The impact of labor prices onthe contagion effect of FTAs

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Abstract
In a two-country footloose-capital model with the asymmetry of labor prices by setting different production technologies, this paper describes the relocation of firms corresponding to different trade costs and obtains the breaking point at which the agglomeration of relocation occurs. Extending it into a three-country model, we then analyze the impact of different labor prices on the contagion effect of FTAs in the short and long run, respectively. The existence of the contagion effect of FTAs is conditioned in the short run, and it is more beneficial for a third countryto choose the first FTA partner with a relatively higher labor price after theinitial FTA shock in the short term if a certain condition is satisfied. Moreover, the contagion effect of FTAs does exist in the long run. If global free trade is not achieved, unless the third country has the lowest labor price it is more advantageous to choose the potential FTA partner with a lower labor price.

1 Introduction
The proliferation of FTAs has increased rapidly in recent years. The FTA relationship between two countries implies the elimination of trade barriers. However, one FTA does have significant effects on the trade and national welfare of other nations apart from the signatories. Thus third countries have to decide on whether and how to sign new FTAsin order to offset the losses that FTA may entail. It seems that the establishment of FTAs is contagious. Therefore the contagion effect of FTAs reflects the interaction mechanism of the establishment of FTAs among several countries.

Most literature has focused on the determinants or motivations of FTA formation so far, see Krugman (1989), Bhagwati (1991), Bhagwati (1993), Bhagwati (2008), Mansfield and Pevehouse (2000), Mansfield, Milner and Rosendorff(2002), Wu (2006), Yi,Harvie and Kimura (2005), Vicard (2012), Martin, Mayer and Thoenig(2008, 2010), Lester and Mercurio (2009), etc. However, there aren't lots of studies on the contagion effect of FTAs. Baldwin (1993) is the first to study this effect by introducing the domino theory into regionalism, showing that a country's incentive to join a customs union is affected by the formation or enlargement of the union because of the trade diversion it generates. Sapir (2001) empirically examines the existence of the domino effect in the regionalism in Western Europe with a standard gravity model. With the econometric method, Egger and Larch (2007) argue that a country's incentive to participate in a preferential trade agreement is dependent on other countries. Furusawa and Konishi (2007) look at this issue from a different perspective. They examine the formation of FTAs by considering them to be a network formation game, showingthat if all countries are symmetric, the complete FTA network is pair-wise stable. Chen and Joshi (2010) develop a three-country theoretical model to take into account the third-country effect, finding that the establishment of an FTA between two countries is influenced by their FTA relationships with third countries. The most iconic study on the contagion effect of FTAs is the work of Baldwin and Jaimovich (2012), which applies a classic model in new economic geography, i.e. the constructed-capital (CC) model of Baldwin (1999). They theoretically examine the existence of the contagion effect of FTAs in the short run with the CC model. The CC model applied in their work injects new vitality into the analysis of the contagion effect of FTAs from the perspective of new economic geography.

Nevertheless, the impact of labor prices on the contagion effect of FTAs is not taken into consideration in the analysis of Baldwin and Jaimovich (2012), and the long-run contagion effect of FTAs isn't examined. In addition, compared to the CC model applied by Baldwin and Jaimovich (2012), the footloose-capital (FC) model of Martin and Rogers (1995) takes on its advantages in the examination of the contagion effect of FTAs. Different from the CC model, it is comparatively more reasonable to reflect the economic activities of firms in reality due to the mobility of capital across regions in the FC model, which also increases the tractability to a certain extent. However, labor prices are assumed to be equalized internationally in the simplest FC model. Persyn (2013) is the first to introduce different labor prices into the FC model by setting different production technologies, which isn't to aim at the contagion effect of FTAs.

The impact of labor prices on the contagion effect of FTAs needs to be studied in depth because policymakers will have to take account of the differences in labor prices in order to minimize the loss other FTAs bring when choosing potential FTA partners. Consequently, this paper replaces the CC model with the FC model in reference to Persyn (2013) as the basic framework to analyze the impact of labor prices on the contagion effect of FTAs based on the work of Baldwin and Jaimovich (2012).

For the reasons above, the novelties of this paper are as follows. First, taking the FC model as the basic framework, and regarding the impact of different labor prices on the relocation of firms, we obtain the explicit functions of the spatial distribution of firms under different trade costs. Second, analyzing the contagion effect of FTAs by using the FC model with different labor prices, while examining the existence of the effect, we not only show how labor prices impact the decision of third countries in choosing potential FTA partners in the short term, but also the long-term effect. Therefore, the value added in this paper lies in that introducing the asymmetry in labor prices into the discussion on this topic can be deemed as a constructive development, and it contributes to the examination of the contagion effect empirically. Besides, the analysis of the long-term dimension enables us to obtain more abundant features of the contagion effect of FTAs, which is beneficial in providing more constructive and comprehensive advice for policymakers.

The remainder of the paper is organized as follows. Section 2 presents our general framework, a two-country FC model with different labor prices, and related analysis on the relocation of firms. Section 3 is based on the previous section, which studies how labor prices affect the decision of third countries in choosing potential FTA partners both in the short and long-term. Section 4 concludes.

