Regional Effect of Trade Liberalization on the Firm-level Exports

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Abstract

This paper extends the model of Melitz (2003) to decompose the tariff and wage effect of trade liberalization on the firm-level intensive margin of exports. The tariff effect of trade liberalization is associated with the reduction in exporting firms' variable trade costs, on the contrast, the wage effect manifests itself through increasing regional wages caused by rising local labor demand. The model shows that the two types of effects have opposite influence on the firm-level exports. The wage effect varies across regions due to the different regional industrial composition, which leads to different regional response to trade liberalization.

Keywords: Trade Liberalization · Regional Wage · Tariff Effect · Wage Effect · Regional Effect

JEL Classification: D22·F10·F14·L10

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1. Introduction

In the past twenty years many developing countries have substantially lowered tariffs to stimulate their exports. This empirical evidence motivates a number of paper to examine the impact of trade liberalization on exporting behaviors. Bustos (2011) examines the impact of a regional free trade agreement on technology upgrading among Argentina exporting firms. Baldwin and John (2004) and Fan et al. (2014) find a positive correlation between the tariff reduction and innovation and export product quality by using Canadian and Chinese export data, respectively. Yu (2013) documents the fact that in China, trade liberalization increases non-processing trade firms' productivity. More paper documents the fact that trade liberalization increases both the export-market participation (extensive margin) and the export volume (intensive margin). (Baldwin and John, 2004; Ahmed, N., 2000; Kassim, L., 2013).

However, in most countries, especially in developing countries the industrial composition is different across regions. In addition, the mobility of labor force is limited across regions (Cai et al,, 2002; Topalova, 2010; Autor et al,, 2013; Lin et al,, 2004; Hasan et al., 2012; Bound and Holzer, 2000; Johoson, 2003; Candelaria et al., 2013). As such, a country wide policy change, such as trade liberalization, could have different effect across regions (Topalova, 2010; Kovak., 2013; Autor et al,, 2013). Taking into account of the regional difference in industrial composition and the limited labor force mobility, trade liberalization tends to have different impact on firms located in different regions. Specifically, trade liberalization, on one hand, decreases the firm-level variable trade cost (*tariff effect*). On the other hand, it affects the regional wage level by expanding the local labor demand of exporting

firms (*wage effect*). While the tariff effect has received sufficient attentions, the wage effect has rarely been analyzed. This paper attempts to decompose the impact of trade liberalization on the firm-level exports by disentangling the tariff and wage effect. We develop a model to show the fact that exporting firms grow slower in regions experiencing larger *average tariff* reduction.

This paper is closely related to the regional economics and trade liberalization literature. Topalova (2010) investigates the impact of trade liberalization on regional poverty in India, and find that regions exposed more to trade liberalization experiences a slower poverty reduction. Autor et al, (2013) document the positive relationship between regional unemployment and the degree to which the region exposed to import competition by using the data on US local markets. Kovak. (2013) shows that trade liberalization has different impact on regional wages in Brazil. Koenig et al. (2010), Cassey and Schmeiser (2013) and Krautheim (2012) separately document the role the regional industrial composition plays on exporting firms' behaviors.

This paper contributes to the literature in two aspects. First, it provide a theoretical framework to disentangle tariff and wage effect. If the wage effect is simply neglected, the impact of trade liberalization on firms' exports tends be overestimated. Second, This paper points out the different impact of trade liberalization across regions. It implies that to keep all region in a balanced growth rate, the local governments need to further implement some policies to corporate with the central government.

The structure of this paper is as follows. In section 2, we outline the model; Section 3 disentangles the trade liberalization to tariff and wage effect, respectively. Section 4 concludes.

2. Model

In this section, we develop a model to disentangle the tariff and wage effect of a trade liberalization on the firm-level intensive margin of exports.

