha$. The second method I use is to use Levinsohn and Pertin (2003)'s method to estimate TFP of each firm, and at the same time, the coefficients for labor and capital can be estimated, which are capital and labor shares of each sector. Firms in each sector have the same level of labor and capital share, say, β_s and α_s. In this assumption, I loosen the constraint of constant return to scale. Also, I use Olley-Pakes (1996)'s way to estimate firms TFP and sector shares. Table 5 exhibit capital and labor shares determined by these methods. It should be noticed that the estimated TFP by both OP and LP methods are the observed ones that include the effect on distortions. In my estimation, I converted the observed TFP into the "real" TFP by adding back the distortions.

Table 5

	Method 1	Method 2(LP)	Method 3(OP)
Capital Share			
Mean	0.55	0.18	0.48
Max	0.88	0.26	0.65
Min	0.15	0.11	0.33
Labor Share			
Mean	0.45	0.14	0.42
Max	0.85	0.23	0.58
Min	0.12	0.08	0.22

Firm's productivity: OP and LP methods are both used to estimate firms TFP. To exclude the bias induced by distortion, I use the equation below to estimate the "real" TFP and put it into my empirical model.

$$\mathrm{TFP}_{\mathrm{real}} = \ln\left(e^{TFP_{LP}}(1+\tau_L)^{\alpha}(1+\tau_K)^{\beta}\right)$$

Control Variables

Aside from the variables mentioned above, there are also several variables that enter the empirical model. (1) Firm's age. The longer an enterprise exists in the market, the more likely it is to accumulate mature marketing experience, advanced production technology and good corporate reputation, etc., thus influencing the export decision of the enterprise (2) Firm's asset-liability ratio. Enterprises have to bear a relatively high sunk cost of export in the international market, and long-distance transportation will also reduce the speed of capital turnover, so whether they can get adequate financial support in time is one of the factors affecting the export decision making of enterprises. (3) Firm's size represented in log form of firm's total employment. The larger the scale of firm's size, the lower the average cost of production, and the easier it is to export. (4) Outsource degree of a firm, defined as intermediate input to value added in log form. According to the new economic geography theory, the stronger the degree of industrial concentration where the enterprise is located, the more fine level of specialization, the easier it will be for industry division, and the easier it is for enterprises to be outsourced and to purchase intermediate inputs from other enterprises, thus saving the cost of production and create export competitive advantage. (5) Whether a firm is State-owned enterprises. SOEs have received the vast share of subsidies each year, which may help them to export more, while on the other hand most SOEs are in capital intensive sectors, which may weaken their ability to export. (6) Firm's total input measured in the log form of capital and labor. (7) Firm's ownership, which includes private firms, foreign firms and state-owned enterprises (SOEs)

Market segment: In short term local government can implement market segment strategy to protect local employment and tax income to promote economic growth (Ming Lu, 2009), especially when other provinces implement the same strategy, the profit of the local province would be harmed. To investigate into market segment among provinces, a province-level panel data is necessary. I use the 'price method' developed by Parsley and Wei(1996, 2001) to identify market segment with relative price indexes of 12 goods. 'Price method' is based on 'iceberg cost model' (Samuelson, 1954) which originates from one price law. Because of the existence of transaction cost like transportation cost, value of goods will diminish as iceberg melting during trade, so even if there is no arbitrage condition, the price of the same good in two regions will not be equal. However, the relative price will fluctuate in a given interval. Assume in region i and j the relative price of goods with no arbitrage is c, then only when $P_i(1-c) > P_j$ or $P_j(1-c) > P_i$ will trade between i and j exist. As a result, when there is no arbitrage, the relative price $\frac{P_{mi}^t}{P_{mj}^t}$ will lie into interval [1-c, 1/(1-c)].

Our raw data contains the price indexes of 12 goods in 31 provinces, from year 1995 to 2015. These indexes measure the sales increases of grains, grease, meat, aquatic product, vegetables, fruits, alcohol and tobacco, clothing, medicine, fuels, building materials, hardware, and daily necessities. The transaction cost contributes to the price difference, letting the price ration fluctuate in no arbitrage interval, which is to say, $\frac{P_{mi}^t}{P_{mj}^t} \in$ [1-c, 1/(1-c)], where m represents the type of goods, t represents the year it is, and i and j represent each province. When the market segment decreases, the no arbitrage interval becomes narrower, and I can use the variance of the price difference to measure such an interval, thus the less $\mathrm{Var}(\frac{P_{mi}^t}{P_{mj}^t})$ is, the less market segment will be. The raw data I obtain does not have the price difference of different goods, but does have the increase in price of each good, so I can identify the price ratio between goods in the equation below:

$$\Delta \mathrm{Q}_{\mathrm{mij}}^{\mathrm{t}} = \ln\left(\frac{P_{mi}^t}{P_{mj}^t}\right) - \ln\left(\frac{P_{mi}^{t-1}}{P_{mj}^{t-1}}\right) = \ln\left(\frac{P_{mi}^t}{P_{mi}^{t-1}}\right) - \ln\left(\frac{P_{mj}^t}{P_{mj}^{t-1}}\right)$$

Then the identification can be further represented as:

$$\mathrm{Var}\left(\left|\ln\left(\frac{P_{mi}^t}{P_{mi}^{t-1}}\right) - \ln\left(\frac{P_{mj}^t}{P_{mj}^{t-1}}\right)\right|\right)$$

The reason for taking absolute value is that the order of i and j will influence the sign of $\ln\left(\frac{P_{mi}^{t}}{P_{mi}^{t-1}}\right) - \ln\left(\frac{P_{mj}^{t}}{P_{mj}^{t-1}}\right)$, which might increase the level of variance when actually the negative number represents the same idea. Besides, taking logarithms makes the distribution closer to normal distribution.

To measure market segment more precisely, the price difference brought by the heterogeneity of goods must be excluded. First, I calculated the mean value of $|\ln\left(\frac{P_{mi}^{t}}{P_{mi}^{t-1}}\right) - \ln\left(\frac{P_{mj}^{t}}{P_{mj}^{t-1}}\right)|$, between 69 pairs of neighboring provinces, and got $\mathrm{mean}(|\Delta \mathrm{Q}_{\mathrm{mij}}^{\mathrm{t}}|)$, then I estimated the equation below:

$$\left|\Delta \mathrm{Q}_{\mathrm{mij}}^{\mathrm{t}}\right| = \alpha + \beta \mathrm{mean}\left(\left|\Delta \mathrm{Q}_{\mathrm{mij}}^{\mathrm{t}}\right|\right) + \mathrm{q}_{\mathrm{mij}}^{\mathrm{t}}$$

in which $\mathrm{q}_{\mathrm{mij}}^{\mathrm{t}}$ is the error term, and the error term is the fixed effect interesting to us. Lastly, I use the indicator below to measure market segment between two provinces.

$$\mathrm{seg}_{\mathrm{mij}}^{t} = sd(\mathrm{q}_{\mathrm{mij}}^{\mathrm{t}})$$

Finally, to find the market segment degree of each province, I calculate the mean value of $\mathrm{seg}_{\mathrm{mij}}^{t}$ between two neighboring provinces. For example, to see the level of Shanghai's market segment, the mean value of market segment between Shanghai and Zhejiang and the one between Shanghai and Jiangsu can be used.

c. Data cleaning

First, I use the investment deflator constructed by Brandt and Rawski (2008) to deflate capital. Since the deflator only lasted to 2006, I use the investment index number published by national bureau as the deflator for year 2007 instead. CPI is used to deflate employees' wages. Value added is deflated by using the benchmark output deflator for each two-digit sector built by Brandt (2010). Intermediate input is deflated by using the benchmark input deflator for each sector built by Brandt (2010). Industry identification ID of several sectors in China were adjusted according to new classification criteria, so I adjusted all industry IDs before and in year 2002 to be in concordance with those after 2002. Lastly, I exclude some outliers in the dataset. Observations with negative and missing value added, industrial output, net fixed assets, gross fixed asset, intermediate input, wage bills are dropped. Besides, a firm should have at least 8 employees to maintain a reliable accounting system, so I exclude firms without at least 8 employees. According to Brandt (2010), variables used to estimate TFP are all deflated to 1998 baseline level.

V.2 Descriptive Analysis

Table 6 summarizes key variables. A simple glance gives us some intuition of China's firm's performance in manufacturing sector. First, over 26% of firms have engaged in exporting activities, and 16% of firms' revenue are driven by exporting, suggesting that during 1998-2007, exporting has contributed a lot to China's development. Second, notice that even the average for $MPL/\overline{w}$ is less than 1, the average for MPL/w is almost close to one, suggesting the wage reported by China's firms are relatively accurate in that average MPL does not violate too much away from firms paid wage. The capital distortion is much higher than labor distortion, and this maybe the evidence most firms are not able to use the market interest rate to achieve loans, even banks are having enough funding support these firms. Also, we can see that around 12% of firms in China receive a subsidy from the government, which suggests government's strong interference in the market. Unfortunately, however, I cannot detect what kind of subsidy a firm is receiving by only looking at this variable. Finally, notice that some firms' capital input is negative, and this is still possible, since depreciations are also taken into consideration.

Table 6

Variable	Description	Observation	Mean	SD	Min	Max
Export selection	Export selection	1,463,643	0.26	0.44	0.00	1
Export intensity	Export intensity	1,197,191	0.16	0.33	0.00	1
MPL/w_bar	Labor distortion	1,646,841	0.75	6.01	-9.62	7271
MPL/w	Labor distortion	1,651,466	1.02	11.62	-40.99	10429
MPK/r_bar	Capital distortion	1,584,090	40.49	2831.67	-30275.38	1955113
MPK/r	Capital distortion	1,095,223	191.24	30125.54	-105169.20	29300000
TFP_real	TFP removing distortions	1,449,372	6.51	1.45	-8.69	15
Age	Firm's age	1,661,804	10.41	11.82	0.00	449
Size	Employees	1,663,950	265.87	1004.43	0.00	188151
Finance	Asset/Liability	1,663,111	5.20	221.31	0.00	180000
Outsource	Intermediate inputs/VAD	1,655,897	5.56	141.45	0.00	76216
Subsidy	Receives subsidy	1,663,959	0.12	0.33	0.00	1
Province export	Province export ratio	1,463,640	0.26	0.12	0.00	1
capital	Capital input	1,594,675	28872.79	375077.60	-193843.60	104000000
labor	Labor input	1,663,956	3728.39	28947.79	0.00	17300000

A. Distortions by types of firms

Figure 7 and 8 show how labor and capital distortions differ across firms' types. Both figures suggest that the State-owned enterprises enjoy the lowest labor and capital distortion, while private firm's distortions rank the highest, and foreign firm's distortion level stays in the middle. This suggests that state-owned enterprises are likely to produce at a lower MRPK and MRPL than private and foreign firms when given the same average interest rate and wage level, implying SOEs enjoy potential support on capital and labor inputs. Another possible explanation is that, as shown above, SOEs mainly belong to labor-intensive sectors, while distortions are lower in more capital-intensive sectors, which is exhibited in part B.

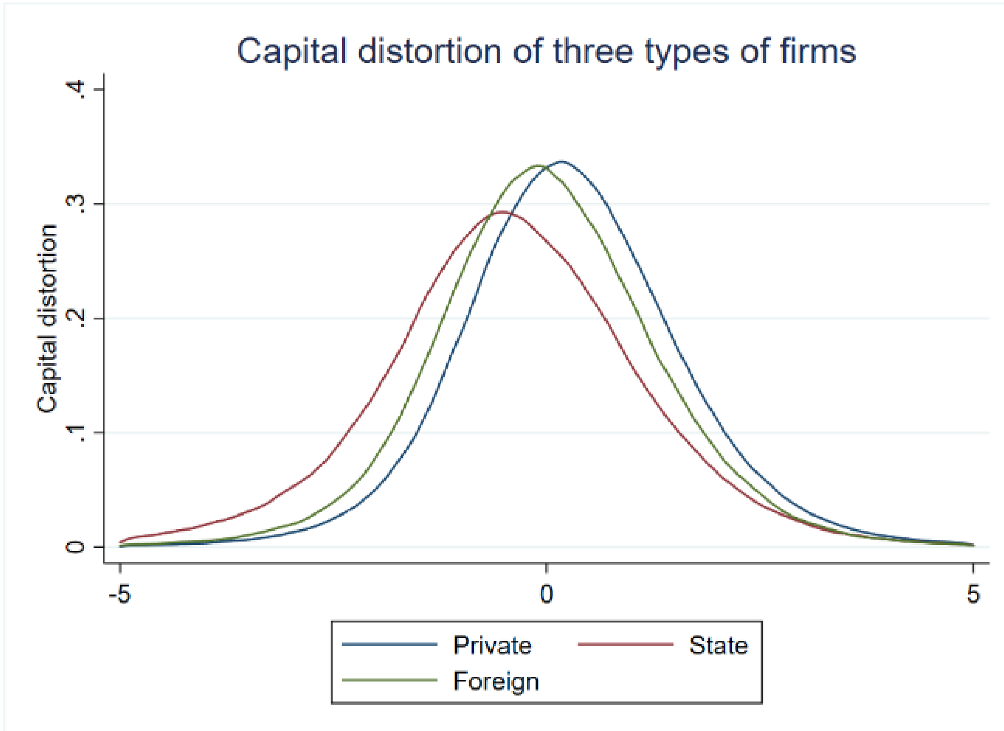

Figure 7

Figure 8

A simple explanation on why SOEs are having a lower capital cost is that they have access to lower cost credit from bank. However, what is the reason behind this? The first reason is that SOEs are more able to pay back their loans to banks, since many of them are facing soft budget constraints (Kornai, 2003), while many private firms never pay back their loans after they get the money (Huang, 2003). As a result, banks are more willing to borrow to SOEs but not private companies, and they usually require a higher rate of return when facing private companies. Another reason is that, as pointed out by Song (2019), whether a firm can receive loans depends on its relationship to the funding entities. Usually, most SOEs are having a close relationship to local governments, who have strong influences on local banks' business decisions, and that enable them to receive loans with a cheaper price.

