Taiwan's trading arrangements and industrial location

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Abstract

A New Economic Geography model is used to assess the impacts of trading arrangements on industrial development in Taiwan, a small economy. Addressing a trading system with three regions—the small economy, the large economy (referring to mainland China), and the global market—the simulation results show that, without reducing the trade costs between the small economy and the global market and if the small and the large economy are integrated, the small economy will become a deindustrialized periphery. In contrast, if the trade costs between the small economy and the global market are reduced low enough—either by the small economy's adopting a global-market priority trading arrangement or by its serving as a hub—agglomeration of industry takes place in the small economy.

Keywords: Trade costs, Agglomeration, Cross-Strait trade liberalization

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1. Introduction

China’s size in terms of population and its increased openness since the late 1970s have given rise to competitive pressures in other developing countries in the neighborhood. Some have argued that the Asian crisis of 1997-98 was at least partly due to increasing competition from China’s economic might. In the face of China’s emergence as an economic power, countries and regions nearby have adopted different polices. For instance, the Association of Southeast Asian Nations (ASEAN) signed the Free Trade Agreement (FTA) with China, the enforcement of which began at the beginning of 2010. Hong Kong has entered into the proceeding of the Comprehensive Economic Cooperation Agreement (CEPA) with China since 2004 due to political arrangement. As a hub of international trade for centuries, Singapore swiftly engaged in planning for and forging a vast array of FTAs to sustain its role as a hub. Since the signing of the first FTA under the ASEAN Free Trade Area (AFTA) in 1993, Singapore's network of FTAs has expanded to cover 18 regional and bilateral FTAs with 24 trading partners as of May 2010, including the U.S., China, and Japan. South Korea’s (Korea) government has long endeavored to globalize Korea’s brands, and now Samsung, Hyundai and LG are among the top 100 global brands. Korea has also signed FTAs with the U.S., the EU, ASEAN, Singapore, and other entities. However, its FTA with China is still in progress.

How to construct the relationship between Taiwan and China has been a subject of intense debate in Taiwan, and different political parties have pursued different policies and guidelines when they were in office; for example, the current government inclines toward releasing all trade and investment restrictions as they relate to China. However, the best policy for Taiwan as it confronts giant China has not yet been determined. Which is the best model with which Taiwan can sustain its economic growth: that of Hong Kong, Singapore, or Korea, or perhaps continuing the trade and investment restrictions between Taiwan and China? This paper examines the impacts on Taiwan's economy of different policies related to trade relationships with China.

The ease of factor movement between Taiwan and China is a distinguishing characteristic as compared with other inter-country relationships. China has been a major destination of Taiwan's foreign direct investment (FDI) as FDI to China accounted for over 60% of Taiwan's total FDI in the past decade and 9.86% of Taiwan's domestic investment in 2009. The accumulated investment in China from Taiwan has been estimated to have reached around 45.8 billion U.S dollar as of 2007 as reported by China's Ministry of Commerce, higher than the 38.8 billion from Korea, and the 33.4 billion from Singapore. Currently, one to two million Taiwanese, or 5-10% of Taiwan's population, are regularly working or living in China, most of them accompanying firms' reestablishment or investment in China.

Given Taiwan's heavy investment in and involvement with China, a new economic geography (NEG) model can help to analyze the impact of changing trade costs between Taiwan and China. NEG models assume that firms and entrepreneurs have free mobility across different locations, which is consistent with the ease of movement across the Taiwan Straits and is appropriate for describing interregional trade relationships. Furthermore, the links between firms through the input-output structure (one of the major features of the manufacturing sector) and the resulting cumulative causation mechanism that is assumed in some NEG models can be used to characterize Taiwan and China's industrial development since manufacturing is still an important sector for both economies.