2.1. Labor Supply

Consider a country consisted by many regions, indexed by j. Each industry in this economy is denoted by i. Labor is the only input in the production[1], and is assumed to be mobile between industries, but not across regions. As a result, the wage level is identical across different industries within a region, but varies across regions. [2] The labor supply in region j is assumed to be a linear function of regional wage:

$$L_j = a_j + b_j\omega_j \tag{1}$$

where L_j and ω_j are labor supply and wage in region j. Note that the elasticity of labor supply, which is positively correlated with b_j,[3] allows to vary across regions.

Considering a particular region j, we suppress the subscript j for notional simplicity. The labor supply function can be simplified as

$$L = a + b\omega \tag{1'}$$

Further, assume that production exhibits constant returns to scale. As such, the margional production cost for a firm with productivity ϕ_k is: $MC(\phi_k) = \frac{\omega}{\phi_k}$.

[1]For simplicity, we assume the market entry and fixed costs are not paid in labor, but capital.

[2]Here we can relax the assumption by assuming a fixed moving cost across regions. Labor will not move across regions due to a small regional wage difference.

[3]The elasticity of labor supply implies by equation (1)is $\frac{1}{\frac{a_j}{\omega b_j}+1}$.

2.2. Labor Demand

A representative consumer's preference to all varieties takes the CES form.

$$U = \left[\int_{\iota \in \Omega} q(\iota)^{\frac{1-\sigma}{\sigma}} d\iota \right]^{\frac{\sigma}{1-\sigma}} \tag{2}$$

where σ is the elasticity of substitution between any two products.

Each firm maximizes its profits by choosing its optimal price and quantity. The optimal quantity determines the firm's labor demand. Denote firm k in industry i's labor demand as l_i^k. The industry-level labor demand is the aggregate labor demand of each individual firm in this industry:$L_i = \sum_k l_i^k$. The total regional labor demand is the aggregate labor demand of all industries within the region.

$$L = \sum_i L_i \tag{3}$$

where L_i is the total labor demand in industry i. Each firm hires employees to make productions to serve the domestic and (or) foreign market. We further divide the labor demand for any firm in industry i to domestic production and foreign production labor demands. In particular,

$$l_i(\omega, \phi_k, \tau_i) = l_i^{ne}(\omega, \phi_k) + 1_{ex} \cdot l_i^e(\omega, \phi_k, \tau_i) \tag{4}$$

where $l_i^e(\omega, \phi_k, \tau_i)$ is the labor demand of an exporting firm for serving the foreign market at wage level ω, trade cost τ_i and productivity ϕ_k.[4] $l_i^{ne}(\omega, \phi_k)$ is the labor

[4]The labor force required to produce the output sold in the domestic market is called domestic production labor demand, while the labor force required to produce the output sold in the foreign market is called the foreign production labor demand.

demand of this firm for serving the domestic market. 1_{ex} is an indicator function, which takes value 1 if this firm exports, 0 otherwise. For a nonexporting firm, it only has domestic production labor demand. Note that the trade cost τ_i only *directly* affect the foreign production labor demand, but not the domestic production labor demand.[5] Therefore, the total labor demand in industry i can be written as the aggregate individual firm's domestic and foreign labor demand. That is

$$L_i = \sum_{k=1}^{n_i^{ne}} l_i^{ne}(\omega, \phi_k) + \sum_{v=1}^{n_i^{e}} l_i^{e}(\omega, \phi_v, \tau_i) \tag{5}$$

where n_i^{ne} and n_i^{e} are the total number of firms and exporting firms in industry i, respectively.[6] Note that in equation (5) we use ϕ_k and ϕ_v to denote the productivity level. This is because that the domestic and foreign markets have different productivity cutoffs, and not every firms engaging in exporting. As such, the productivity distribution among all firms and exporting firms is different.

Similar to Melitz (2003), the labor demand of a firm with productivity ϕ_k, hired to make the domestic production, is by solving the following optimization problem

$$\max_{p,q} \left[p(\omega, \phi_k) - \frac{\omega}{\phi_k} \right] q(\omega, \phi_k)$$

[5] Although the change of trade cost τ_i does not directly affect the domestic labor demand, it indirectly affect it by changing the regional wage level.