The question is that, can a private firm receive lower cost credits from banks? Yes, they can. Sometimes private firms can employ many workers and help boost local economy, make special deals with the government (Song, 2019), thus resulting in a very low cost capital and land input. Foxconn is a good example. Or, if a private firm has a close relationship to SOEs, they can still get support from SOEs even though they cannot receive loans from banks (Song, 2019). But most private firms do not satisfy any of these two conditions, so that they have to pay a higher price to obtain capital.

The reason for why SOEs have a lower labor cost is also interesting. One possible explanation is that SOEs in China have high labor redundancy. It is known in China that many jobs in SOEs are referred as the "Iron bowl" which means a secure job, and many employees will not be fired, so that many of the employees are not fully devoted to their jobs. Another example is that in many private firms, employees are facing a larger burden than those in SOEs. Many employees in private firms need to work for more than 10 hours every day, while employees in SOEs only need to work for 8 hours which includes their noon rest. With these burdens, it is very likely for private firms to create more value added and have a higher MPL, which is verified in the data. In my dataset, I also find the wage level for employees in SOEs and private firms are quite similar. Given a similar wage, a private firms' higher marginal product revenue of labor will suggest a higher labor distortion.

B. Distortions by sectors

In part B, I took the mean value of the log term of capital and labor distortions of each two-digit level sector. Figure 9 and 10 sort 29 sectors by their standardized labor share, which is equal to $\frac{\text{labor share}}{\text{labor share+capital share}}$, from top to bottom in ascending sequence, as well as showing the distortion level of each sector. Both figures suggest that in labor intensive sectors, capital share and labor share are relatively higher. Figure 11 and 12 exhibit the linear relationship between standardized labor share and distortions. Labor distortion shows a strong positive relationship to the labor share, supporting the argument that labor-intensive sectors are facing a higher labor distortion. Capital distortion also has a positive relationship to sector's labor share, even this relationship is not as strong as the one for labor distortion and has a larger variance.

Similar to part A, this pattern can also be explained by that a larger share of SOEs who enjoy more support are in capital-intensive sectors. It should be noticed that no causal relationship between part A and part B is inferred.

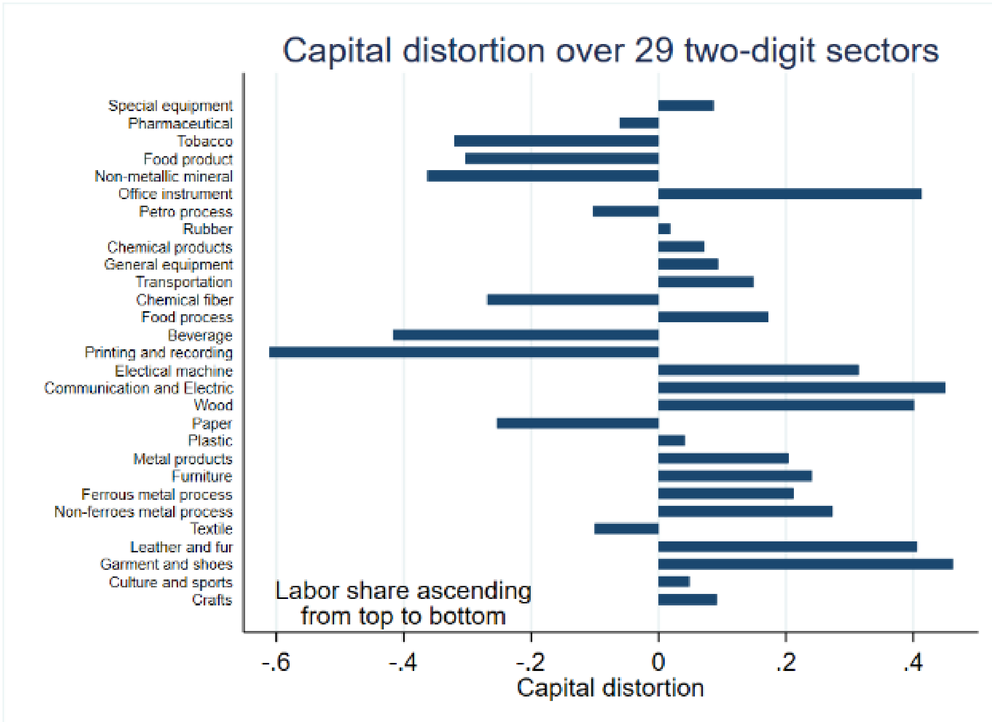

Figure9

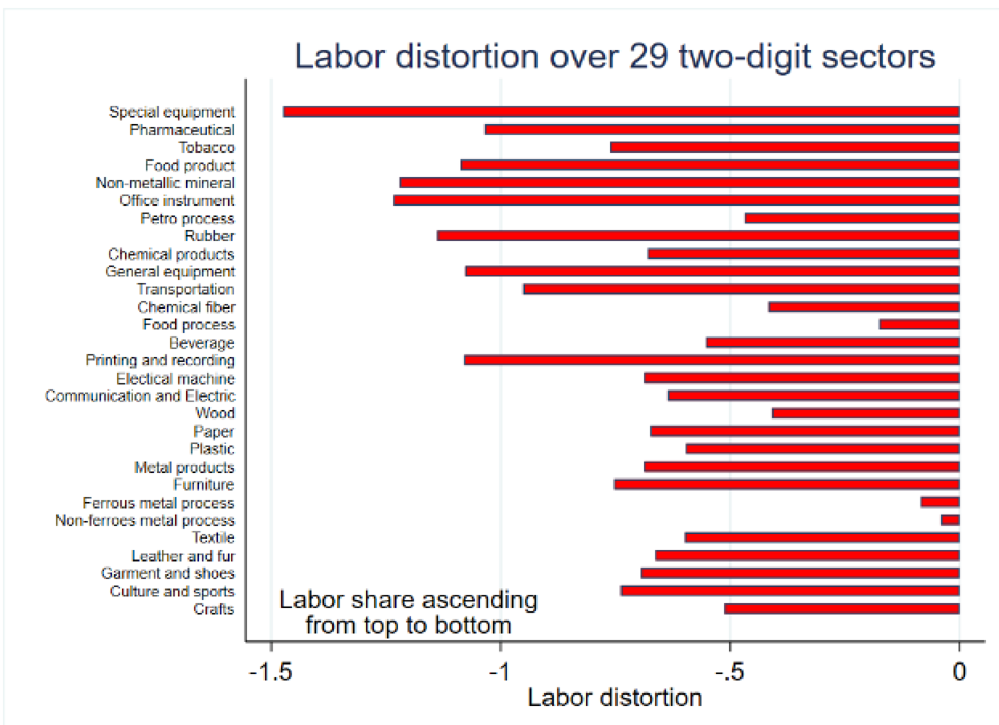

Figure 10

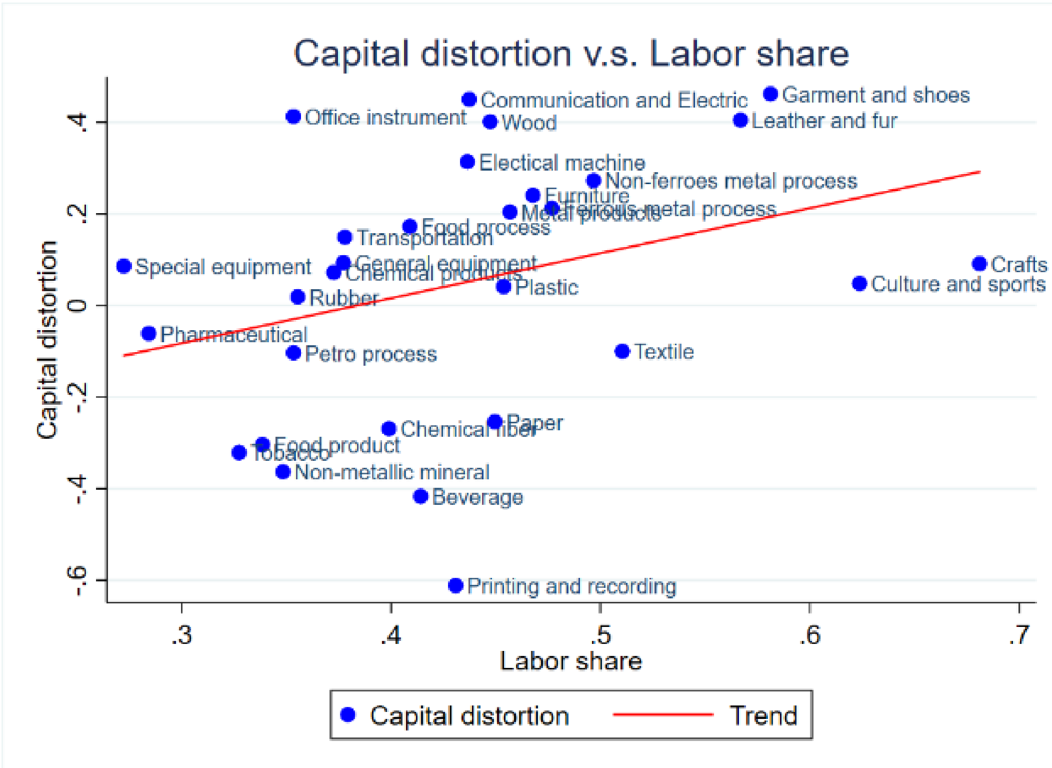

Figure 11

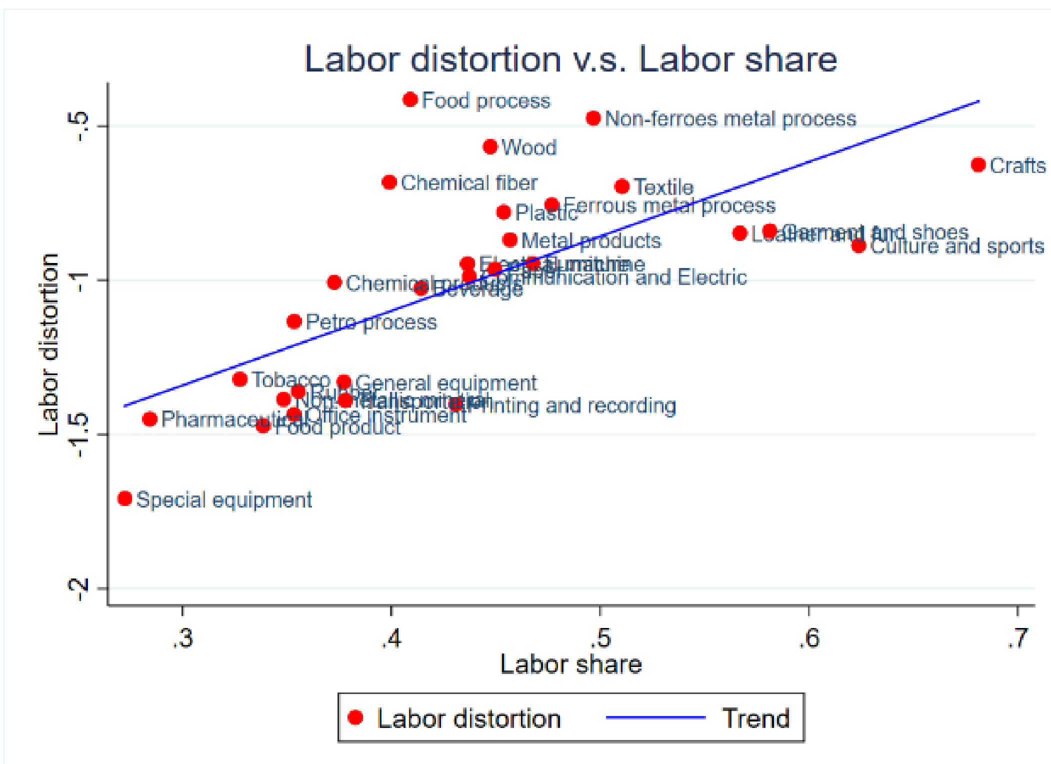

Figure 12

C. Distortions by time

In part C, I show how capital and labor distortion change over time, and it can be seen that both distortions are increasing.

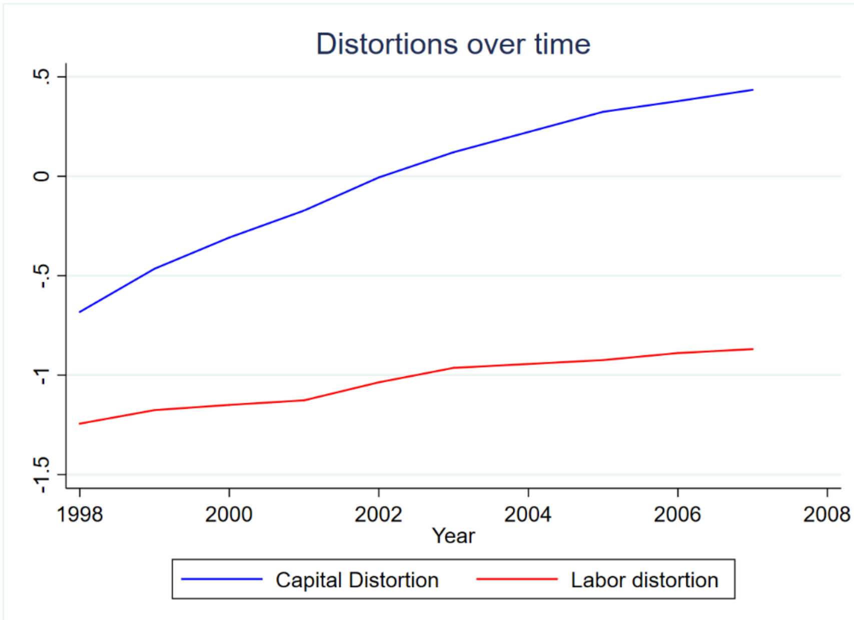

Figure 13

D. Distortion by region

Part D exhibits how capital and labor distortions differ across regions in China. Following the classification standard of National Statistic Bureau of China, the nation is divided in to 4 parts: Northeast, East, Central and West region, and based on this standard I took the mean value of capital and labor distortion in log term for 4 regions. Figure 14 and 15 suggest that both capital and labor distortions are lowest in the west part of China, while highest in the east. The northeast ranks the 2nd lowest and central region of China ranks 3rd.