The major differences between China and Taiwan lie in their economic scales and average standard of living. Generally speaking, per-capita GDP and average standard of living imply the gap of factor productivity among countries. However, skilled workers and entrepreneur can move almost freely from Taiwan to China, so the initial productivity gap between the two economies is ignored in this paper. Consequently, the difference in labor endowment and the ensuing differential in labor costs are major element to be considered when analyzing the impacts of trade policy experiments on Taiwan and China. That makes the model in the present paper a NEG model associated with home market effect. Moreover, since Taiwan and China have already integrated into the global trading system, trading relationships with the rest of the world will affect Taiwan's economy as well. Therefore, a third region is introduced in the trading system in the model, representing the chief trading partners of Taiwan and China.

To capture the asymmetries and global trading relationship of Taiwan and China , the paper proposes some key modifications to Krugman and Venables (1995) to address the effects of changing trade costs among Taiwan, China, and the global market. Abandoning the assumption of two identical economies, the paper considers a large economy with a horizontal supply curve, a small economy with a vertical supply curve, and the third region as a global consumption market of manufactured goods without the manufacturing sector. The assumption associated with the global market is that the chief trading partners of Taiwan and China are advanced countries with higher per-capita GDP that do not have competitive advantage in producing manufactured goods.

There are many literatures using a three-country or -region setting to address how changes in trade costs affects regional developments. The framework of the present model is similar to that of Puga and Venables(1997) and (1998). However, in both models, countries are assumed to be of equal size. The Puga and Venables (1997) analysis started from very high trade barriers among all countries, each with self-sufficient, domestically oriented production in its manufacturing sector. An initially symmetric equilibrium exists where all countries have the same number of firms. By contrast, Puga and Venables (1998) assumed an initial equilibrium in which manufacturing is concentrated in some region, labeled North, and the two countries with no industry are labeled South. The policy implications are different in three ways between our model and Puga and Venables'.

First, according to Puga and Venables(1997) and (1998) and at low enough trade barriers between countries, the country lagging behind in industrial development starts reattracting firms because of its increasingly good access to the more advanced country and its low labor costs, despite having a smaller local base of suppliers. However, in contrast to in their model, the relationship between reductions in trade costs and agglomeration is monotonic in our model so that the reindustrialization will not occur in a small country, such as Taiwan.

Second, Puga and Venables (1998) suggested a North-South preferential trade agreement (PTA) that is favorable to the liberalizing southern economy compared to the other southern economy. There will be a large share of industry spreading to the southern economy that gives this economy higher real wages. In our model, the favorable outcome of a North-South PTA arrangement for the liberalizing southern economy, such as Taiwan, depends on whether the level of trade barriers between the two South economies, that is, Taiwan and China, is high enough, or whether Taiwan can successfully transforms itself as a hub with high trade efficiency.

Third, in Puga and Venables (1998), for both southern economies multilateral liberalization among all countries is more beneficial than the North acting as a hub—which forms a bilateral PTA with each of the southern economies, but the barriers between the southern economies remain unchanged, since under multilateral liberalization the first industrialized southern country get a larger share of industry and the backward southern one become industrialized earlier than under other arrangements. However, since the wages in Taiwan will not be less than those in China, the spread of industry to Taiwan will not arise under multilateral liberalization, and a high trade barrier between Taiwan and China is more favorable to Taiwan in our model. All the differences in the effects of trade policies between ours and Puga and Venables (1998) are mainly brought about by the assumption related to the size of the two developing countries.

There are some NEG literatures with three regions or countries considering the home market effect (HME) as the present model, e.g. Suedekum(2007) and Behrens, Lamorgese, Ottaviano, Tabuchi (2009). However, their models did not introduce the effects of linkages between manufacturing firms or migration-induced demand linkages. Baldwin et al. (2003) and Forslid (2004) assumed three regions with different shares of world factor endowments and combined the HME with mobile physical capital to create agglomeration of industry in the region with the largest endowment as trade costs are gradually reduced, even omitting the expenditure shifting associated with capital movement and supply link stemming from a lower price index. However, to conform to Taiwan's trading environment, including both the agglomeration forces and asymmetric pattern of three regions in a model is important, since these factors may result in different welfare effects of preferential trade agreement.[2] That is what we are doing in the present model contrasted with those of Baldwin et. al. (2003) and Forslid (2004).