2 The Model

We take the FC model as the basic framework due to its obvious tractability. Labor prices are assumed to be internationally equalized in this model. Undoubtedly the equalization of labor prices is incompatible with reality when we explain international trade issues with models in new economic geography. Meanwhile, based on the equalization of labor prices, the simplest FC model prevents us from analyzing the impact of different labor prices on economic activities. Therefore, we make some modifications to the FC model and thus introduce different labor prices in reference to Persyn (2013).

First we construct a two-country model as the basic theoretical framework. Then we extend it into a three-country model when studying how different labor prices affect the decisions of third countries in choosing potential FTA partners.

2.1 Assumptions

There are two countries, Country 1 and Country 2. Both countries are endowed with labor and capital, with the world's endowment denoted as L^w and K^w, respectively. In particular, Country i is endowed with L_i units of labor and K_i units of capital, $i=1,2$. As in the FC model, we assume the international immobility of labor.Capital is mobile internationally merely in the long run, while in the short run it isn't. Return on capital will have to be repatriated to its country of origin for consumption wherever it is employed. Thus in the long run capital will move to the country with the highest nominal capital reward until the long-run equilibrium is achieved where nominal rewards in each country are equalized.

In each country there are two sectors, agriculture (Sector A) and manufacturing (Sector M). Sector A produces homogeneous goods under constant returns to scale. In reference to Persyn (2013), we assume that the production of one unit of A good takes a_{Ai} units of labor only in Country i. Trade in A goods is frictionless under perfect competition. Unlike the FC model, due to the asymmetry in the production technology of A sectors in our paper, the equalization of A goods implies that labor prices in the two countries must be different. Thus we manage to introduce different labor prices as the critical exogenous condition into our model.

Sector M is a Dixit-Stiglitz monopolistic competition sector, whose production is subject to increasing returns to scale.To be more specific, each industrial firm produces only one variety, so the quantity of firms is equal to that of industrial varieties. Each variety requires one unit of capital, which constitutes the fixed costs of production. Besides, it takes a_M units of labor for each unit of M goods as the variable costs. Furthermore, the production of each industrial firm is located merely in one country. Local consumers bear no trade costs for M goods. However, international trade of M goods is constrained by iceberg trade costs, i.e. only 1 unit of M goods will arrive in the export market when τ units are shipped. Meanwhile we assume that trade costs are always symmetric between the two countries.

The preference of a typical consumer can be expressed as a Cobb-Douglas utility function:

$$U = C_M^{\mu} C_A^{1-\mu};\ C_M = (\int_{i=0}^{n^w} c_i^{1-1/\sigma} di)^{1/(1-1/\sigma)},\ 0<\mu<1<\sigma \tag{1}$$

where C_M is consumption of the composite of all varieties of M goods and C_A is consumption of A goods. μ is the proportion of industrial varieties consumed to the total expenditure in a country. σ is the constant elasticity of substitution between any two industrial varieties. n^w is the total number of industrial varieties. $n^w = n_1 + n_2$, where n_i represents the number of industrial varieties produced in Country i. Consistent with Dixit-Stiglitz monopolistic competition, every consumer purchases all varieties to achieve the highest utility. Then the indirect utility function for Country i is:

$$V_i = \frac{E_i}{P_i};\ P_i \equiv p_{Ai}^{1-\mu}(\Delta_i n^w)^{-a};\ \Delta_i \equiv (\int_{j=0}^{n^w} p_j^{1-\sigma} dj)/\mathrm{n}^w,\ a \equiv \mu/(\sigma-1) \tag{2}$$

where E_i is the total expenditure of Country i. P_i represents Country i's perfect price index. Specifically $\Delta_i n^w$ represents the price index for industrial goods and Δ_i is the average industrial price index.

2.2 Short-run Equilibrium

In the short run, since capital is assumed to be immobile across countries, we take the capital stock in each country as given. We first solve the market clearing conditions for each sector.

2.2.1Sector A

The price of A goods is equalized for its internationally costless trade under perfect competition. We choose A goods as numeraire, which implies that $p_A = 1$. Therefore the demand of consumers in Country i for A goods is:

$$c_{Ai} = \frac{(1-\mu)\mathrm{E}_i}{p_A} = (1-\mu)\mathrm{E}_i \tag{3}$$

and then the global expenditure on A goods is $(1-\mu)\mathrm{E}^w$.

2.2.2 Sector M

Following Dixit-Stiglitz monopolistic competition, Country j's demand for one industrial variety produced in Country i can be expressed as:

$$c_{ij} \equiv \frac{p_{ij}^{-\sigma} \mu E_j}{\Delta_j n^w};\ i, j = 1, 2 \tag{4}$$

where p_{ij} represents the consumer price of Country i's industrial variety in the market of Country j.

As the labor prices in different countries are different, and with the mechanism of Dixit-Stiglitz, Sector M maximizes its profit by setting a constant mark-up of marginal cost as the consumer price. The consumer prices of an industrial variety both in the domestic market and the foreign market are listed as follows:

$$p_{11} = \frac{w_1 a_M}{1-1/\sigma},\ p_{12} = \frac{\tau w_1 a_M}{1-1/\sigma},\ p_{21} = \frac{\tau w_2 a_M}{1-1/\sigma},\ p_{22} = \frac{w_2 a_M}{1-1/\sigma} \tag{5}$$

where w_i is the labor price of Country i. As is shown above, the labor price has a direct influence on the consumer prices of an industrial variety. More specifically, higher labor prices push up the production costs, thus leading to higher prices of the industrial variety directly.