Two potential reasons account for a lower level of both capital and labor distortions in the West and Northeast. The first reason is similar to the argument above. Since the East area is developing faster and have higher incomes than other regions, private firms in the East are more prosperous, thus bringing a higher distortion.

The second reason is viewed in a national strategic side. Before the 1990s, northeast China was an economically developed region as well as an important industrial base in China. However, with the deepening of reforms and opening up, the economic development speed of northeast China gradually lagged behind that of the eastern coastal region. In view of this, the country put forward the revitalization strategy of northeast China and other old industrial bases.

"Western development" is a policy of the central government of the People's Republic of China, which aims to "use the remaining economic development capacity of the eastern coastal areas to improve the economic and social development level of the western region and consolidate national defense". In January 2000, the state council established the leading group for the development of the western region. After deliberation and approval by the National People's Congress, the western development office of the state council officially began to operate in March 2000. The overall policy includes the following major projects: West-to-east gas and electricity transmission projects; South-north water diversion project; and The Qinghai-Tibet railway.

As a result, during the period 2000-2007, the central government has provided great support and established many beneficial policies to the firms in the Northeast and the West, which can potentially be the reason for lower capital and labor distortion in these areas.

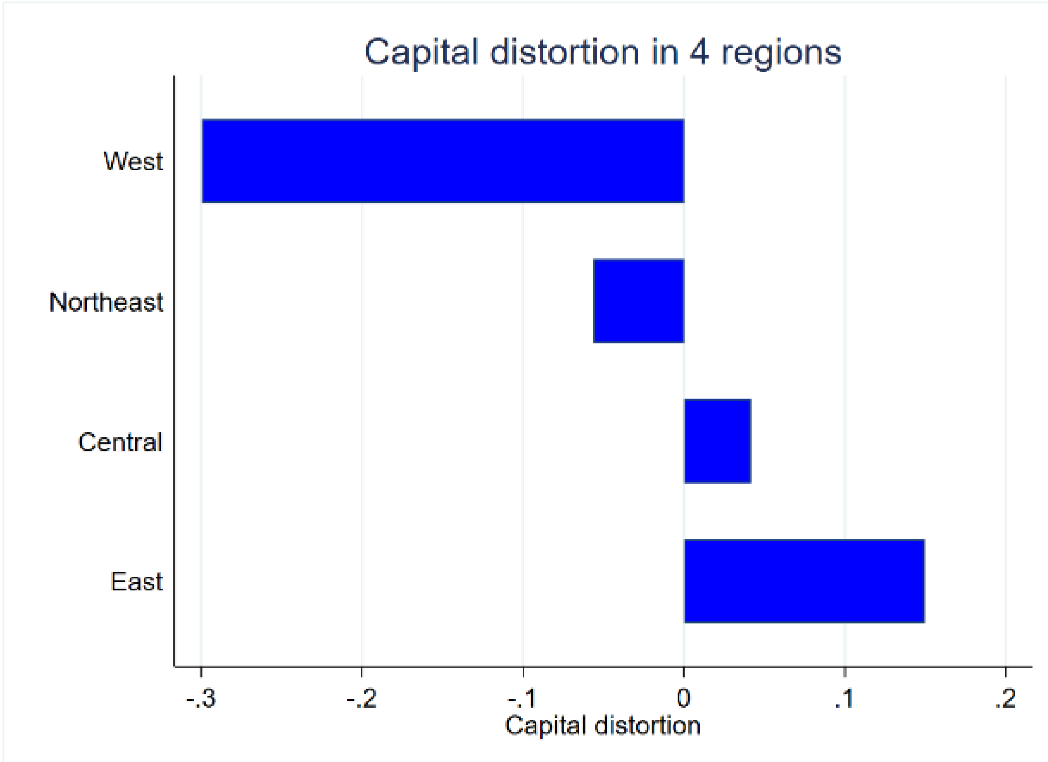

Figure 14

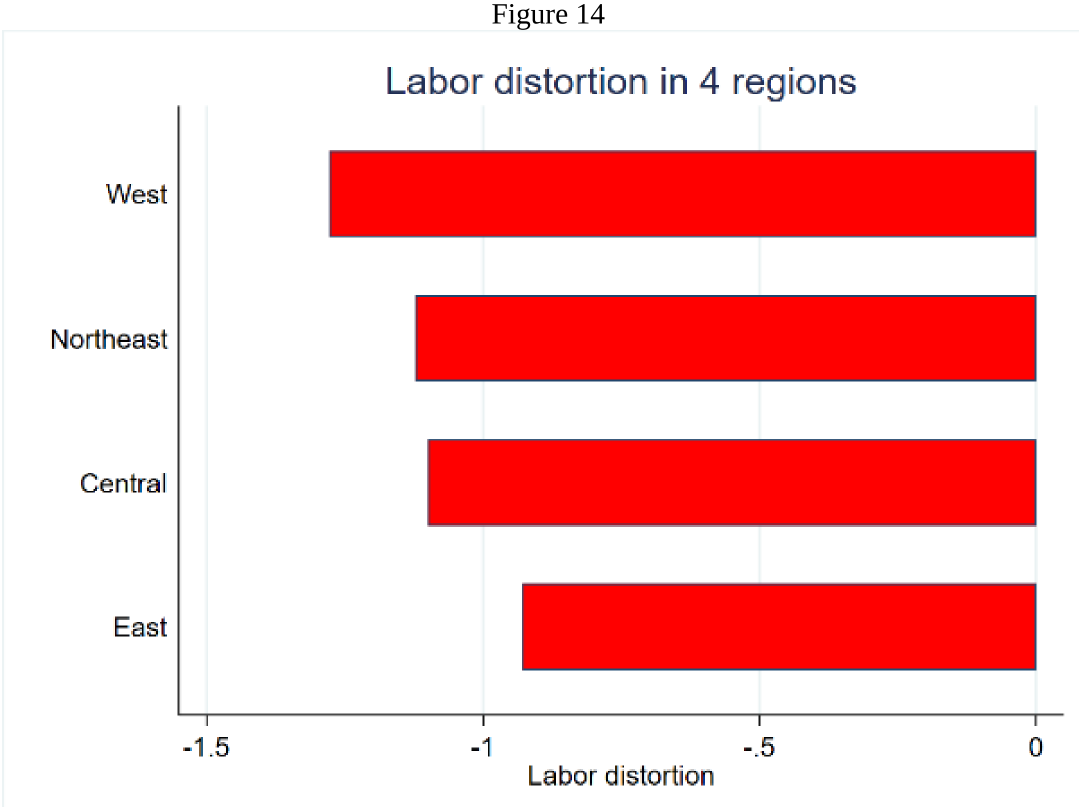

Figure 15

E. Distortions and export

E.1 Distortions of three types of firms

Figure 16 and 17 show how export probability and export intensity differ across firm types. It can be seen that foreign firms are the main force of exporting, with both highest level in export probability and export intensity. Private firms have the second largest in export probability and export intensity. Thus, the distribution of labor and capital distortion suggested in figure 5 and 6 cannot fully explain the export condition of these three types of firms. But since foreign firms are of minority in the composition of all the firms in China, if I only focus on private firms and SOEs, I can find that private firms are of the highest distortion level as well as highest export.

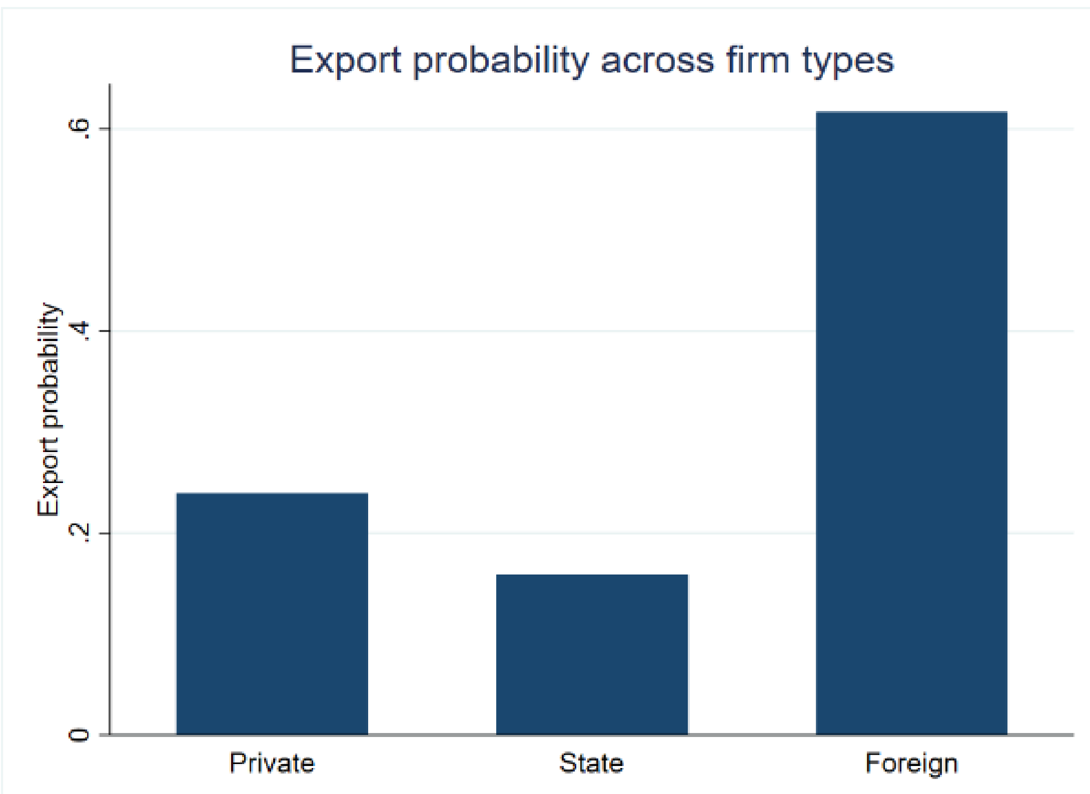

Figure 16

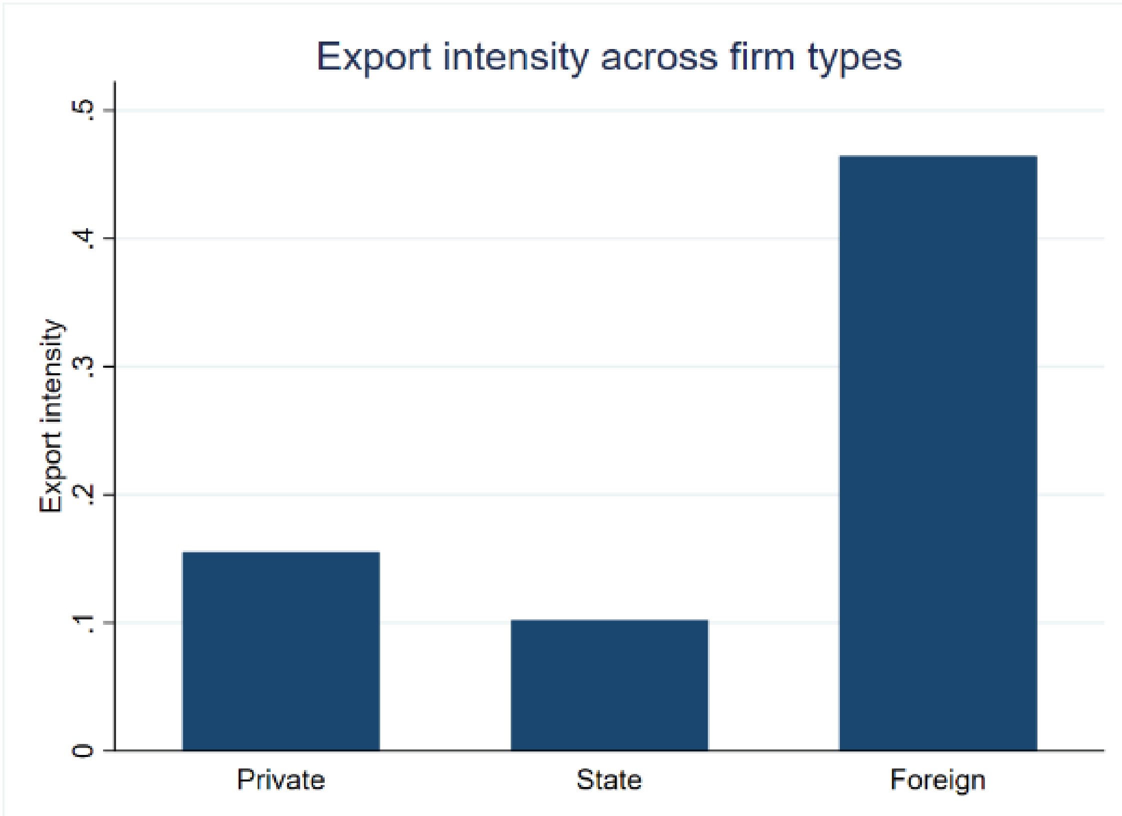

Figure 17

E.2 Distortions across sectors

Figure 18, 19, 20 and 21 all suggest that capital and labor distortions have a positive relationship to both export probability and export intensity. Nevertheless, if I only view these graphs, I can only conclude that labor distortion‘s correlations to export probability and intensity are weak and has a large variance. However, as suggested in part B, positive relationship between distortions and standardized labor shares can help explain why distortions have a positive relationship to exports. Figure 22 and 23 tell us that labor-intensive sectors are much more likely to export and have a higher export intensity than capital intensive sectors in China, while at the same time firms in labor intensive sectors are more likely to face higher labor and capital costs.