As a matter of fact, the relationship across Straits can be described as that of two domestic regions because of the ease of factor movement between Taiwan and China. Some literatures, for instance, Krugman and Livas Elizondo (1996) Crozet and Soubeyran (2004), Brulhart, Crozet, and Koenig (2004) addressed the impacts of trade liberalization on the internal geography within a country in a two-country, three-region framework, i.e., two domestic regions with mobile labor force in between and one foreign country with fixed labor endowment. However, the synchronized trade policy for the two domestic regions referred in those papers seems not the issue for Taiwan and China at the present moment. Besides, in the three-region and

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[2] For instance, in Baldwin et. al (2003)'s footloose capital model, all members in the preferential trade agreement gain from any level of preferential liberalization. However, Puga and Venables(1997) find a counterexample to this result in a different model with vertical linkages among firms, which has much stronger agglomeration forces.

two-country models mentioned above, the agglomeration force results from labor’s mobility between regions, instead of firms buying goods from each other as intermediate inputs. It is worth noting that the input-output linkages between firms is more appropriate to the case of Taiwan and China, since most interregional migration from Taiwan to China, mainly done by skilled works or entrepreneurs, comes along with the flow of FDI to China by the Taiwanese firms, and that will create a circular causality to produce agglomeration of manufacturing firms in a single location.

Therefore, this paper contributes to the literature in two respects. First, the exogenous asymmetric framework, based on the essential distinction among Taiwan, China, and the global import market, has not previously been considered in the NEG model, and it allows us to make a policy assessment pertaining to a small economy with footloose factor movement toward an extremely large economy. Furthermore, this framework results in different evaluations of many trade policies rather than being limited to those offered by literature. The most significant difference is that suggested by the next point. In the present paper, the relationship between integration and industrial location is monotonic, that is, falls in trade costs between two regions only cause deindustrialization in the small region and no relocation of production will occur from core to periphery. However, in standard NEG models considering regions ex-ante identical, for instance, Krugman and Venable (1995), Puga and Venables

(1997), (1998), and Puga (1999), that relationship is non-monotonic under the same assumptions of footloose entrepreneurship and labor immobility. Thus, whether reducing trade barriers with trading partners is beneficial to a country as a whole depends on current level of trade costs, and that it is difficult for policy makers to apply the implication derived from the standard NEG models. In contrast, the present paper indicates the explicit consequence of reductions in trade barriers between two regions with extreme asymmetry in population.

In this paper, several policy experiments are carried out to analyze the impacts of different trading arrangements on industrial location, Taiwan's equilibrium wage and manufacturing employment. Since there are still some ongoing artificial trade restrictions between Taiwan and China, the policy experiments include, first, continuously maintaining high trade barriers between Taiwan and China; second, eliminating the former trade barriers; third, a global-market priority trading arrangement; and, fourth, Taiwan's serving as a hub with good access to other markets. The simulation results show that the last two experiments, which are similar to the modes adopted by Korea and Singapore, respectively, can bring about an increase in wage and manufacturing employment in Taiwan. However, eliminating the trade barriers between Taiwan and China alone, without reducing Taiwan's trade costs with other regions, results in higher unemployment in Taiwan.

Additionally, China's labor costs along the coastal area have been rising recently due to the clustering of industry and certain policies implemented by the Chinese government, such as the Employment Contract Law, and the appreciation of China's Yuan since 2005. The scenario corresponding to rising labor costs in China is also considered and several simulations about the impacts of the higher wage in China on a firm's locational decision under various trade costs are conducted.

The remaining sections are organized as follows: Section 2 introduces the evolution of Taiwan's trade policies with respect to China and Taiwan's economic changes coupled with these trade polices. Section 3 introduces the model, its assumptions, and parameters. Section 4 lays out the policy experiments and discusses the simulation results. Section 5 investigates the impacts of rising wages in China on firms' locational decision across Straits. Section 6 concludes.

2. Background

The simulations conducted in the paper are related to the cross-strait policies undertaken by Taiwan's government. To provide a background, the evolution of policies is reviewed here and divided into five periods which are 1949-1977, 1978-1996, 1997-2000, 2001-2008, and after 2008.