[6] Here we follow the Melitz (2003) that an exporting firm must also has positive sales in the domestic market.

$$
\begin{aligned}
l_i^{ne}(\omega, \phi_k) &= \frac{q(\omega, \phi_k)}{\phi_k} \\
q(\omega, \phi_k) &= A_i p(\omega, \phi_k)^{-\sigma} \\
p(\omega, \phi_k) &= \frac{\sigma}{\sigma - 1} \left(\frac{\omega}{\phi_k} \right)
\end{aligned}
$$

We can express the domestic labor demand of a firm with productivity ϕ_k as follows:

$$
l_i^{ne}(\omega, \phi_k) = A_i \left(\frac{1}{\phi_k} \right)^{1-\sigma} \left(\frac{\sigma}{\sigma - 1} \right)^{-\sigma} \omega^{-\sigma} \tag{6}
$$

where A_i is the domestic residual demand for the products of industry i. $q(\omega, \phi_k)$ and $p(\omega, \phi_k)$ are the optimal domestic quantity and price, respectively.

Accordingly, the labor demand of an exporting firm with productivity ϕ_v is by solving the firm's optimization problem in the foreign market

$$
\max_{p^*, q^*} \left[p^*(\omega, \phi_v, \tau_i) - \frac{\tau_i \omega}{\phi_v} \right] q^*(\omega, \phi_v, \tau_i)
$$

$$
\begin{aligned}
l_i^e(\omega, \phi_v, \tau_i) &= \frac{q^*(\omega, \phi_v, \tau_i)}{\phi_v} \\
q^*(\omega, \phi_v, \tau_i) &= A_i^* p^*(\omega, \phi_v, \tau_i)^{-\sigma} \\
p^*(\omega, \phi_v, \tau_i) &= \frac{\sigma}{\sigma - 1} \left(\frac{\tau_i \omega}{\phi_v} \right) \\
l_i^e(\omega, \phi_v, \tau_i) &= A_i^* \left(\frac{1}{\phi_v} \right)^{1-\sigma} \left(\frac{\sigma}{\sigma - 1} \right)^{-\sigma} (\tau_i \omega)^{-\sigma}
\end{aligned} \tag{7}
$$

where A_i^* is the residual demand for products of industry i in the foreign market, and τ_i captures the trade cost in industry i, which includes the transportation cost, tariff, etc.

3. The Impact of Trade Liberalization on Exporting Firms' Intensive Margin

From equation (7), the trade liberalization increases the sales of exporting firms in the foreign market through lowering the trade cost τ. This is the tariff effect of trade liberalization on the firm-level intensive margin of exports. At the meanwhile, the trade liberalization makes each exporting firms expand their sales in the foreign market, which increases the regional labor demand and pushes up the regional wage. The increasing regional wage has a negative impact on the firm-level intensive margin of exports. This is the wage effect of trade liberalization on the firm-level intensive margin of exports. We formalize the mentioned intuition in the following inequalities[7]:

$$\frac{\partial l_i^{ne}(\omega, \phi_k)}{\partial \omega} < 0 \tag{8.1}$$

$$\frac{\partial l_i^{e}(\omega, \phi_v, \tau_i)}{\partial \omega} < 0 \tag{8.2}$$

$$\frac{\partial l_i^{e}(\omega, \phi_v, \tau_i)}{\partial \tau_i} > 0 \tag{8.3}$$

$$\frac{\partial \omega}{\partial \tau_i} > 0 \tag{8.4}$$

Inequalities (8.1) and (8.2) imply that the firm-level domestic and foreign labor demand is decreasing in the regional wage level ω. Inequality (8.3) implies that the tariff effect of the trade liberalization on any exporting firm's labor demand for serving the foreign market is positive. At last, (8.4) documents the positive correlation between the trade cost and regional wage level. From the above analysis, the trade liberalization affects exporting firms' intensive margin through two

[7]The detailed proof is in the Appendix.

channels: the tariff and the wage channel. To evaluate the impact of the trade liberalization on exporting firms' behavior, we have to disentangle the tariff and wage effect.