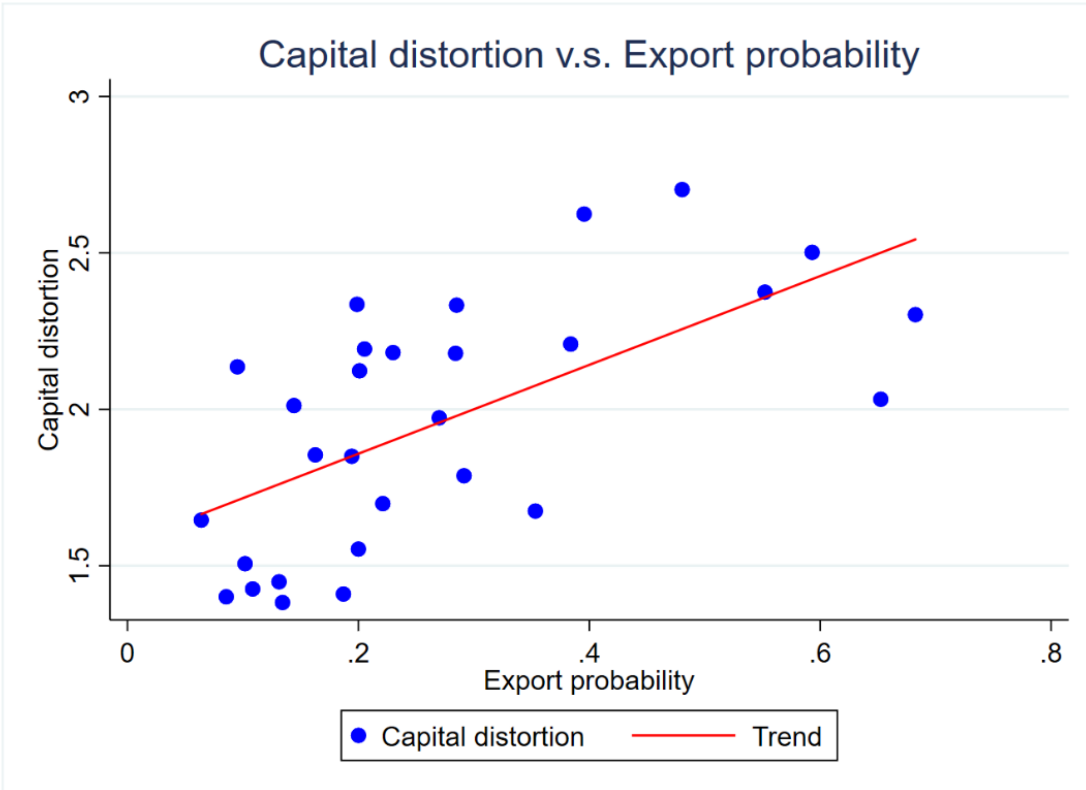

Figure18

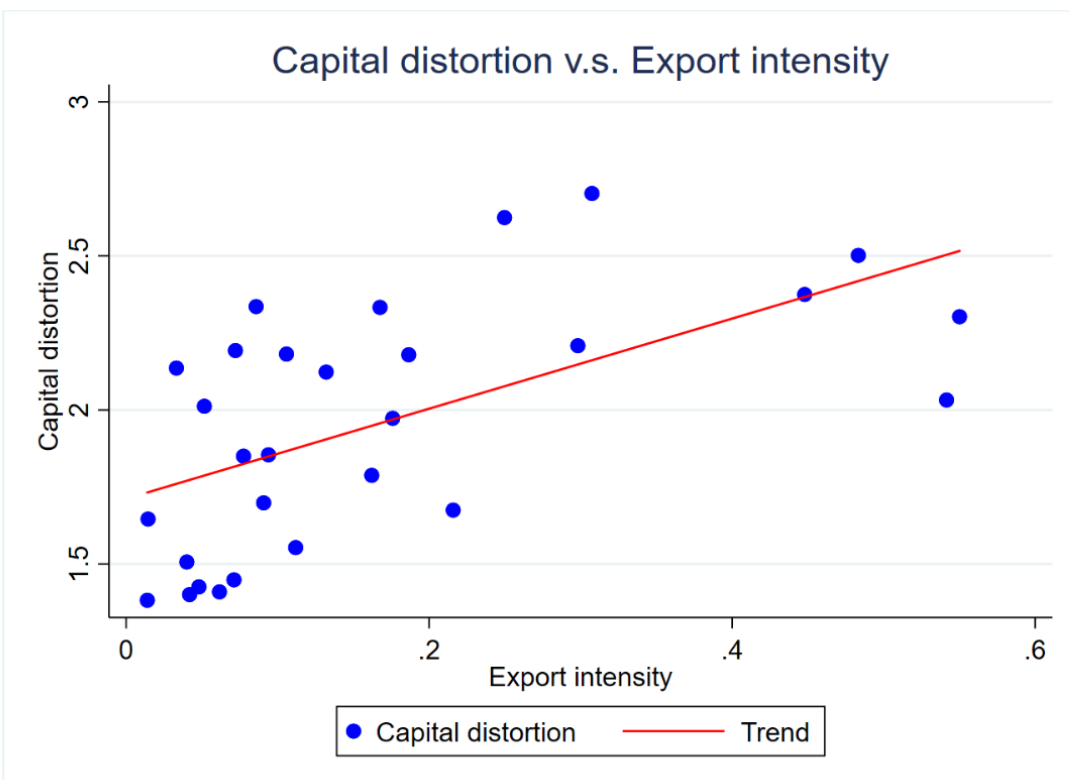

Figure 19

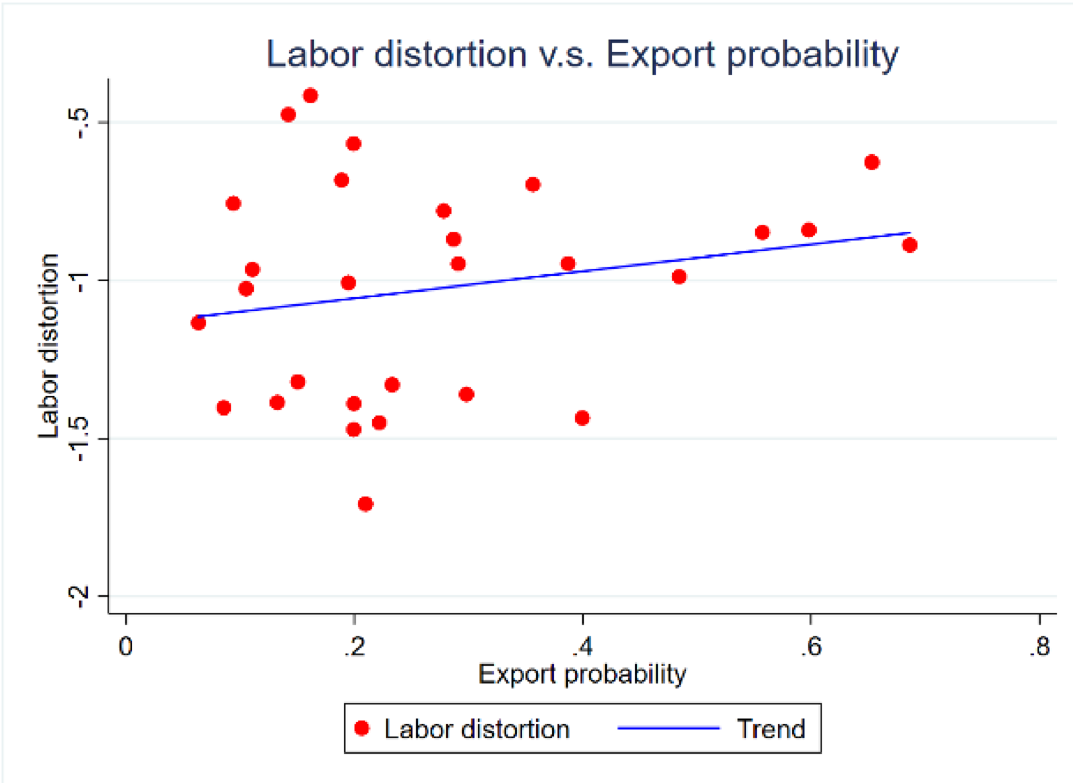

Figure 20

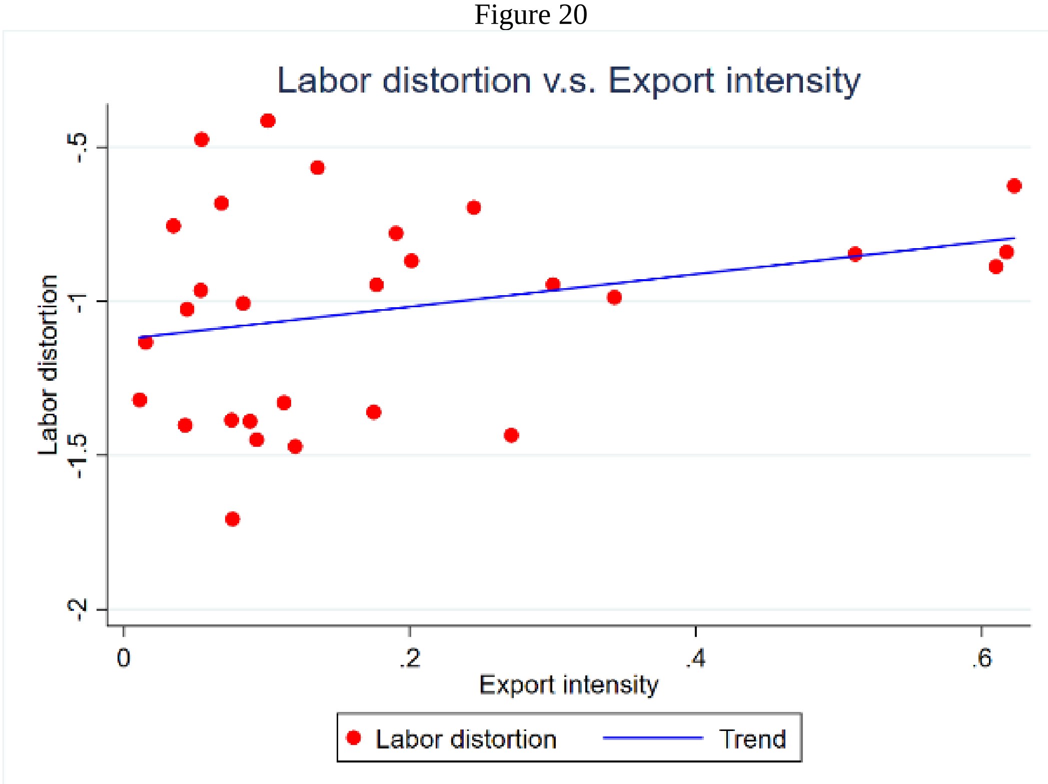

Figure 21

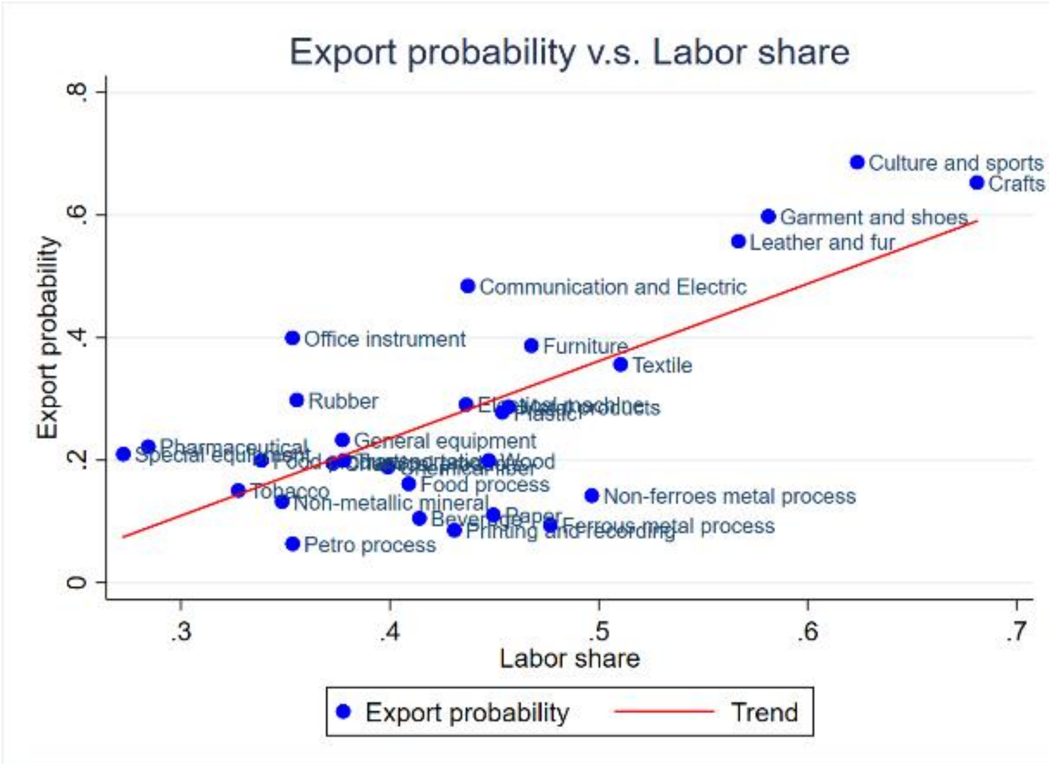

Figure 22

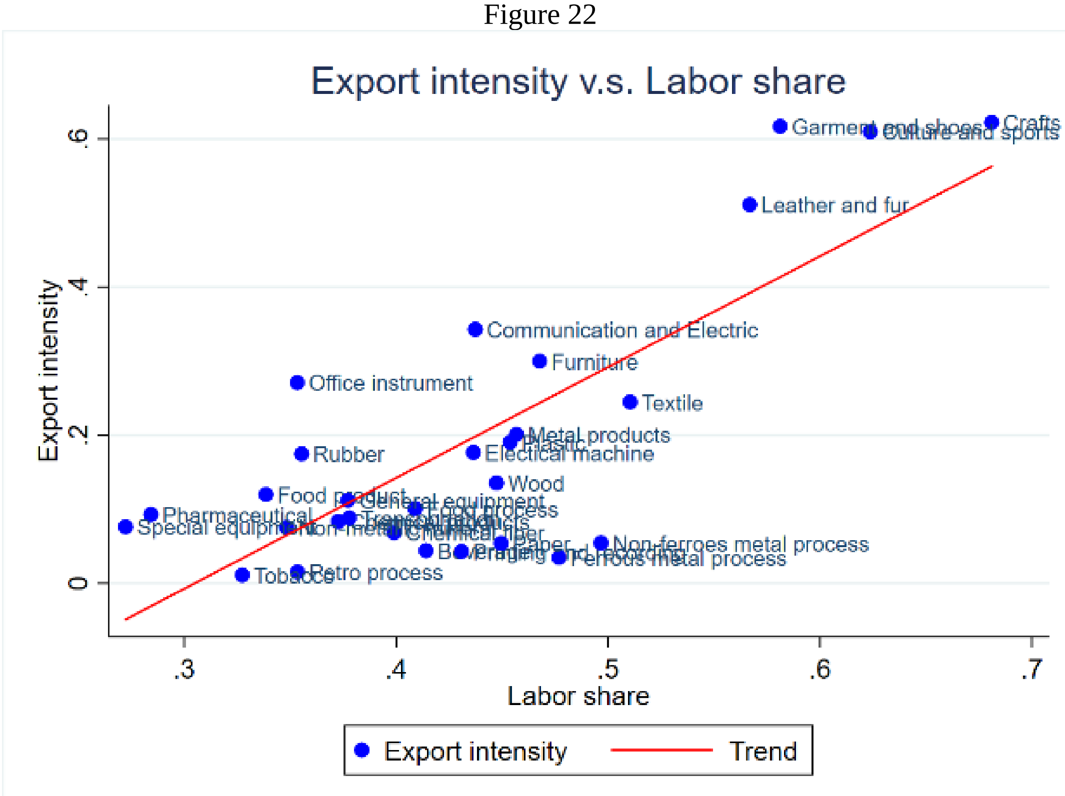

Figure 23

E.3 Distortions across regions

In part E.3, I display the distribution of export intensity, export probability, capital distortion and labor distortion across China. Indicators on each map are presented at city level, and the blank area suggests missing values. Figure 24 and 25 show that on the east coast, firms have higher export probability and export intensity than firms in other regions. Figure 26 and 27 show that both capital and labor distortion are higher in the east coast area, while they are relatively low in the west. In sum, viewing from the spatial perspective, capital and labor distortions both show a positive relationship to export probability and export intensity.

However, the maps suggest the same pattern as shown in figure 14 and 15 that the gap in labor distortion between the east and west is not as large as the gap in capital distortion.