During1949-1977, Taiwan and China armed against each other and stayed far apart with hardly any investment and trade exchanges due to government's restrictions. Taiwan's average annual economic GDP growth rate is 9.08% during 1951-1977, and unemployment rate had been declining from 4.52% to 1.76% over the same period.

During the period 1978-1996, the trade and investment interaction across the Straits had been increasing associated with gradually opening policies. China's economic reform began in 1978 and Chinese economy has become increasingly open since then. In 1985, Taiwan's government released the transshipment trade between Taiwan and China. Trade restrictions across Straits were gradually lifted in the following years, albeit mostly through the intermediary trading hub of Hong Kong. In 1987, Taiwan people were allowed to pay family visits to the mainland China. Many Taiwanese tried to find investment chances while visiting mainland China. In 1990, introducing the regulation of a 'positive list' of permissible investment items, Taiwan allowed indirect investment to mainland China made by its firms, while from 1993 onwards, Taiwanese firms could directly invest in China after permitted by Taiwan's government.

In the meantime, Taiwan amassed a substantial accumulation of foreign exchange reserves from a significant trade surplus during the 1980s, and that lead to a significant upward pressure on the new Taiwan dollar ($NT) in the currency market.

However, the appreciation of $NT, and the increase in costs of land and labors that went along with the higher $NT value all made Taiwan's labor-intensive industry try to transfer its production to a cheaper place. In addition, after the occurrence of Tiananmen Square protests of 1989, China set up many policies to encourage investment from Taiwan's firms so as to make up less FDI from other countries. As a result of all the preceding political and economic factors arisen during 1978-1996, investment made by Taiwanese firms in China increased significantly, and the flow of trade across Straits expanded swiftly during the 1990s. China had become an important export market of machinery and raw materials and an important import source of semi-finished product for Taiwan's economy, and ranked as Taiwan's third largest trade partner in 1996. Until 1996, Taiwan's accumulated actual FDI to China was US$15.06 billion according to China's official statistics and took the second place among all countries', ranking only behind Hong Kong.

However, Taiwan's share of the U.S. import market declined from 5.14% in 1989 to 3.15 in 1997, while China's share increased from 2.53% to 7.19% over the same period. The average annual economic growth rate and unemployment rate during 1978-1996 was 7.71% and 1.88%, respectively.

Although growth momentum sustained for Taiwan's economy during 1978-1996, the speed and scale of cross-strait exchanges and competition from China in global import markets arose the attention of Taiwan's government. Thus, a "no haste, be patient" policy began to be implemented in July 1997. Restrictions on investments made by Taiwanese firms to China include strategic high-tech sectors (e.g. semiconductors) and infrastructure projects, and a US$ 50 million ceiling on any investment project to China. There were also upper limits on accumulated amount invested in China for Taiwan's companies ranged over 20-40% of equity according to the size of an enterprise. Official statistics on both sides of the Strait illustrated the expansion of Taiwanese FDI to China had slowed down. However, there were evidences suggested that many Taiwanese firms made investment to China through a third place, such as British Virgin Islands and Cayman Islands, to avoid government's regulations. Generally speaking, the "no haste, be patient" policy effectively controlled the investment to China made by big enterprise and the companies with stock went public. Consequently, some industries, e.g. semiconductors, petrochemicals, and steel, with important contributions to Taiwan's industrial production nowadays, were well developed. During the enforcement period of the cautionary policy, 1997-2000, the average annual economic growth rate was 5.18% and unemployment rate was 2.8%.

In 2000, Taiwan's ruling party switched and the cross-Strait economic policies had been adjusted toward the direction of "proactive liberalization with effective management" in 2001 due to the negative economic growth rate of -1.65% in that year and firms' active appealing to lift the restrictions set by the former administration. Hence, FDI made to China had been largely released and Taiwan's government removed the bans on more than 1,800 items of industrial goods to investment in China, including many important information and communication products which still accounted for a large part of Taiwan's industrial production at that time. The US$ 50 million ceiling on individual investment project to China had been cancelled and the $NT 60 million limit on accumulated investment made by person or small and medium-sized enterprises to China had been lifted to NT $80 million.