2.2.3 Capital Reward

Since it takes one unit of capital as the fixed cost to produce an industrial variety, according to Dixit-Stiglitz monopolistic competition the reward of one unit of capital is equivalent to the operating profit of an industrial firm, i.e. $\pi = px/\sigma$, where x represents the output. Under the market-clearing condition, the reward of one unit of capital can be expressed as follows:

$$\pi_1 = B_1 \frac{\mu E^w}{\sigma K^w},\ \pi_2 = B_2 \frac{\mu E^w}{\sigma K^w} \tag{6}$$

where B_i $(i = 1, 2)$ is the sale bias, namely:

$$B_1 \equiv \frac{w_1^{1-\sigma} s_{E1}}{\Delta_1} + \frac{\phi w_1^{1-\sigma} s_{E2}}{\Delta_2},\ B_2 \equiv \frac{\phi w_2^{1-\sigma} s_{E1}}{\Delta_1} + \frac{w_2^{1-\sigma} s_{E2}}{\Delta_2} \tag{7}$$

where $\phi = \tau^{1-\sigma}$ $(\phi \in [0,1])$, which represents the trade freeness. s_{Ei} is Country i's share of market size (or expenditure) in the world. And:

$$\Delta_1 \equiv s_{n1} w_1^{1-\sigma} + \phi s_{n2} w_2^{1-\sigma},\ \Delta_2 \equiv \phi s_{n1} w_1^{1-\sigma} + s_{n2} w_2^{1-\sigma} \tag{8}$$

where s_{ni} represents Country i's share of industry varieties, that is the proportion of Country i's capital stock of the world.

2.2.4 Market Size

From Expression(6) above we see that the reward of one unit of capital merely depends on market size, s_{Ei}, since the other parameters are assumed to be given in the short run. Next we work out the expression of s_{Ei}.

Saving isn't considered in our model, which means that all incomes are spent on consumption. Therefore the global expenditure is composed of labor income and capital reward. Thus:

$$E^w = w_1 L_1 + w_2 L_2 + \mu E^w / \sigma = (w_1 s_{L1} + w_2 s_{L2}) L^w + \mu E^w / \sigma \tag{9}$$

the global expenditure can be written as:

$$E^w = \frac{(w_1 s_{L1} + w_2 s_{L2}) L^w}{1 - \mu/\sigma};\ s_{Li} = \frac{L_i}{L^w},\ i = 1, 2 \tag{10}$$

where L^w represents the total labor force in the world, and s_{Li} is Country i's share of it.

Similarly, the expenditure in one country is composed of its total labor income and capital reward. However, the capital reward in each country isn't determined endogenously, because it depends on the uncertain distribution of capital employed. Hereby we assume that the capital reward of a country is

proportional to that of the world. Specifically the ratio is the capital stock of that country to the world's total capital stock. Thus we have:

$$E_i = w_i L_i + \mu E^w K_i / \sigma K^w;\ i = 1,2 \tag{11}$$

Combined with the expression of world expenditure, E^w, Country i's share of market size to the world expenditure can be written as:

$$s_{Ei} = (1-\mu/\sigma) w_i s_{Li} / \sum_{i=1}^{2} w_i s_{Li} + \mu s_{Ki} / \sigma;\ s_{Ki} = \frac{K_i}{K^w},\ i = 1,2 \tag{12}$$

and from this expression it is easy to note that the market size of a country doesn't depend merely upon its capital stock and labor force. There exist exogenous differences in labor prices, which directly affect the market size. Ceteris paribus, higher labor price of a country will lead to a relatively larger market size.

2.3 Long-run Equilibrium

Capital moves in search of the highest reward internationally in the long run. The long-run equilibrium is achieved when capital reward is equalized in each country. In the equilibrium state, the reward of each unit of capital equals the world average level, that is:

$$\pi_1 = \pi_2 = \bar{\pi} = \mu E^w / \sigma \mathrm{K}^w \tag{13}$$

thus we have $B_1 = B_2 = 1$. The expression of B_i is specified to get:

$$\frac{s_{E1}}{\Delta_1} + \phi \frac{s_{E2}}{\Delta_2} = \frac{1}{w_1^{1-\sigma}},\ \phi \frac{s_{E1}}{\Delta_1} + \frac{s_{E2}}{\Delta_2} = \frac{1}{w_2^{1-\sigma}} \tag{14}$$

Let $a = 1/w_1^{1-\sigma} = w_1^{\sigma-1}$. Similarly $b = w_2^{\sigma-1}$. $\sigma > 1$ implies the equivalence of $w_1 > w_2$ and $a > b$. Next we discuss the impact of different labor prices on the relocation of firms by considerating different tradefreenesses:

(i) $\phi = 0$

The solution to condition $\phi = 0$ is $s_{ni} = s_{Ei}$ $(i = 1,2)$. When international trade is completely restrained, consumers can only purchase the industrial varieties produced in their own country. Thus the relative amount of capital employed in a country is equivalent to its relative market size. Meanwhile, because the difference in labor prices is reflected on the relative market size of each country, the larger the difference in labor prices, the bigger gap in market size between the two countries, which leads to the larger difference of the relocation of firms in the long run.