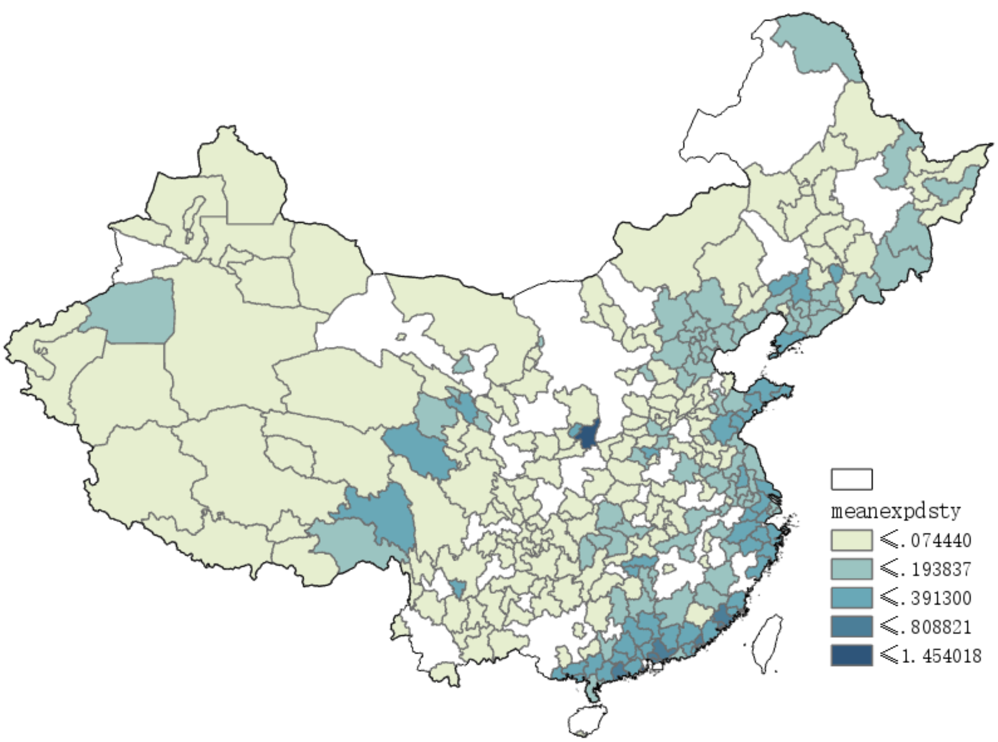

Figure 24
Export intensity

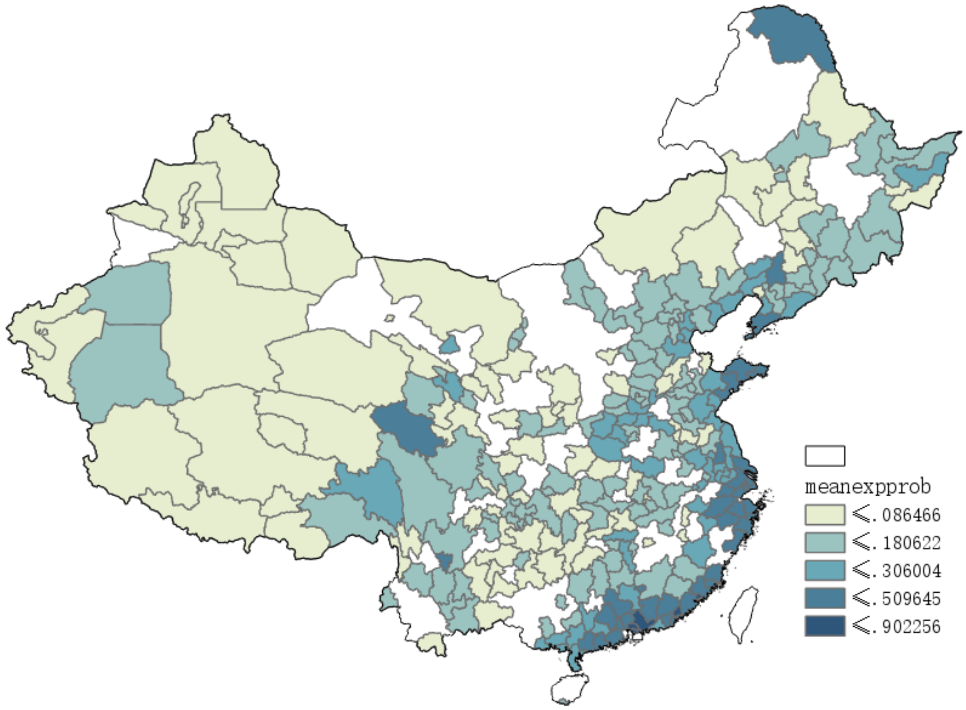

Figure 25
Export probability

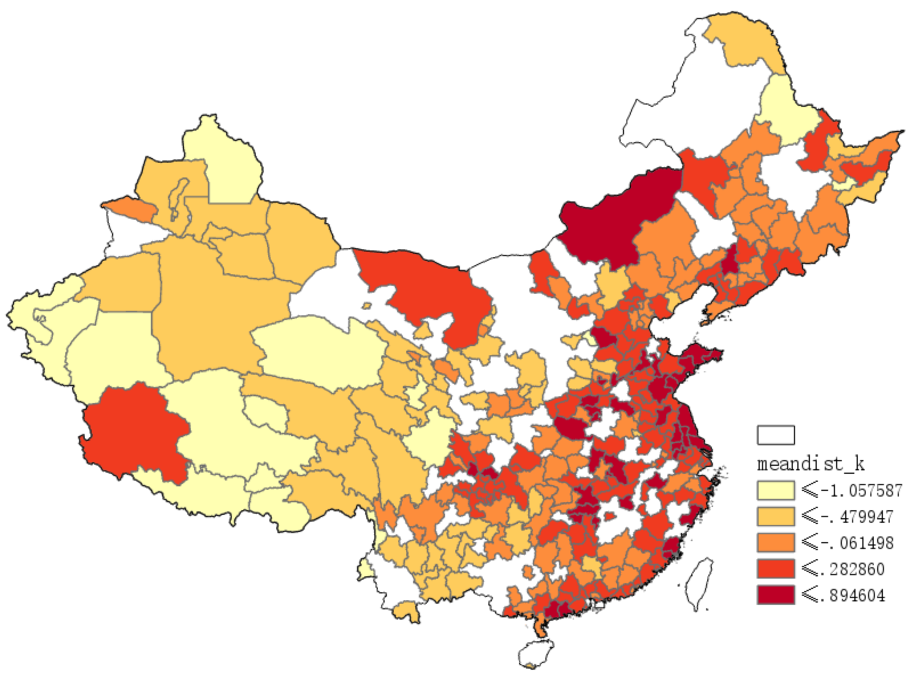

Figure 26
Capital distortion

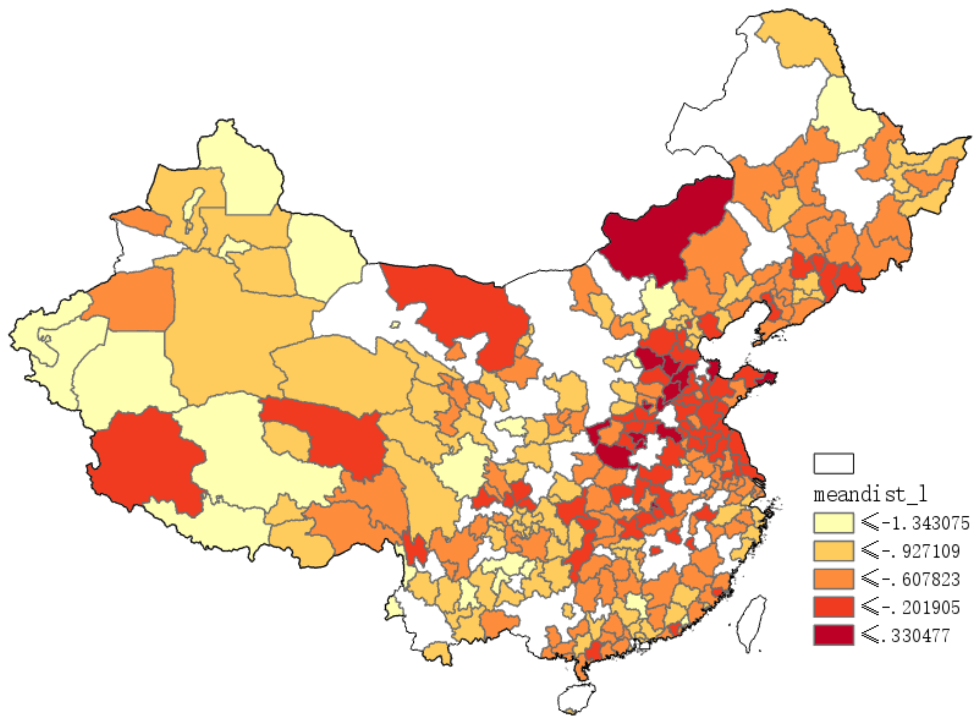

Figure 27
Labor distortion

Moreover, based on average capital and labor distortions of each city, I use a k-means clustering method to cluster each city in China to 4 groups in order to see whether there is a similar pattern of how the distortions are allocated across regions. In areas with dark red color, both capital and labor distortions are lowest, areas in blue color ranks the second lowest, green the third lowest, and areas in red are with the highest capital and labor distortions. This clustering method, which automatically clusters the observations, presents a similar pattern as discussed: cities that receive the lowest labor and capital distortions are located in the west, while cities receiving the highest distortions are in east coast of China.