Consequently, Taiwan's FDI to China had increased form an annual average of US$ 1.71 billion between 1991 and 2000 to an average of US$ 8.02 billion per year between 2001 and 2010 and that as a percentage to Taiwan's domestic capital formation rose from 4.05% to 15.6% over the period 2001-2010. However, after the new policy implemented in 2001, Taiwan's domestic investment as a proportion to GDP notably declined. The average investment rates in Taiwan is 25.17% during the period 1997-2000 and 21.07% during the period 2001-2008, compared to 30.44% and 29.75%, respectively, in South Korea over the same periods. In addition, Taiwan's outward investment in China brought about an agglomeration effect due to the fact that the investment and production of Taiwanese downstream industries located in

China induced the investments by upstream industries succeeded to reduce the transportation costs of intermediate inputs. Taiwan's FDI to China was originally concentrated on labor-intensive industries, but progressively switched to relatively capital and skilled-labor intensive industries afterward. Therefore, according to a report conducted by the Statistical Office of Ministry of Economic Affairs, Taiwan, the ratio of the components, and semi-finished products used by Taiwanese firms' in China and imported from Taiwan declined by 14.41 %, from 53.72% in 1996 to 39.31% in 2006.

As illustrated in some economic statistics, Taiwanese economic performances had been deteriorating. The average unemployment in Taiwan increased from 2.8% during 1997-2000 to 4.41% during 2001-2008. The growth in real average wages in Taiwan's industry and services has been declining quickly; the average annual growth rate during 1980s was 7.51%, that of the 1990s was 3.12%, and during 2000-2008 the annual growth rate has been negative, that is -0.23%. The income equality in Taiwan has been expanding, suggested by the ratio of income share of highest 20% to that of lowest 20% rising sequentially from 4.17 in 1980, 5.18 in 1990, 5.55 in 2000 to 6.05 in 2008.

To avoid excessively economic dependence on China, Taiwan's mainland policy guideline was adjusted to "proactive management and effective liberalization" in 2006.

The Taiwanese government newly stipulated “Directions Governing Policy Review and Coordination for Major China-bound Investment Projects”, which defined major investments, the review procedures and items for major investment projects, investor coordination items, and due investor commitments. However, the enforcement period of the new policy is short and its effects can hardly be evaluated since Taiwan’s ruling party changed in 2008.

The new government in Taiwan adjusted cross-strait economic and trade policies progressively toward liberalization and easing the present restrictions. For instance, the upper limits on accumulated amount invested in China for Taiwan’s companies were lifted to 60% of equity (the former limits ranged over 20 to 40%). However, firms establishing headquarter or being the subsidiary of global enterprise in Taiwan can be exempted from the 60% upper limit. Direct cross-strait flights and transportation began in Dec. 15, 2008. Memorandum of Understanding (MOU) on financial regulation and supervision with China effected in Jan. 16, 2010 mutually opened up banks of both areas to set up new branches in the other. The restrictions on investment in China by major industries in Taiwan, including wafer foundries, assembly, TFT-LCD panel, etc., has been released further. Moreover, the Taiwanese government plans to sign Cross-strait Economic Cooperation Framework Agreement (ECFA) regarding trade liberalization between China and Taiwan in 2010.

3. Model

In this section we set up the formal model, which is based on that of Krugman and Venables (1995). Here we consider a trading system with three regions: a large economy, a small economy and the global market. The small economy is endowed with fixed units of labor, while the large economy is endowed with infinitive units of labor, so that the wage in the small one is variable but that in the large one always remains constant. Both the small and the large economies contain two sectors, agriculture and manufacturing. Workers are mobile between the two sectors within an economy, but cannot move across geographical regions. However, firms are movable between the two economies. The global market with the expenditure of E_0 is treated as a consumption market of industrial goods without the manufacturing sector, importing manufactured goods from the other two regions. And that, manufactured goods sold outside the producing regions incur iceberg trade costs.