(ii) $\phi = 1$

When $\phi = 1$, we have $B_1 \neq B_2$ due to $a \neq b$. Then $\pi_1 \neq \pi_2$ means this equation has no solutions. In other words, capital flow won't cease unless the labor price in each country is equalized. The labor price in Country 1 is assumed to be higher than Country 2, i.e. $a > b$, andconsequently $\pi_1 < \pi_2$. At this point capital reward in Country 1 is less than that in Country 2, so capital in Country 1 will flow to Country 2, and so will the industrial firms. It isn't difficult to understand intuitively that the higher labor price in Country 1 pushes up the production costs of its industrial firms, meaning industrial varieties produced in Country 2 have a competitive advantage in price. Therefore, all the industrial firms will relocate to the country with a relatively lower labor price undoubtedly regarding the pre-condition that no trade costs exist.

(iii) $0 < \phi < 1$

That $a > b$ is assumed for convenience, ditto. The following two cases are considered:

1) $b = a\phi$

As the case when $\phi = 1$, the equation has no solutions because $\pi_1 < \pi_2$ when $b = a\phi$. To be more specific, capital reward in Country 2 is higher than that in Country 1 just to meet the condition that $b = a\phi$. Accordingly agglomeration occurs when all the capital, namely all the industrial firms flow to Country 2.

2) $b \neq a\phi$

In this case, the equation can be solved to get:

$$s_{n1} = \frac{ab(1-\phi^2)}{(a-b\phi)(b-a\phi)} s_{E1} - \frac{a\phi}{b-a\phi}$$

$$s_{n2} = \frac{ab(1-\phi^2)}{(a-b\phi)(b-a\phi)} s_{E2} - \frac{b\phi}{a-b\phi} \quad (15)$$

Since $a > b$, we have $a > b\phi$. $b > a\phi$ when $s_{ni} \in [0,1]$. Let the numerator minus the denominator in the slope of Expression (15):

$$ab(1-\phi^2) - (a-b\phi)(b-a\phi) > \phi(a-b)^2 > 0 \quad (16)$$

Therefore the numerator is greater than the denominator. Besides, both of them are greater than zero, so the coefficient of market size, namely the slope of the expression of s_{ni}, is greater than one, which implies that the home market effect in Fujita, Krugman and Venables (2001) also exists in this model.

In summary, if the labor price in Country 1 is higher than that in Country 2, then: (ⅰ) when $0 \leq \phi < b/a$ both countries have a certain amount of industrial firms, and the agglomeration of capital doesn't occur because of different labor prices and (ⅱ)When $b/a \leq \phi \leq 1$, agglomeration occurs with all the capital flowing to the country with relatively lower labor costs seeking higher capital reward, i.e. capital concentrates in Country 2 in our case. The critical point $\phi = b/a$ where agglomeration of capital occurs is the so-called breaking point in new economic geography. Apparently, in contrast to the literature, this breaking point is completely dependent on the labor prices of both countries after the asymmetry in labor prices is introduced into our model.

3 Contagion Effect of FTAs withDifferent Labor Prices

We constructed the FC model with different labor prices in the previous section as the theoretical foundation of analyzing the contagion effect of FTAs. Baldwin and Jaimovich (2012) applied the CC model to study the contagion effect of FTAs. Through a typical government objective function to reflect the change of welfare of a certain country faced with different FTA relationships, they proved the existence of the contagion effect in the short term theoretically, while ignoring the long-term effect.

Next we turn to the impact of different labor prices on the contagion effect of FTAs both in the short and long run. In accordance with the FC model, the distribution of capital employed is deemed as given in the short run. After the existing FTA relationship is changed, industrial firms are assumed not to relocate their production in the short run. Consequently, in our paper capital reward (namely the operating profit of industrial firms) is used to reflect the short-run welfare of a country faced with different FTA relationships. For long-run analysis, capital is internationally mobile searching for the highest capital reward, the flow of which won't cease until global reward has been equalized, hence an industrial firm is able to make decisions on its location of production. Because capital reward no longer operates as the measuring index for the long-run welfare, we steer towards the indirect utility function of consumers instead.

3.1 Short-run Effect

Based on the basic framework, now we extend it into a model composed of three countries: Country 1, Country 2 and Country 3. Since the distribution of industrial firms or capital employed is taken

exogenously in the short run, weassume the even distribution in each country for simplicity, i.e. $s_{ni}=1/3$ $(i=1,2,3)$. Recall the basic model in the previous section, the market size of a country depends on several given factors, including the capital stock, the amount of labor and its price. Thus the market size of each country is assumed to be identical, i.e. $s_{Ei}=1/3$ $(i=1,2,3)$. Besides, let $\alpha=1/a=w_1^{1-\sigma}$, $\beta=1/b=w_2^{1-\sigma}$, $\gamma=1/c=w_3^{1-\sigma}$. We assume that the labor price of Country 1 is higher than Country 2, namely $w_1>w_2$. Thereby we have $a>b>0$ and then $\beta>\alpha>0$.