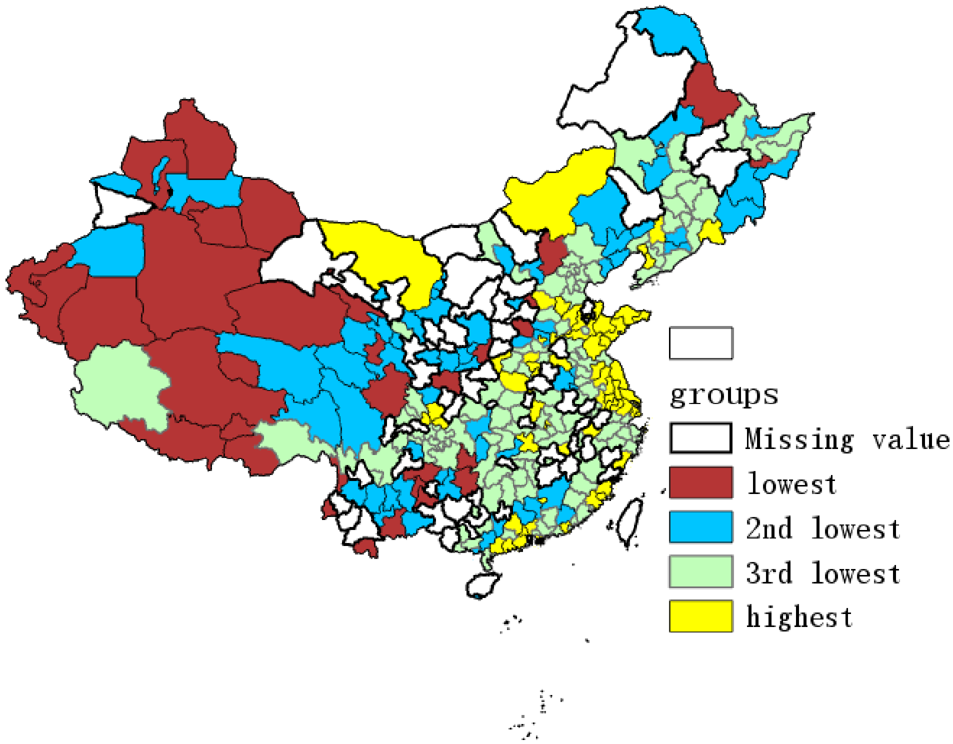

Figure 28
K-means clustering based on capital and labor distortion

Finally, I use a k-means clustering method to cluster all observations into 4 groups, and then calculate each group's weight in each city. Figure 29 shows the weight of the group in which labor and capital distortions are at their lowest value. It can be seen the west part of China has the largest ratio of firms that lie in the group with the lowest distortion terms. Similarly, figure 30 shows the ratio of firms belonging to the group with the highest distortion, and the result suggests that in east coast areas, cities may have a larger number of firms which lie in the group in which the distortions are highest.

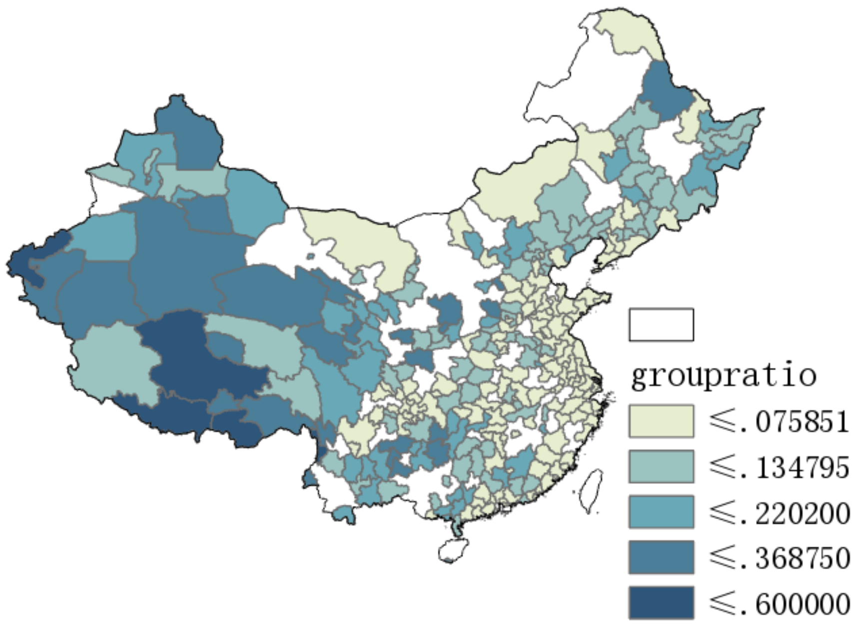

Figure 29
Weight of distortions with lowest value

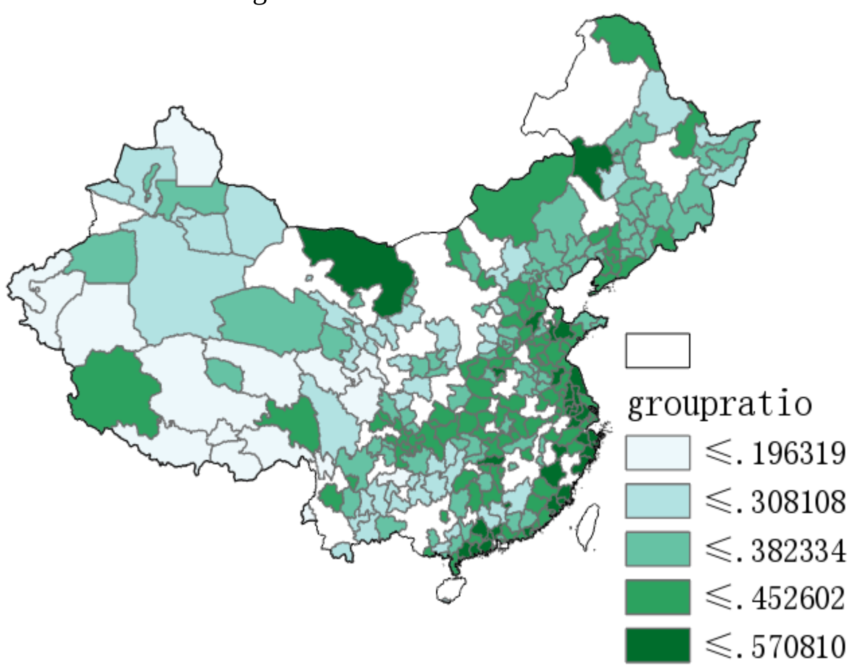

Figure 30
Weight of distortions with highest value

VI. Results

The aim of this paper is to see how distorted input factors affect firms export behavior. Since there are many firms who are not engaged in exporting goods, the selection bias (whether to enter the international market) may exist. To avoid such problem, Two-stage Heckman method is used in this paper. For the first stage, I use Probit model to estimate the model below:

$$exp_{it} = \alpha_{it} + \beta dist_{it} + \tau X_{it} + \gamma provex_{it} + ksubsidy_{it} + Time\ fixed\ effect + Two\ digit\ sector\ fixed\ effect + province\ fixed\ effect + Time\ fixed\ effect \times Two\ digit\ sector\ fixed\ effect$$

In first stage, exp_{it} is referred to whether a firm export or not. When it is 0, the firm does not export, and otherwise 1. $dist_{it}$ represents how the resource allocation is distorted within a firm, X_{it} represents all the firm-level control variables. There are two variables serving as outside variables for only first stage:

① $subsidy_{it}$ represents whether a firm has received subsidies this year. It is believed that subsidies will be given to firms to change whether it will engage into international competition, but not how much they will export. Also, this variable only has significantly positive effect in the first stage.

② $\gamma provex_{it}$ represents the ratio of number of exporting firms to total number of firms in each province, when excluding the firm itself, so it is still a firm-level variable.

These two instruments maybe endogenous, however, since there is one possibility that in east coast provinces, in which the local export ratio is high, firms are more active in exporting activities, thus having a higher export intensity. Also, as pointed out by Lu (2018), some firms in China are heavily subsidized for exports, and the condition for receiving subsidies is that these firms should only export but not sell domestically. In my robustness check, I tried to locate and find these firms and dropped these observations, which may make these two instruments more reasonable. Another way to solve these potential biased estimations is to use other empirical models, including Tobit and zero-inflated binomial regressions.

Besides, I use exp_{it-1}, whether a firm exported last year, as a third outside variable. However, it is based on a strong assumption that a firm is more likely to export if it exported last year, while the export density is not affected by this outside variable.

In the second stage, $lnexpdsty_{it}$ is the logarithmic form of firms' export intensity. The second stage excludes the outside variables, and adds in the Inverse-Miller-Ratio:

$$\begin{aligned} lnexpdst_{it} = \alpha_{it} + \beta dist_{it} + \tau X_{it} + \gamma IMR_{it} + Time\ fixed\ effect \\ + Two\ digit\ sector\ fixed\ effect + province\ fixed\ effect \\ + Time\ fixed\ effect \times Two\ digit\ sector\ fixed\ effect \end{aligned}$$

VI.1 Basic results

a. Capital distortion

Table 7 shows the effect of capital distortion on export selection and export intensity. Column (1) and (3) are results for the 1st stage of the two-stage Heckman regression, in which export selection is the dependent variable. Column (1) suggests that increasing capital distortion makes firms more likely to export, and capital distortion makes firms less likely to engage high cost within country trade. Column (3) shows the result of capital distortion's effect on export selection when last year's export selection serving as the third instrument, and in column (3) capital distortion also has a positive relationship to export selection. Column (2) and (4) are results for the 2nd stage, where export intensity is the dependent variable. Both columns exhibit a positive relationship between capital distortion and export intensity, indicating when facing a higher cost, a firms' production will be sold more in foreign markets.

It can also be noticed that TFP are all with negative sign, which matches my expectation that domestic market is more competitive.

The coefficients for whether a firm has received a subsidy in column (1) and (3) are both significantly positive, which seems to be contradict my model: if the domestic market is more competitive, why do firm choose to not sell in the domestic market when they are receiving subsidies? A potential reason is that the subsidy itself is endogenous to a firms export status. In other words, government will only provide subsidies to firms that are exporting. This also helps explain why I choose this variable as an instrument.

Table 7

VARIABLES	(1) Export selection	(2) ln(exp intensity)	(3) Export selection	(4) ln(exp intensity)
Capital distortion	0.506***	0.523***	0.304***	0.255***
	(0.0321)	(0.0710)	(0.0299)	(0.0405)
TFP_real	-0.265***	-0.368***	-0.154***	-0.225***
	(0.0183)	(0.0438)	(0.0202)	(0.0297)
Market segmentation	0.00335	0.0191	0.0365	0.107
	(0.00941)	(0.0322)	(0.0648)	(0.0891)
lnage	0.0570***	-0.0353***	-0.0272***	-0.114***
	(0.00604)	(0.0121)	(0.00622)	(0.00989)
ln(size)	0.0792***	0.0377	0.0316	-0.00662
	(0.0287)	(0.0293)	(0.0200)	(0.0305)
lnfinance	0.0119	0.0514***	-0.00254	0.0446**
	(0.0189)	(0.0166)	(0.0136)	(0.0177)
ln(total input)	0.321***	0.0246	0.204***	-0.167***
	(0.0305)	(0.0503)	(0.0199)	(0.0254)
firm type = SOE	-0.273***	-0.454***	-0.151***	-0.298***
	(0.0196)	(0.0373)	(0.0118)	(0.0359)
firm type = foreign	0.783***	0.549***	0.388***	0.169***
	(0.0685)	(0.105)	(0.0321)	(0.0466)
Outsource	0.0911***	0.0183	0.0664***	-0.0347**
	(0.0178)	(0.0166)	(0.0135)	(0.0163)
subsidy or not	0.203***		0.128***	
	(0.0333)		(0.0145)	
province export	3.548***		2.030***	
	(0.0700)		(0.0953)	
IMR		0.669***		
		(0.176)		
One-year lag export selection			2.578***	
			(0.0445)	
IMR2				-0.526***
				(0.0518)
Time FE	√	√	√	√
Province FE	√	√	√	√
Sector FE	√	√	√	√
Time × Sector FE	√	√	√	√
Constant	-5.434***	-2.528***	-4.168***	1.542***
	(0.214)	(0.737)	(0.220)	(0.255)
Observations	1,207,412	267,980	779,728	171,971
R-squared		0.239		0.272

Cluster standard error in province level are used.

b. Labor distortion

Table 8 shows the effect of labor distortion, which is identified by $\ln(\frac{\mathrm{MPL}}{\bar{\mathrm{w}}})$, on export selection and export intensity. Column (1) and (3) both show a positive relationship between labor distortion and export selection, and in column (2) and (4) labor distortion also has a positive effect in export intensity, indicating that labor distortion will push firms to export and sell more in foreign markets. Still, the coefficients for the "real" TFP I use are all significantly negative.