3.1. Regional Differentiation of the Wage Effect

The industrial distribution of labor usually varies across regions. The disparity could be caused by regional level comparative advantages, e.g. geographic, policy advantage (Cai et al,, 2002). A consequence of the different regional industry composition is that the regional wage adjusts differently in response to a country wide trade liberalization. This model yields the following relationship between the regional wage change and the weighted average trade cost change.

$$\Delta\omega = \sum_i \beta_i \Delta\tau_i \tag{9}$$

$$\text{where, } \beta_i = \frac{L_i^e\,(-\sigma)\,\tau_i^{-\sigma-1}}{b + \frac{\sigma}{\omega}L},\ L_i^e = \sum_v l_i^e(\omega, \phi_v, \tau_i)$$

where L_i^e is the total labor demand of exporting firms in industry i for serving the foreign market. Equation (9) implies a positive correlation between the weighted average trade cost change, $\sum_i \beta_i \Delta\tau_i$, and the regional wage change, $\Delta\omega$. β_i is positively correlated with $\alpha_i = \frac{L_i^e}{\sum_n L_n}$[8], the labor share in exporting production of industry i. This positive correlation indicates that regions more exposed to trade liberalization, in terms of the weighted average trade cost reduction, the regional wages increase more in response to trade liberalization. As such, the wage effect is larger in regions more exposed to trade liberalization.

[8] $\beta_i = \frac{(-\sigma)\widetilde{\tau}\frac{\partial\widetilde{\tau}}{\partial t_i}}{\frac{b}{L} - \frac{\sigma}{\omega}}\alpha_i$

3.2. Decomposition of the Impact of Trade Liberalization

With all the above analysis, we can decompose the impact of trade liberalization on the firm-level intensive margin of exports to the tariff effect and regional wage effect:

$$\begin{aligned}\Delta q^*(\omega, \phi_v, \tau_i) &= \Delta l_i^e(\omega, \phi_v, \tau_i) \cdot \phi_v \\ &= \left[\underbrace{\frac{\partial l_i^e(\omega, \phi_v, \tau_i)}{\partial \tau_i} \Delta \tau_i}_{\text{tariff effect}} + \underbrace{\frac{\partial l_i^e(\omega, \phi_v, \tau_i)}{\partial \omega} \Delta \omega}_{\text{wage effect}} \right] \phi_v \end{aligned} \tag{10}$$

where $q^*(\omega, \phi_v, \tau_i)$ is the export sales of a representative firm in the foreign market with productivity ϕ_v, at tariff level τ_i and wage level ω. Equation (10) implies that all other things equal, the more the increase in the regional wage, the less impact of the trade liberalization on the firm-level intensive margin of exports.[9] This implication indicates that the regional industrial composition has significant impact on the effect trade liberalization. We formally summarize the results of the model in the following Proposition.

Proposition 1. *The impact of trade liberalization on the firm-level exports can be decomposed as the tariff effect and wage effect. The tariff effect is positive, which increases the firm-level exports, while the the wage effect is negative, which decreases the firm-level exports.*

Proposition 1 implies a negative relationship between tariff and wage effect. Wage effect offsets the tariff effect. All other things equal, the impact of trade

[9]Note that the tariff effect is the same across all regions, the only difference is from the wage effect.

liberalization on the firm-level export is larger when the wage effect is smaller. It is intuitive that tariff effect dominates the wage effect, otherwise, exporting firms do not expand their production and the labor demand does not rise.