The representative consumer in each economy receives only labor income, and has Cobb-Douglas preferences over agriculture and a CES aggregate of the manufactured goods. The preferences can be represented by an expenditure function $\Omega_a^{1-\upsilon}\Omega_m^{\upsilon}V$, in which V is utility, Ω_a is the price of agriculture, and Ω_m is the price index for manufactures, and υ is the share of manufactures in consumer's expenditure. The small economy is endowed with L units of labor, with wage rate w. The budget constraint takes the form,

$$wL = \Omega_a^{1-\upsilon} \Omega_m^{\upsilon} V$$

The agricultural sector is perfectly competitive and uses only labor with constant returns to scale technology. Let agriculture be costlessly tradable and serves as numeraire ($\Omega_a = 1$). We assume one unit of labor produces one unit of agricultural output, so that wage rate, w, equals one if the economy produces agriculture, and exceeds unity only when the economy specializes in the production of manufactured goods.

The manufacturing sector has imperfectly competitive firms, producing differentiated goods under increasing returns to scale. The CES manufacturing composite takes the form,

$$m = (\sum_{i=1}^{n} y_i^{\frac{\delta-1}{\delta}} + \sum_{j=1}^{n_1} (\frac{y_j}{t})^{\frac{\delta-1}{\delta}})^{\frac{\delta-1}{\delta}},$$

where n is the number of varieties produced in the small economy, and n_1 is that in the large economy. y_i and y_j denotes the quantities of variety i and j produced in the small and the large economy, respectively. The elasticity of demand for a single variety is δ, and it is given that $\delta > 1$. Manufactured goods imported from abroad incur iceberg trade costs at a rate of t. If a unit of manufactured goods is shipped from abroad, a proportion of $1/t$ arrives.

Following Krugman and Venables(1995), we assume that the manufactured good produced by each firm can be used both as intermediate input to other firms and consumption good for final consumer demand. As in Venables(1996), the production input is a Cobb-Douglas composite of labor and an aggregate of differentiated manufactured goods as intermediate inputs, and the latter with the share of θ. In equilibrium[3], each firm produces the same quantity of output and a firm in the small economy produces output of d for domestic sale, exports the quantity of x_1 to the large economy, and export the amount of x_0 to the global market. The production of $x_1 + x_0 + d$ for any variety requires the same fixed (a) and variable (b ($x_1 + x_0 + d$)) quantities of the production input. Each firm's total cost function is therefore

$$TC = w^{1-\theta}\Omega_m^{\theta}(a + b \cdot (x_1 + x_0 + d)) \tag{1}$$

In equilibrium, all firms in the small economy have the same profit maximizing FOB price, which is a constant relative mark-up over marginal cost,

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[3]If firms enter and exit in response to positive and negative profits, at equilibrium manufacturing sector profits will be exhausted in both economies. There is a unique level of output that gives firms zero profits, see (6).

(2) $$p = \frac{\delta}{\delta - 1} w^{1-\theta} \Omega_m^{\theta} b.$$

Since t units have to be shipped from the exporting region so that one unit arrives in the importing region. The CIF price of a good shipped to abroad is t times its FOB price, where $t \geq 1$. In this model, the trade costs between different pairs of regions are different. Let τ represents the rate of trade costs between the large and the small economy, ρ is that between the large economy and the global market, and ρ_c is that between the small economy and the global market.

The levels of demand from different locations for a single variety of product produced in the small economy, specified in equation (1), take the form,

(3) $$\begin{aligned} d &= p^{-\delta} \Omega_m^{\delta-1} E \\ x_1 &= p^{-\delta} \cdot \tau^{1-\delta} \cdot \Omega_{m,1}^{\delta-1} \cdot E_1 \\ x_0 &= p^{-\delta} \cdot \rho_c^{1-\delta} \cdot \Omega_{m,0}^{\delta-1} \cdot E_0 \end{aligned}$$

where E and E_1 are defined as the total value expenditure on manufactured goods in the small economy and the large economy, respectively, and $\Omega_{m,1}$, $\Omega_{m,0}$ are the price indexes of the composite manufactured good in the large economy and the global market, respectively. The price index for manufactured good in the small economy (Ω_m) is given by

(4) $$\Omega_m = (np^{1-\delta} + n_1 (p_1 \tau)^{1-\delta})^{1/(1-\delta)}$$

where p_1 represents the price of each variety produced in the large economy. Equation (4) suggests that Ω_m falls as the number of firms in each economy, n, n_1 increase, and rises as the prices of manufacturing in each economy, p, p_1 increase.