Table 8

VARIABLES	(1) Export selection	(2) ln(exp intensity)	(3) Export selection	(4) ln(exp intensity)
Labor distortion	0.336***	0.402***	0.255***	0.188***
	(0.0488)	(0.0545)	(0.0414)	(0.0574)
TFP_real	-0.144***	-0.266***	-0.111***	-0.171***
	(0.0236)	(0.0277)	(0.0200)	(0.0270)
Market segmentation	0.00759	0.0184	0.0352	0.107
	(0.0114)	(0.0302)	(0.0662)	(0.0921)
lnage	0.0438***	-0.0508***	-0.0346***	-0.123***
	(0.00667)	(0.0110)	(0.00660)	(0.00944)
ln(size)	0.582***	0.622***	0.370***	0.266***
	(0.0508)	(0.0636)	(0.0350)	(0.0551)
lnfinance	-0.000530	0.0403**	-0.0100	0.0400**
	(0.0190)	(0.0161)	(0.0138)	(0.0172)
ln(total input)	-0.184***	-0.543***	-0.134***	-0.441***
	(0.0425)	(0.0390)	(0.0324)	(0.0440)
firm type = SOE	-0.266***	-0.456***	-0.148***	-0.294***
	(0.0182)	(0.0369)	(0.0113)	(0.0358)
firm type = foreign	0.803***	0.600***	0.399***	0.178***
	(0.0685)	(0.105)	(0.0327)	(0.0490)
Outsource	0.110***	0.0452**	0.0772***	-0.0252
	(0.0192)	(0.0180)	(0.0141)	(0.0180)
subsidy or not	0.200***		0.125***	
	(0.0323)		(0.0143)	
province export	3.508***		2.000***	
	(0.0763)		(0.0969)	
IMR		0.742***		
		(0.164)		
One-year lag export selection			2.586***	
			(0.0448)	
IMR2				-0.525***
				(0.0515)
Time FE	√	√	√	√
Province FE	√	√	√	√
Sector FE	√	√	√	√
Time × Sector FE	√	√	√	√
Constant	-2.787***	0.190	-2.407***	2.944***
	(0.223)	(0.499)	(0.336)	(0.383)
Observations	1,207,412	267,980	779,728	171,971
R-squared		0.237		0.269

All standard errors are clustered at province level. All control variables and fixed effects are included in estimation

VI.2 Decomposition of distortions

Instead of looking only at $\ln\left(\frac{MPL}{\bar{w}}\right)$ as the labor distortion, I also investigated the effect of $\ln(\frac{\mathrm{MPL}}{\mathrm{w}})$, where w is the wage level for each firm. However, since MPL and w both can present firm's cost, the effect of $\ln(\frac{\mathrm{MPL}}{\mathrm{w}})$ will be ambiguous. To control for the effect brought by w while at the same time looking at the distortion level to each firm's wage, I decompose $\frac{\mathrm{MPL}}{\bar{w}}$ into $\frac{\mathrm{w}}{\bar{w}} \times \frac{\mathrm{MPL}}{\mathrm{w}}$, take the log term for both $\frac{\mathrm{w}}{\bar{w}}$ and $\frac{\mathrm{MPL}}{\mathrm{w}}$, and then add them to my empirical model. Table 8 suggests that both $\frac{\mathrm{w}}{\bar{w}}$ and $\frac{\mathrm{MPL}}{\mathrm{w}}$ have positive effects on export selection and export intensity. Similarly, $\ln\left(\frac{MPK}{\bar{r}}\right)$ can be decomposed into $\ln\left(\frac{r}{\bar{r}}\right)$ and $\ln\left(\frac{MPK}{r}\right)$.

In panel A of table 9, the positive coefficient of $\ln(\frac{\mathrm{w}}{\bar{w}})$ infers that when a firm is facing a relatively higher cost comparing to the industry level, it is more likely to export, and have a higher export intensity. The positive coefficient of $\ln(\frac{\mathrm{MPL}}{w})$ suggests that when the unobserved distortion to a firms' reported wage, which induce a higher real cost in labor input, increases, firms will also tend to export and export with a higher share. Panel B exhibits the results for decomposition on capital distortion, and the coefficient through column (1) to (4) for $\ln(\frac{\mathrm{r}}{\bar{r}})$ shows that a higher relative interest rate would cause more firms to export, and the positive coefficients of $\ln(\frac{\mathrm{MPK}}{r})$ infers firm's unobserved discount in interest rate leads to a higher possibility of export and a larger export intensity.

Table 9

Panel A: Labor distortion decomposition				
	(1)	(2)	(3)	(4)
VARIABLES	Export selection	ln(exp intensity)	Export selection	ln(exp intensity)
ln(MPL/w)	0.511***	0.854***	0.327***	0.545***
	(0.0724)	(0.0762)	(0.0485)	(0.0777)
ln(w/w_bar)	0.797***	1.070***	0.493***	0.571***
	(0.0839)	(0.0810)	(0.0540)	(0.0653)
TFP_real	-0.381***	-0.766***	-0.237***	-0.533***
	(0.0551)	(0.0568)	(0.0362)	(0.0519)
Subsidy & Province export	√		√	
One-year lag export selection			√	
Observations	1,207,412	267,980	779,776	171,974
R-squared		0.247		0.277
Panel B: Capital distortion decomposition				
ln(MPK/r)	0.449***	0.515***	0.264***	0.298***
	(0.0361)	(0.0507)	(0.0245)	(0.0321)
ln(r/r_bar)	0.447***	0.509***	0.266***	0.293***
	(0.0386)	(0.0502)	(0.0256)	(0.0335)
TFP_real	-0.315***	-0.515***	-0.177***	-0.363***
	(0.0289)	(0.0462)	(0.0247)	(0.0361)
Subsidy & Province export	√		√	
One-year lag export selection			√	
Observations	837,211	183,370	569,303	124,009
R-squared		0.244		0.277

All standard errors are clustered at province level. All control variables and fixed effects are included in estimation

VI.3 Further discussions

a. TFP's effect on distortion

In this part, I empirically prove the corollary suggested in my theoretical model. To prove that firms with higher TFP are less affected by labor and capital distortions, I take the interaction term between labor distortion and capital distortion. Panel A in table 10 shows that the interaction term of labor distortion and TFP are all significantly negative through column (1) to (4), indicating that the positive effect of labor distortion on export can be mitigated when firms are having higher TFP. Panel B in table 10 exhibits how TFP will affect capital distortion's effect on export selection and export intensity. The interaction terms of capital distortion and TFP are also significantly negative, suggesting that firms with higher TFP are less affected by capital distortion. The coefficients for labor distortion capital are all significantly positive as well, and the signs for the coefficient of TFP remain negative, in both Panel A and B, which strengthen my robustness, as well as supporting my theoretical model.

Another way to verify this conclusion is to divide the sample into 3 groups based on their TFP, and it can be imagined that if my theoretical model is true, then in the group firms with highest average TFP will be least affected by distortions. However, since it is hard to find the exact threshold of TFP for firms to switch from only exporting to selling domestically at the same time, which of the rest 2 groups the threshold lies in is something remains unknown, so that I cannot foresee the difference between the effect of labor and capital distortions of the two groups with the lowest and second lowest TFP.

Table 10

	Panel A: Labor distortion × TFP			
	(1)	(2)	(3)	(4)
VARIABLES	Export selection	ln(exp intensity)	Export selection	ln(exp intensity)
Labor distortion	0.525***	0.911***	0.354***	0.577***
	(0.0708)	(0.0705)	(0.0497)	(0.0724)
TFP_real	-0.322***	-0.719***	-0.198***	-0.517***
	(0.0504)	(0.0574)	(0.0338)	(0.0555)
Labor distortion × TFP_real	-0.00918***	-0.0158***	-0.0101***	-0.00851**
	(0.00273)	(0.00388)	(0.00191)	(0.00388)
Fixed Effects	√	√	√	√
Control Variables	√	√	√	√
Subsidy & Province export	√		√	
One-year lag export selection			√	
Observations	1,207,412	267,980	779,776	171,974
R-squared		0.243		0.274
	Panel B: Capital distortion × TFP			
Labor distortion	0.503***	0.543***	0.334***	0.276***
	(0.0429)	(0.0734)	(0.0320)	(0.0433)
TFP_real	-0.260***	-0.430***	-0.139***	-0.310***
	(0.0205)	(0.0465)	(0.0220)	(0.0304)
Capital distortion × TFP_real	-0.0161***	-0.0160***	-0.0147***	-0.00491**
	(0.00306)	(0.00286)	(0.00254)	(0.00240)
Fixed Effects	√	√	√	√
Control Variables	√	√	√	√
Subsidy & Province export	√		√	
One-year lag export selection			√	
Observations	1,207,412	267,980	779,776	171,974
R-squared		0.241		0.274

All standard errors are clustered at province level. All control variables and fixed effects are included in estimation

b. SOEs vs non-SOEs

In Table 11 and 12, I use seemingly unrelated regression (SUR) to see the how capital and labor distortion perform differently on SOEs and Non-SOEs, in order to verify my corollary. In table 11, column (1) reports the difference of labor distortion's effect on firms' export decision between SOE and Non-SOE. Column (2) reports the difference of capital distortion's effect on firms' export decision between SOE and Non-SOE. In table 12, column (1) reports the difference of labor distortions' effect on export intensity between SOE and Non-SOE. Column (2) reports the difference of capital distortions' effect on the export intensity between SOE and Non-SOE. Coefficient difference reports the differences of the coefficients on factor distortions between SOE and Non-SOE, and empirical p-value reports the significant value of the differences.

Results in table 11 suggest that for both private firms and SOEs, capital and labor distortion have a positive effect on firms' export probability. Also, distortions are having a larger effect on Private firms than on SOEs, and the SUR model shows that the difference of the coefficient on factor distortions between private firms and SOEs are all significant at 1% level. However, table 12 suggests that both capital and labor distortions behave similarly on both private firms and SOEs, and even though the coefficients for private firms are larger than SOEs, the differences between the coefficients are statistically insignificant, which runs counter expectations.

Why do differences exist of distortions' effect on export selection, but not on export intensity? One explanation is that some SOEs providing daily use products, like tap water and electricity that does not export regardless of any level distortion. However, when both SOEs and private firms enter the international market, only distortions will have an effect on export intensity since those SOEs that never exported are dropped from the sample. Another explanation is that SOEs are the main forces of earing foreign exchange, so that some SOEs may enjoy a low distortion that is directed by the central government, which may offset the positive relationship between export selections. When these subsidized SOEs enter into the international market, further subsidies are not necessary.

Table 11

	Export selection			
	(1)		(2)	
VARIABLES	Private	SOEs	Private	SOEs
Diffenrence	0.193**		0.188***	
Emipirical P-value	0.021		0	
Labor distortion	0.395***	0.202***		
	(0.0913)	(0.0446)		
Capital distortion			0.397***	0.209***
			(0.0244)	(0.0227)
TFP_real	-0.256***	-0.0613*	-0.289***	-0.0787***
	(0.0600)	(0.0315)	(0.0186)	(0.0202)
Fixed Effects	√	√	√	√
Control Variables	√	√	√	√
Constant	-2.078***	-4.148***	-4.853***	-5.528***
	(0.519)	(0.224)	(0.251)	(0.223)
Observations	1,043,921	1,043,921	1,043,921	1,043,921

All standard errors are clustered at province level. All control variables and fixed effects are included in estimation

Table 12

	ln(Export intensity)			
	(1)		(2)	
VARIABLES	Private	SOEs	Private	SOEs
Diffenrence	0.091		0.036	
Emipirical P-value	0.174		0.621	
Labor distortion	0.653***	0.562***		
	(0.0723)	(0.0758)		
Capital distortion			0.444***	0.408***
			(0.0645)	(0.0370)
TFP_real	-0.583***	-0.498***	-0.466***	-0.402***
	(0.0557)	(0.0518)	(0.0603)	(0.0400)
Fixed Effects	√	√	√	√
Control Variables	√	√	√	√
Constant	1.665**	0.643**	-2.138**	-2.644***
	(0.683)	(0.299)	(0.856)	(0.254)
Observations	182,142	182,142	182,142	182,142

All standard errors are clustered at province level. All control variables and fixed effects are included in estimation

VII. Robustness check

VII.1 Different TFP and industrial shares

There are different ways of estimating labor and capital shares of industries. In fact, since capital and labor price distortions cannot be observed directly, each method of estimating factor shares would be biased, as long as I use distorted capital and labor input of each firm as estimators. However, I can assume that the direction of the bias is random, since the distortion for each firm is uncertain. Thus, if I can use different methods to estimate the factor shares, and prove that the empirical results are still consistent, then I can say that the effect of distortions in input prices on estimated factors shares is small enough.

First, instead of using the estimated "real" TFP defined above, I return to TFP estimated by the LP method. During this process, the industry shares do not vary, since the "real" TFP comes from TFP by the LP method. Panel A in table 13 shows that capital and labor distortions still have a positive effect on firms' export selection and export intensity, and the coefficients for TFP are all significantly negative through column (1) to (4). In panel B, I use the 1st method discussed in table 5 to estimate the labor and capital distortions, and the results remain consistent. In panel C, I use OP method to estimate the new TFP and use it as a control variable. Note that when I change the way to estimate TFP, the estimated labor share and capital share are changing to the new one as well, thus resulting in changes in labor distortion and capital distortion. Panel C shows that effects of capital and labor distortions on export selection and export intensity, which remain consistent when the new TFP and factor shares are employed.

Table 13

	Panel A: TFP_LP			
	(1)	(2)	(3)	(4)
VARIABLES	Export selection	ln(exp intensity)	Export selection	ln(exp intensity)
Labor distortion	0.269***	0.656***		
	(0.0580)	(0.0623)		
Capital distortion			0.318***	0.428***
			(0.0257)	(0.0470)
TFP_LP	-0.208***	-0.787***	-0.289***	-0.610***
	(0.0236)	(0.0277)	(0.0288)	(0.0453)
Observations	1,210,031	268,104	1,210,031	268,104
R-squared		0.244		0.243
	Panel B: Method 1 industry shares			
Labor distortion	0.520***	0.882***		
	(0.0569)	(0.0544)		
Capital distortion			0.0796***	0.120***
			(0.0158)	(0.0246)
TFP_LP	-0.448***	-0.991***	-0.0255	-0.268***
	(0.0523)	(0.0538)	(0.0222)	(0.0395)
Observations	1,210,031	268,104	1,210,031	268,104
R-squared		0.253		0.246
	Panel C: TFP_OP			
Labor distortion	0.0780**	0.240***		
	(0.0364)	(0.0539)		
Capital distortion			0.437***	0.724***
			(0.0453)	(0.0580)
TFP_OP	-0.00179	-0.336***	-0.409***	-0.914***
	(0.0341)	(0.0508)	(0.0511)	(0.0669)
Observations	1,210,031	268,104	1,210,031	268,104
R-squared		0.238		0.246

All standard errors are clustered at province level. All control variables and fixed effects are included in estimation

VII.2 Export-oriented regions

Is relative competition between domestic and international market in manufacturing sectors the only reason explaining the inverse effect of TFP and distortions on export? Bai, Jin and Lu (2018) provided another possible explanation. In her research, she found that firms with higher productivity are facing a higher firm-level distortion, and as a result, even the productivity cutoff for exporting is higher than the one for selling domestically, firms with lower productivity can still export more, because they are sufficiently subsidized.