Next we work out the operating profit of an industrial firm in each country under different FTA relationships, i.e. the five cases listed as follows. Then the existence of the contagion effect of FTAs and the impact of different labor prices on it are examined through the comparisons of different cases.

Case 1: no FTAs

Under the MFN (most-favored-nation) condition the trade freeness between every two countries is set as $\phi\in(0,1)$. Based on the assumptions above, the initial operating profit of an industrial firm in Country i can be written as:

$$\pi_1^0=\frac{\mu E^w}{\sigma K^w}\left(\frac{\alpha}{\alpha+\phi\beta+\phi\gamma}+\frac{\phi\alpha}{\phi\alpha+\beta+\phi\gamma}+\frac{\phi\alpha}{\phi\alpha+\phi\beta+\gamma}\right),$$
$$\pi_2^0=\frac{\mu E^w}{\sigma K^w}\left(\frac{\phi\beta}{\alpha+\phi\beta+\phi\gamma}+\frac{\beta}{\phi\alpha+\beta+\phi\gamma}+\frac{\phi\beta}{\phi\alpha+\phi\beta+\gamma}\right),$$
$$\pi_3^0=\frac{\mu E^w}{\sigma K^w}\left(\frac{\phi\gamma}{\alpha+\phi\beta+\phi\gamma}+\frac{\phi\gamma}{\phi\alpha+\beta+\phi\gamma}+\frac{\gamma}{\phi\alpha+\phi\beta+\gamma}\right) \quad (17)$$

Note from the equations that the operating profit of an industrial firm will be lower in a country with higher labor price. In particular, higher labor prices drive up the production cost, and thus constant mark-up pricing leads to higher industrial price. As a consequence, the operating profit drops in response to the decreased consumer demand.

Case 2: 1-2 FTA

Suppose a shock to the system that Country 1 and Country 2 establish an FTA relationship. The operating profit of an industrial firm will definitely be impacted due to the international immobility of industrial firms in the short run. We denote the operating profit of a firm in Country i by π_i^{12} $(i=1,2,3)$ in this case. For each country, we have:

$$\pi_1^{12}=\frac{\mu E^w}{\sigma K^w}\left(\frac{\alpha}{\alpha+\beta+\phi\gamma}+\frac{\alpha}{\alpha+\beta+\phi\gamma}+\frac{\phi\alpha}{\phi\alpha+\phi\beta+\gamma}\right),$$
$$\pi_2^{12}=\frac{\mu E^w}{\sigma K^w}\left(\frac{\beta}{\alpha+\beta+\phi\gamma}+\frac{\beta}{\alpha+\beta+\phi\gamma}+\frac{\phi\beta}{\phi\alpha+\phi\beta+\gamma}\right),$$
$$\pi_3^{12}=\frac{\mu E^w}{\sigma K^w}\left(\frac{\phi\gamma}{\alpha+\beta+\phi\gamma}+\frac{\phi\gamma}{\alpha+\beta+\phi\gamma}+\frac{\gamma}{\phi\alpha+\phi\beta+\gamma}\right) \quad (18)$$

then:

$$\pi_3^{12}-\pi_3^0=\frac{\mu E^w}{\sigma K^w}\left[\left(\frac{\phi\gamma}{\alpha+\beta+\phi\gamma}-\frac{\phi\gamma}{\alpha+\phi\beta+\phi\gamma}\right)+\left(\frac{\phi\gamma}{\alpha+\beta+\phi\gamma}-\frac{\phi\gamma}{\phi\alpha+\beta+\phi\gamma}\right)\right]<0 \quad (19)$$

Therefore, no matter how large the difference of labor prices is, there will be a definite decline in the operating profit of an industrial firm in Country 3 if Country 1 signs an FTA with Country 2. To be more specific, since neither Country 1 nor Country 2 has an FTA relationship with Country 3, the price index and customers' demand remain unchanged in Country 3. As a consequence, the decline of operating profit for the industrial firms in Country 3 derives exclusively from the other two countries. The drop of price indices both in Country 1 and Country 2 leads to a trade diversion, which indicates a decline in the demand for M goods produced in Country 3 from these two countries. This is exactly what contributes to the decline in the operating profit of an industrial firm in Country 3.

Case 3: 1-2 FTA & 1-3 FTA

In order to compensate for the loss brought by the FTA of Country 1 and Country 2, it is possible for Country 3 to sign an FTA with Country 1. We denote the operating profit of a firm in Country i by $\pi_i^{12\&13}$ $(i=1,2,3)$ in this case. Then we have:

$$\pi_1^{12\&13}=\frac{\mu E^w}{\sigma K^w}\left(\frac{\alpha}{\alpha+\beta+\gamma}+\frac{\alpha}{\alpha+\beta+\phi\gamma}+\frac{\alpha}{\alpha+\phi\beta+\gamma}\right),$$
$$\pi_2^{12\&13}=\frac{\mu E^w}{\sigma K^w}\left(\frac{\beta}{\alpha+\beta+\gamma}+\frac{\beta}{\alpha+\beta+\phi\gamma}+\frac{\phi\beta}{\alpha+\phi\beta+\gamma}\right),$$
$$\pi_3^{12\&13}=\frac{\mu E^w}{\sigma K^w}\left(\frac{\gamma}{\alpha+\beta+\gamma}+\frac{\phi\gamma}{\alpha+\beta+\phi\gamma}+\frac{\gamma}{\alpha+\phi\beta+\gamma}\right) \quad (20)$$