Proposition 2. *When the industrial composition differs across regions and the mobility of labor force between regions is limited, a country wide trade liberalization has different impact on the firm-level intensive margin of exports among exporting firms located in different regions. All other things equal, the larger the average tariff reduction in a region, which implies a larger increase in the regional wage, the smaller the impact of trade liberalization on firms' exports.*

The Proposition implies that if the trade liberalization leads to the same tariff reduction in all industries, the intensive margin of exporting firms will increase less in regions, where more labors work in the exporting sectors. This is because in the region experiencing a larger regional wage increase caused by the expansion of exporting sectors, the wage effect offsets tariff reduction effect. In order to keep a balanced firm-level exporting growth, the local governments need to further subsidize or tax the local exporting firms. One example is that in 2003, accompany the trade liberalization, Chinese central government gives the authority to the local governments to decide how much of the 25% of the export tax rebate they pay to the local exporting firms based on their financial status (Chandra and Long, 2013).

4. Conclusion

In this paper, we extend the model of Melitz (2003) to investigate the impact of trade liberalization on exporting firms' intensive margin of exports. The model

predicts that an decrease in the trade cost will have both a tariff and wage impact on firms' exports. On one hand, the trade liberalization decrease firm-level variable trade cost, and hence increase the firm-level exports. But on the other hand, the trade liberalization rises the local labor demand by expanding the exporting firms' sales in the foreign market. The rising local labor demand pushes up the regional wage, which drives up the variable production cost. The increasing in the regional wage drives down the firm-level intensive margin of exports. Ignoring the regional wage effect of trade liberalization on the firm-level intensive margin of exports leads to overestimate the impact of trade liberalization on firms' exports. This paper suggests that a country wide policy change could have different effect in different regions. In order to keep all regions a balanced growth rate, the local government needs to enact some policies according to the country wide policy change.

Appendix

To show the inequality of (8.4), we only need to show the opposite is impossible. Assume $\frac{\partial \omega}{\partial t_i} < 0$.This implies the following inequality:

$$a + b\omega = \sum_n \left[\sum_k l_n^{ne}(\omega, \phi_k) + \sum_v l_n^e(\omega, \phi_v, \tau_n) \right] \tag{A1}$$

Take derivative of equation (A1) w.r.t. τ_i

$$\begin{aligned} b\frac{\partial \omega}{\partial \tau_i} &= \sum_k \left(\frac{\partial l_i^{ne}(\omega, \phi_k)}{\partial \omega} \frac{\partial \omega}{\partial \tau_i} \right) + \sum_v \left(\frac{\partial l_i^e(\omega, \phi_v, \tau_i)}{\partial \omega} \frac{\partial \omega}{\partial \tau_i} + \frac{\partial l_i^e(\omega, \phi_v, \tau_i)}{\partial \tau_i} \right) \\ &\quad + \sum_{n \neq i} \left[\sum_k \left(\frac{\partial l_n^{ne}(\omega, \phi_k)}{\partial \omega} \frac{\partial \omega}{\partial \tau_i} \right) + \sum_v \left(\frac{\partial l_k^e(\omega, \phi_v, t_n)}{\partial \omega} \frac{\partial \omega}{\partial \tau_i} \right) \right] \\ \Rightarrow \left[\sum_n \sum_k \left(\frac{\partial l_n^{ne}(\omega, \phi_k)}{\partial \omega} + \frac{\partial l_n^e(\omega, \phi_v, \tau_n)}{\partial \omega} - b \right) \right] \frac{\partial \omega}{\partial \tau_i} &= -\sum_v \frac{\partial l_i^e(\omega, \phi_v, \tau_i)}{\partial \tau_i} \end{aligned} \tag{A2}$$

Due to the fact that $\frac{\partial l_n^{ne}(\omega, \phi_k)}{\partial \omega} < 0$, $\frac{\partial l_n^e(\omega, \phi_v, \tau_n)}{\partial \omega} < 0, b > 0$ and $\frac{\partial l_i^e(\omega, \phi_v, \tau_i)}{\partial \tau_i} > 0$. The RHS of eq (A2) is negative, and the coefficient of $\frac{\partial \omega}{\partial \tau_i}$ on the RHS of eq (A2) is negative. Therefore, we must have $\frac{\partial \omega}{\partial \tau_i} > 0$.