It is widely accepted that in China firms are provided with tax rebate if they engaged in export behavior. But how do I identify those firms that are fully subsidized and how do I identify the regions in which firms' export activities are most intervened by local government? In my estimation, even though I cannot observe the tax rebate rate, I can still assume that firms only export and located in regions in which most firms export are mostly likely to receive a tax rebate.

Green bars in figure 31 represent each city's density of the percentage of the firms that export, while white bars represent average export intensity of each city. I choose cities with export ratios over 30% and with over 70% of average export intensity as the cities that are export oriented. Figure 32 shows where these cities are located in. Most cities belong to south-east coast area, while two of them are in the mid-west area, and the one that lies in the upper-right corner borders upon Russia, and do have a lot of trade volume with Russia.

In figure 33, I strengthen my restrictions and select cities in which more than 40% of firms choose to export, and the location of these cities are shown in figure 34.

To begin, I drop all observations whose location cannot be identified so that based on these selected cities, I ran the following regression. Panel A in table 14 shows the regression results in which firms with over 90% export intensity that are located in these selected cities are removed. Panel B shows the results where all observations in selected cities are removed. Panel C exhibits the result in which only observations in selected cities are considered. Lastly, panel D exhibits the results with observations in the cities that are more strictly selected.

After removing the observations in the selected city, both panel A and panel B give consistent results: both capital and labor distortions have positive effect on export selection and export intensity. When looking at firms located in export-oriented cities, results shown in panel C and D are also consistent.

As discussed in the last part of chapter 3, trading across provinces is more likely to happen in non-export regions, since most firms' products are selling to the domestic market, and local cities or provinces are not large enough to absorb all firms' products. When observations that are potentially heavily subsidized for export are removed and the results remain consistent, my conclusion may gain further support.

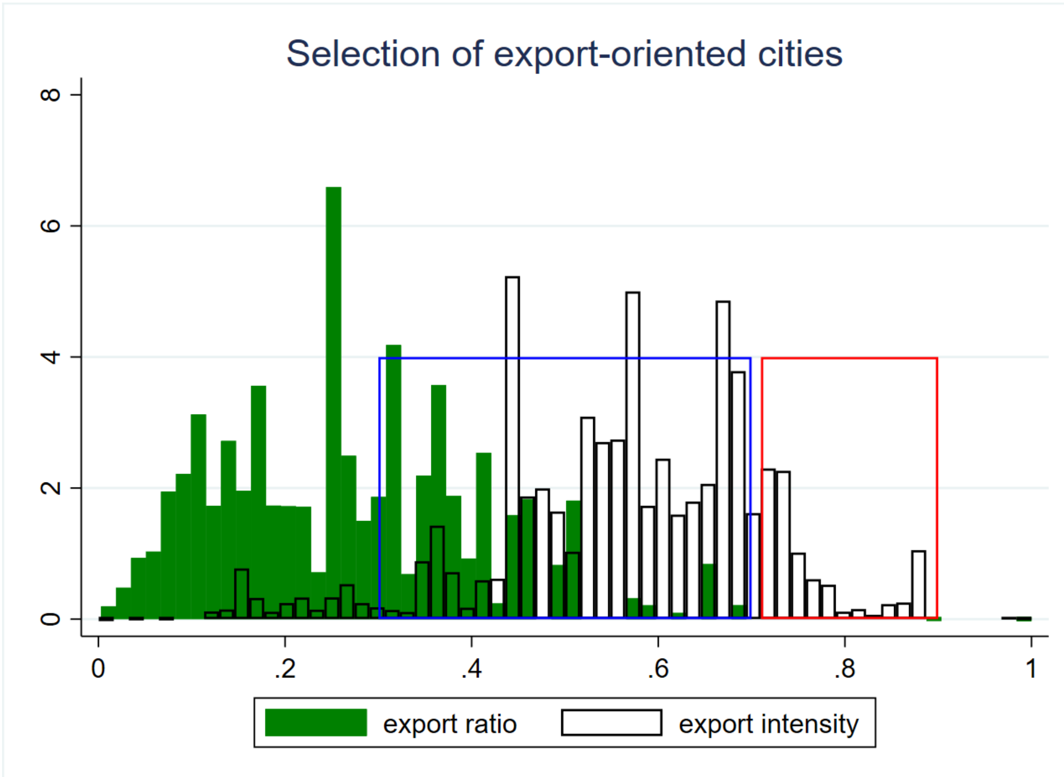

Figure 31

Figure 32
Selected Export-oriented cities

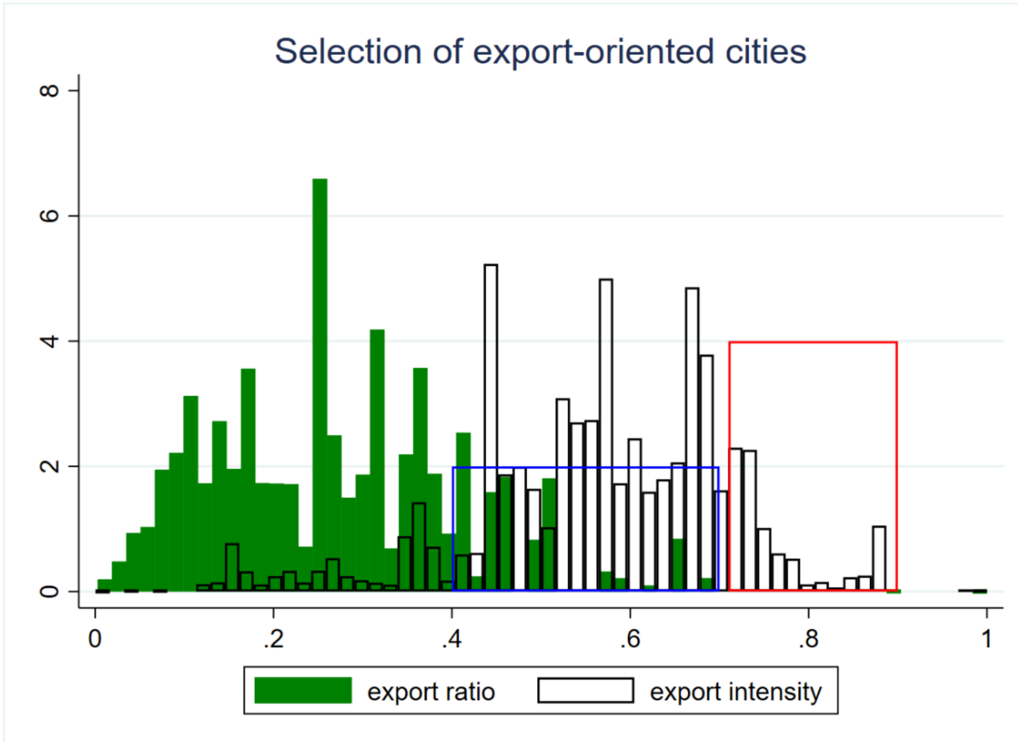

Figure 33

Figure 34
Selected Export-oriented cities

Table 14

VARIABLES	(1) Export selection	(2) ln(exp intensity)	(3) Export selection	(4) ln(exp intensity)
		Panel A		
Labor distortion	0.245***	0.683***		
	(0.0708)	(0.0682)		
Capital distortion			0.282***	0.458***
			(0.0303)	(0.0400)
TFP_real	-0.171***	-0.809***	-0.235***	-0.632***
	(0.0665)	(0.0668)	(0.0299)	(0.0460)
Observations	1,148,614	232,843	1,148,614	232,843
		Panel B		
Labor distortion	0.125***	0.577***		
	(0.0447)	(0.0733)		
Capital distortion			0.315***	0.419***
			(0.0387)	(0.0479)
TFP_real	-0.0416	-0.720***	-0.261***	-0.604***
	(0.0444)	(0.0723)	(0.0403)	(0.0550)
Observations	875,237	209,767	875,237	209,767
		Panel C		
Labor distortion	0.507***	0.553***		
	(0.0686)	(0.117)		
Capital distortion			0.388***	0.247**
			(0.0396)	(0.0585)
TFP_real	-0.541***	-0.671***	-0.475***	-0.412**
	(0.0964)	(0.125)	(0.0729)	(0.101)
Observations	232,747	58,337	232,747	58,337
		Panel D		
Labor distortion	0.542***	0.580**		
	(0.113)	(0.128)		
Capital distortion			0.388***	0.256**
			(0.0578)	(0.0490)
TFP_real	-0.550***	-0.710**	-0.448***	-0.435**
	(0.142)	(0.129)	(0.0921)	(0.0884)
Observations	142,344	46,738	142,344	46,738

All standard errors are clustered at province level. All control variables and fixed effects are included in estimation

VII.3 Sectors with high price index

As I have discussed, a relatively low price in China and a more fragment domestic market contributes to a more competitive domestic market. But between two of these explanations, what is the main driver? In this section, I check whether my results are still consistent when the relative China to US price is close to 1. Table 15 exhibits the relative export price of each 2-digit sector.

Table 15

Sector name	P_{CN}/P_{US}
Tobacco	1.02
Ferrous metal smelting and rolling processing	0.98
Chemical raw materials and chemical products	0.93
Plastic products	0.87
Beverage	0.80
Textile	0.80
Leather, fur, feather	0.80
Non-metallic mineral products	0.76
Food	0.75
Chemical fiber	0.72
Agricultural and sideline food processing	0.68
Paper and paper products	0.68
Rubber products	0.68
Furniture	0.66
Culture and education sporting goods	0.66
Non-ferrous metal smelting and rolling processing	0.60
Pharmaceutical	0.54
Copying of the printing and recording media	0.42
Wood processing	0.37

Panel A in table 16 presents the robustness check in which I only select sectors with relative prices that are greater than 0.85 as my sample. If we take the tariff and transportation costs into consideration, given a relative price that is over 0.85 when assuming there is no other influence, trading within one country should be as competitive as trading in international market, and the distortion terms should have no significant effect on both export selection and export intensity. The empirical results for both labor distortion and capital distortion are consistent, and the coefficients for TFP are still significantly negative. This suggests there may be other factors playing a role, and as I have discussed above, it might come from a more fragmented domestic market in China.

Nevertheless, Panel B exhibits the empirical results for samples with relative prices that are greater than 0.95, in which labor distortions do not have significantly positive relationship to export selection and export intensity. Considering of the existence of transportation cost and tariffs between two countries, it is likely that trade within country being more competitive no longer holds when the prices of the same good in two countries are close to each other. This also suggests that when it comes to the assumption that trading within China is more competitive than trading in international market for manufacturing sectors, a relatively cheaper price is still the dominant factor instead of a fragmented domestic market.

Table 16

	Panel A: relative price > 0.85			
	(1)	(2)	(3)	(4)
VARIABLES	Export selection	ln(exp intensity)	Export selection	ln(exp intensity)
Labor distortion	0.387***	0.908***		
	(0.117)	(0.118)		
Capital distortion			0.426***	0.703***
			(0.0371)	(0.0536)
TFP_real	-0.258***	-0.826***	-0.313***	-0.717***
	(0.0919)	(0.0865)	(0.0371)	(0.0479)
Observations	180,263	30,571	180,263	30,571
R-squared		0.221		0.222
	Panel B: relative price > 0.95			
Labor distortion	0.142	0.135		
	(0.108)	(0.129)		
Capital distortion			0.212***	0.269**
			(0.0742)	(0.105)
TFP_real	-0.0574	-0.302***	-0.120	-0.415***
	(0.0814)	(0.102)	(0.0768)	(0.0932)
Observations	31,576	2,609	31,576	2,609
R-squared		0.342		0.342

All standard errors are clustered at province level. All control variables and fixed effects are included in estimation

VIII. Conclusion

In this thesis, I present how input distortions affect a firm's export decision, and that Melitz's production cutoffs may not be valid for the case of China. By integrating a firms' productivity with capital and labor price distortions, I show that an input subsidy, or input distortion, aimed at supporting a firm's development, may lead firms to less likely export, even when they are paying a lower cost for inputs. A reason behind this counter-intuitive result is that in China's manufacturing sector, the domestic market is more competitive than the international market. There may be two reason for this. First, since most China's manufacturing sectors are labor-intensive, and the wage level in China is relatively low, it can be derived that the price for manufacturing goods sold in China are lower than the price in China's trade partners. To survive in China's market, firms need to be more competitive to lower their cost in order to match the lower price. Second, local protectionism prevails in China, thus resulting in firms being less likely to sell from one province to another if they are not competitive enough. In order to gain a larger market share, they will turn their eyes to the international market, and this also leads to firms with a lower productivity to sell abroad. Empirically, the positive relationship between input distortions, which are measured by the unobservable firm's extra cost, proves my model plausible. The negative relationship between a firm's TFP and their export decision also suggests the domestic market is more competitive.

In addition, I showed that input subsidies, which refer to a low input distortion, are focused on State-owned enterprises, capital-intensive sectors, and the west in China. None of these attributes represents the main force of exporting in China. Therefore, I conclude that input subsidies to firms do not promote exports and that these subsidies are not export subsidies.

However, input price distortions and local protectionism in Chinain the long run hurts China's aggregate TFP, and this China's growth pattern cannot be sustained. This implies both input distortions and local protectionism should be eliminated at the same time. With an increasing worker's wage, development of technology, capital deepening, and a more integrated domestic market, domestic market will no longer be more competitive, and when that point is reached, it will be difficult to argue that subsidies to firms does not result in unfair competition.

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