Case 4: 1-2 FTA & 2-3 FTA

By symmetry, Country 3 can also decide to sign an FTA with Country 2 to compensate for the loss. We denote the operating profit of a firm in Country i by $\pi_i^{12\&23}$ $(i=1,2,3)$ in this case. Thus we have:

$$\pi_1^{12\&23}=\frac{\mu E^w}{\sigma K^w}\left(\frac{\alpha}{\alpha+\beta+\phi\gamma}+\frac{\alpha}{\alpha+\beta+\gamma}+\frac{\phi\alpha}{\phi\alpha+\beta+\gamma}\right),$$
$$\pi_2^{12\&23}=\frac{\mu E^w}{\sigma K^w}\left(\frac{\beta}{\alpha+\beta+\phi\gamma}+\frac{\beta}{\alpha+\beta+\gamma}+\frac{\beta}{\phi\alpha+\beta+\gamma}\right),$$
$$\pi_3^{12\&23}=\frac{\mu E^w}{\sigma K^w}\left(\frac{\phi\gamma}{\alpha+\beta+\phi\gamma}+\frac{\gamma}{\alpha+\beta+\gamma}+\frac{\gamma}{\phi\alpha+\beta+\gamma}\right) \quad (21)$$

Case 5: Global Free Trade

Global free trade impliesno bilateral trade costs exist in this case. Then the operating profit of a firm in Country i can be expressed as π_i^{123} $(i=1,2,3)$. Thus we have:

$$\pi_1^{123}=\frac{\mu E^w}{\sigma K^w}\frac{3\alpha}{\alpha+\beta+\gamma},\ \pi_2^{123}=\frac{\mu E^w}{\sigma K^w}\frac{3\beta}{\alpha+\beta+\gamma},\ \pi_3^{123}=\frac{\mu E^w}{\sigma K^w}\frac{3\gamma}{\alpha+\beta+\gamma} \quad (22)$$

After the FTA shock from Country 1 and Country 2, if Country 3 has an intention to sign a new FTA with either one of the other two countries, it is necessary to make a decision to choose the potential FTA partner due to thelabor price in Country1being different from that in Country 2. The operating profits of industrial firms are described in Case 3 when Country 3 establishes an FTA relationship with Country 1, while Case 4 describes the establishment with Country 2. Comparing the operating profit of an industrial firm located in Country 3 in Case 3 and Case 4, we obtain:

$$\pi_3^{12\&13} - \pi_3^{12\&23} = \frac{\mu E^w}{\sigma K^w} \frac{\gamma(1-\phi)(\beta-\alpha)}{(\alpha+\phi\beta+\gamma)(\phi\alpha+\beta+\gamma)} > 0 \quad (23)$$

From the result $\pi_3^{12\&13} > \pi_3^{12\&23}$, it is more beneficial for Country 3 to choose theFTA partner with a relatively higher labor price: Country 1. Specifically, due to structural symmetry, signing an FTA with either Country 1 or Country 2, total change in sales to these two countries of an industrial firm in Country 3 would share the equivalence.Furthermore, since the higher labor price in Country 1 leads to higher prices of its industrial varieties, then more iceberg trade costs would be eliminated after the establishment of the FTA between Country 1 and Country 3. Thus Country 3 would obtain a lower perfect price index of industrial goods. The greater the fall in the price index, the higher the level of sales an industrial firm will make to local consumers in Country 3. To sum up all the effects, comparatively Country 1 is the optimal potential FTA partner for Country 3 in the short run.

Since Baldwin and Jaimovich (2012) made the assumption in their analysis that labor prices are equalized in each country, after an FTA shock from Country 1 and Country 2, Country 3 definitely has an incentive to sign an FTA with a country in order to compensate for the loss that shock brings. However, in this paper labor prices are assumed to be different, unless the following condition is satisifed:

$$\pi_3^{12\&13} - \pi_3^{12} > 0, \pi_1^{12\&13} - \pi_1^{12} > 0 \quad (24)$$

namely:

$$(\alpha+\beta)(\alpha+\phi\beta+\gamma)(\phi\alpha+\phi\beta+\gamma) - \alpha(\alpha+\beta+\gamma)(\alpha+\beta+\phi\gamma) > 0,$$
$$(\phi\beta+\gamma)(\alpha+\beta+\gamma)(\alpha+\beta+\phi\gamma) - \gamma(\alpha+\phi\beta+\gamma)(\phi\alpha+\phi\beta+\gamma) > 0 \quad (25)$$

Country 3 will establish an FTA with Country 1 after the FTA shock from Country 1 and Country 2. It proves that the existence of the contagion effect of FTAs is conditioned on the specific differences of labor prices. This result can be deemed as a key feature of the contagion effect of FTAs generated from our model with different labor prices.