The impact of the trade liberalization in industry i on the regional wage is as

follows:

$$
\begin{aligned}
b\frac{\partial\omega}{\partial\tau_i}\Delta\tau_i &= \frac{\partial L}{\partial\tau_i}\Delta\tau_i \\
&= \sum_n \left[\sum_k \left(\frac{\partial l_n^{ne}(\omega,\phi_k)}{\partial\omega}\right) + \sum_v \left(\frac{\partial l_n^{e}(\omega,\phi_v,\tau_n)}{\partial\omega}\right)\right]\frac{\partial\omega}{\partial\tau_i}\Delta\tau_i + \sum_v \frac{\partial l_i^{e}(\omega,\phi_v,\tau_i)}{\partial\tau_i}\Delta\tau_i \\
&= \sum_n \frac{-\sigma}{\omega}\left[\sum_k l_n^{ne}(\omega,\phi_k) + \sum_v l_n^{e}(\omega,\phi_v,\tau_i)\right]\frac{\partial\omega}{\partial\tau_i}\Delta\tau_i + \sum_v l_i^{e}(\omega,\phi_v,\tau_i)\,(-\sigma)\,\tau^{-\sigma-1}\Delta\tau_i \\
&= \left(\sum_n \frac{-\sigma}{\omega}L_n\right)\frac{\partial\omega}{\partial\tau_i}\Delta\tau_i + L_i^{e}\,(-\sigma)\,\tau^{-1}\Delta\tau_i \\
&\Rightarrow \frac{\partial\omega}{\partial\tau_i}\Delta\tau_i = \frac{L_i^{e}\,(-\sigma)\,\tau^{-\sigma-1}}{b+\sum_n \frac{-\sigma}{\omega}L_n}\Delta\tau_i \qquad \text{(A3)}
\end{aligned}
$$

where L_i^e is the total labor demand for pure exporting firms in industry i, and L_j is the total labor demand in industry j. The third equation is derived as follows:

$$
\begin{aligned}
\frac{\partial l_n^{ne}(\omega,\phi_k)}{\partial\omega} &= \frac{-\sigma}{\omega}l_n^{ne}(\omega,\phi_k) \qquad \text{(A3.1)} \\
\frac{\partial l_n^{e}(\omega,\phi_v,\tau_n)}{\partial\omega} &= \frac{-\sigma}{\omega}l_n^{e}(\omega,\phi_v,\tau_n) \qquad \text{(A3.2)} \\
\frac{\partial l_n^{e}(\omega,\phi_v,\tau_n)}{\partial\tau_n} &= A_i^*\left(\frac{1}{\phi_v}\right)^{1-\sigma}\left(\frac{\sigma_i}{\sigma_i-1}\right)^{-\sigma}(\omega)^{-\sigma}\,(-\sigma_i)\,\tau^{-\sigma-1} \\
&= A^*\left(\frac{1}{\phi_v}\right)^{1-\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}(\tau\omega)^{-\sigma}\,(-\sigma)\,\tau^{-1} \\
&= l_i^{e}(\omega,\phi_v,\tau_n)\,(-\sigma)\,\tau_n^{-1} \qquad \text{(A3.3)}
\end{aligned}
$$

From (A3), we can derive the impact of the trade liberalization in all industries

on the regional wage:

$$\begin{aligned}
\Delta\omega &= \sum_i \frac{\partial\omega}{\partial\tau_i}\Delta\tau_i \\
&= \sum_i \frac{L_i^e\left(-\sigma\right)\tau^{-\sigma-1}\Delta\tau_i}{b+\sum_n \frac{-\sigma}{\omega}L_n} \\
&= \sum_i \beta_i \Delta\tau_i \qquad \text{(A4)} \\
\text{where } \beta_i &= \frac{L_i^e\left(-\sigma\right)\tau^{-\sigma-1}}{b+\sum_n \frac{-\sigma}{\omega}L_n}
\end{aligned}$$

Define $\alpha_i = \frac{L_i^e}{\sum_n L_n}$, the share of labors in industry i for exporting production. It is easy to show that α_i and β_i is positively correlated.

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