From the analysis above, if Country 3 intends to sign a new FTA after the FTA shock from Country 1 and Country 2, the first potential FTA partner would be Country 1. Based on the new FTA between Country 3 and Country 1, Country 3 may seek to lower its perfect price index further by signing another new FTA with Country 2, namely the global free trade. Therefore we must take into account the condition for the establishment of the FTA between Country 2 and Country 3. It is easy to note that when the condition:

$$\pi_2^{123} - \pi_2^{12\&13} > 0, \ \pi_3^{123} - \pi_3^{12\&13} > 0 \quad (26)$$

namely:

$$\alpha^2 + \alpha\beta + \beta\gamma + \phi\alpha\gamma + \phi\gamma^2 - \phi\beta\gamma - \gamma^2 > 0,$$
$$\alpha^2 + \alpha\gamma + \beta\gamma + \phi\alpha\beta + \phi\beta^2 - \phi\beta\gamma - \beta^2 > 0 \quad (27)$$

is satisfied. Country 2 and Country 3 have an incentive to form an FTA. We have the trade freeness $\phi = 1$ when global free trade is achieved.

3.2 Long-run Effect

Unlike the case in the short run, capital is allowed to move in search of the highest reward internationally in the long run. It means that industrial firms relocate their production for the highest operating profit until a stable equilibrium is achieved, in which each firm in the world obtains the equalized profit (i.e. the nominal reward of one unit of capital). As a consequence, the operating profit of an industrial firm used in the short-run analysis is no longer an effective indicator in measuring the welfare level of a country. We turn to the indirect utility function of consumers, V_i $(i = 1,2,3)$ to reflect the long-run welfare level, that is:

$$V_i = \frac{E_i}{P_i};\ P_i \equiv (\Delta_i n^w)^{-a};\ \Delta_i \equiv (\int_{j=0}^{n^w} p_j^{1-\sigma} dj) / \mathrm{n}^w,\ a \equiv \mu/(\sigma - 1) \tag{28}$$

where the indirect utility V_i of a country depends on its market size E_i and perfect price index P_i. The assumption of symmetric market sizes is retained. Therefore we focus on the perfect price index in the following part, where $P_i \equiv p_{Ai}^{1-\mu}(\Delta_i n^w)^{-a} = (\Delta_i n^w)^{-a}$. It depends merely on industrial varieties, because the A goods is assumed to be numeraire. Besides, we assume that capital in the world won't flow to one country alone in reaction to the initial FTA shock emanating from Country 1 and Country 2. Clearly from the long-run analysis in the two-country model above, the agglomeration of capital occurs when the trade freeness ϕ reaches a critical level, which is dependent on the specific labor price of each country. Thus our restrictions on the trade freeness are as follows:

$$\begin{aligned}
&(\mathrm{i})\ \phi < b/c, \text{ when } c > a > b \text{ (i.e. } w_3 > w_1 > w_2) \\
&(\mathrm{ii})\ \phi < b/a, \text{ when } a > c > b \text{ (i.e. } w_1 > w_3 > w_2) \\
&(\mathrm{iii})\ \phi < c/a, \text{ when } a > b > c \text{ (i.e. } w_1 > w_2 > w_3)
\end{aligned} \tag{29}$$

Next we work out the perfect price index in each country under different FTA relationships, i.e. the four cases listed as follows. Then the impact of different labor prices on the contagion effect of FTAs in the long term are examined through the comparisons of indirect utilities in different cases.

Case 1: 1-2 FTA

If no countries sign FTAs with Country 3 after a shock to the complete economy, i.e. the initial FTA between Country 1 and Country 2, then these two countries will always be faced with the same external tariff in the long run. No matter where an industrial firm relocates its production, Country 1 has the same price index as Country 2. Furthermore, since the labor price in Country 1 is higher than Country 2, no industrial firms locate to Country 1, i.e. $s_{n1} = 0$. Consequently the perfect price index and average industrial price index in Country 3 can be obtained as:

$$P_3^{12} = (\Delta_3^{12} n^w)^{-a},\ \Delta_3^{12} = \phi\beta s_{n2} + \gamma s_{n3} \tag{30}$$

where $s_{n2}, s_{n3} \in (0,1)$. Since capital is assumed not to concentrate to one country alone after the FTA shock, either Country 2 or Country 3 undertakes a certain part of industrial production.

Case 2: 1-2 FTA & 1-3 FTA

After Country 1 signs FTAs with the other two countries respectively, the relative differences in labor prices among these countries have a direct influence on the distribution of industrial firms in the long run, while the average industrial price index of Country 3 depends on the industrial distribution. In this case no industrial firms would relocate their production to the country with the highest labor price. Thus the perfect price index of Country 3 can be expressed as:

$$P_3^{12\&13} = (\Delta_3^{12\&13} n^w)^{-a} \tag{31}$$

where:

$$\begin{aligned}
&(\mathrm{i})\ \Delta_3^{12\&13} = \alpha s_{n1} + \phi\beta s_{n2}, \text{ when } w_3 > w_1 > w_2\ (s_{n3} = 0) \\
&(\mathrm{ii})\ \Delta_3^{12\&13} = \phi\beta s_{n2} + \gamma s_{n3}, \text{ when } w_1 > w_3 > w_2\ (s_{n1} = 0) \\
&(\mathrm{iii})\ \Delta_3^{12\&13} = \phi\beta s_{n2} + \gamma s_{n3}, \text{ when } w_1 > w_2 > w_3\ (s_{n1} = 0)
\end{aligned} \tag{32}$$

Case 3: 1-2 FTA & 2-3 FTA

After Country 2 signs FTAs with the other two countries respectively, we could also conclude that no industrial firms relocate to the country with the highest labor price in the long run. Due to $w_1 > w_2$,

capital agglomeration may occur in the country with the lowest labor price. Thus the long-run price index of Country 3 can be expressed as:

$$P_3^{12\&23} = (\Delta_3^{12\&23} n^w)^{-a} \tag{33}$$

where:

$$\begin{aligned} &(\text{i})\ \Delta_3^{12\&23} = \beta, \text{ when } w_3 > w_1 > w_2\ (s_{n1} = s_{n3} = 0) \\ &(\text{ii})\ \Delta_3^{12\&23} = \beta, \text{ when } w_1 > w_3 > w_2\ (s_{n1} = s_{n3} = 0) \\ &(\text{iii})\ \Delta_3^{12\&23} = \beta s_{n2} + \gamma s_{n3}, \text{ when } w_1 > w_2 > w_3\ (s_{n1} = 0) \end{aligned} \tag{34}$$

Case 4: Global Free Trade

No trade costs exist in the world under this circumstance, so it is evident to note that capital would flow to the country with the lowest labor price in the long run. Specifically the price index of Country 3 is obtained as:

$$P_3^{123} = (\Delta_3^{123} n^w)^{-a} \tag{35}$$

where:

$$\begin{aligned} &(\text{i})\ \Delta_3^{123} = \beta, \text{ when } w_3 > w_1 > w_2\ (s_{n1} = s_{n3} = 0) \\ &(\text{ii})\ \Delta_3^{123} = \beta, \text{ when } w_1 > w_3 > w_2\ (s_{n1} = s_{n3} = 0) \\ &(\text{iii})\ \Delta_3^{123} = \gamma, \text{ when } w_1 > w_2 > w_3\ (s_{n1} = s_{n2} = 0) \end{aligned} \tag{36}$$

From the calculation above, the long-run price indices of Country 3 are obtained under different FTA relationships. To specify how different labor prices affect the decision of Country 3 to choose a potential FTA partner, cases are summarized as follows:

(i) $w_3 > w_1 > w_2$

$$V_3^{123} = V_3^{12\&23} > V_3^{12},\ V_3^{12\&23} > V_3^{12\&13}$$

(ii) $w_1 > w_3 > w_2$

$$V_3^{123} = V_3^{12\&23} > V_3^{12},\ V_3^{12\&23} > V_3^{12\&13}$$

(iii) $w_1 > w_2 > w_3$

$$V_3^{123} > V_3^{12\&13} > V_3^{12},\ V_3^{123} > V_3^{12\&23} > V_3^{12} \tag{37}$$

Clearly in the first two situations of different labor prices above, after the FTA shock from Country 1 and Country 2 it is beneficial for Country 3 to choose Country 2 as the potential FTA partner, and the effect global free trade brings to Country 3 is equal to that of the FTA signed by Country 2 and Country 3. Specifically, since capital mobility in the long run and the difference of labor prices are assumed, capital reward in Country 2 is no less than Country 1, which makes Country 2 the first priority in the list of Country 3's potential FTA partners. Let us focus on the third situation, i.e. $w_1 > w_2 > w_3$. No doubt global free trade is most beneficial for Country 3. In Case 2 (namely 1-2 FTA & 1-3 FTA), the international trade is frictionless between Country 1 and the other two countries. While in Case 3 (namely 1-2 FTA & 2-3 FTA), Country 1 must take account of trade cost when industrial varieties are circulated with Country 3. Note that Country 1 merely acts as the importing country in these two cases due to its highest labor price among the three countries. Thereby compared to Case 2, Country 1's demand for industrial varieties produced in Country 3 decreases in Case 3, which consequently increases the demand for varieties from Country 2. Besides, the elimination of trade costs between Country 2 and Country 3 pushes their reciprocal demands. Therefore, we're unable to compare the indirect utilities, $V_3^{12\&13}$ and $V_3^{12\&23}$ in this situation. Thus if Country 3 has the lowest labor price it is uncertain to decide on which country as its potential FTA partner.

In summary, from the analysis above the contagion effect of FTAs does exist in the long run. Global free trade is most beneficial to Country 3 after the FTA shock from Country 1 and Country 2 whatever the

differences of labor prices. If free trade is not achieved due to any external factor, unless Country 3 has the lowest labor price it is more advantageous for Country 3 to establish an FTA relationship with Country 2 in the long run, exactly contrary to the short-run analysis of the contagion effect of FTAs.

4 Concluding Remarks

In a simple two-country footloose-capital model with different labor prices, a higher labor price leads directly to higher prices of industrial varieties. Different trade costs have an impact on the relocation of firms and the breaking point where agglomeration of capital occurs is dependent on the labor prices of both countries.

When different labor prices are considered, the existence of the contagion effect of FTAs is conditioned in the short run.Besides, it is more beneficial for a third country faced with an FTA shock to choose the first FTA partner with a relatively higher labor price in the shortterm if a certain condition is satisfied. Nevertheless, the contagion effect of FTAs does exist in the long run. Unless the thirdcountry has the lowest labor price it is more advantageous to choose the partner with a lower labor price if global free trade is not achieved.

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