Next, the expenditure on manufactures in the small economy, E, takes the form,

(5) $$E = \upsilon \cdot w \cdot L + \theta \cdot (x_1 + x_0 + d) \cdot n \cdot p \,.$$ [4]

The first term on the right-hand side is consumers' expenditure on manufactures, and the second intermediate demand, amounting to fractions υ of income and θ of manufacturing costs, respectively.

If firms enter and exit the market freely, at equilibrium, there is a unique level that gives firms zero profits. Using $(x_1 + x_0 + d) \cdot p = TC$ and equation (1), (2), and (3), that unique size of firms can be established as,

(6) $$(x_1 + x_0 + d) \equiv p^{-\delta}(\tau^{1-\delta}\Omega_{m,1}^{\delta-1}E_1 + (\rho_c)^{1-\delta}\Omega_{m,0}^{\delta-1}E_0 + \Omega_m^{\delta-1}E) = \frac{(\delta-1)a}{b}$$

For simplicity, we choose units such that $\frac{(\delta-1)a}{b} = 1$, that is, the volume of sales of each firm, $x_1 + x_0 + d$, equals one.

Turning to the labor market, the wage rate, w, and employment in

[4] E is the expenditure in equilibrium.

manufacturing in the small economy is related to the value of output by the equation,

(7) $$w \cdot L_m = (1-\theta) \cdot n \cdot p \cdot (x_1 + x_0 + d)$$

where proportion $1-\theta$ of a firm's revenue is devoted to the wage bill, and L_m is the manufacturing employment in the small economy, $L_m \leq L$.

Equations similar to (2), (4), (5), (6), and (7) that portray the manufacturing equilibrium in the small economy, can be used to define the corresponding equilibrium in the large economy. However, note that the manufacturing wage rate in the large economy, w_1, is always constant and equals one, since its supply of labor is infinite. Therefore, the manufacturing employment in the large economy, $L_{m,1}$, is unlimited and determined by the firms' revenue. Hence, equation (7) can be rewritten as

$$w_1 \cdot L_{m,1} = (1-\theta) \cdot n_1 \cdot p_1 \cdot (x^* + x_0^* + d_1)\,,$$

where x^* denotes the export of manufactured goods from the large economy to the small economy, x_0^{**} is that from the large economy to the global market, and d_1 is the domestic demand within the large economy. By setting the same value of parameters as the small economy, the total sales for a representative firm in the large economy, $x^* + x_0^* + d_1$, also equals to one as well. Corresponding to equation (3), manufacturing expenditure in the large economy , E_1, takes the form

(8) $$E_1 = \upsilon \cdot w \cdot L_{m,1} + \theta \cdot (x^* + x_0^* + d_1) \cdot n_1 \cdot p_1$$

The more employment in manufacturing , $L_{m,1}$, is , the greater is the value of expenditure on manufactured goods in the large economy is. In addition, we assume that the total manufacturing expenditure in the global market, E_0 , is a constant.

We now have a system of equations (summarized in Appendix 1) that can be solved for any given manufacturing employment in the small economy, L_m . Given L_m , we can simultaneously determine n, p, w, Ω_m, E for the small economy, and $n_1, p_1, L_{m,1}, \Omega_{m,1}, E_1$ for the large economy. Note that the sets of endogenous variables to be solved are not identical for the small and the large economy. For the small economy, under fixed labor supply, the manufacturing wage rate is what needs to be determined, while for the large economy, with fixed wage rate, manufacturing employment is what to be decided. The allocation of sector employment in the small economy is regulated by the following adjustment:

(9) $$dL_m / dt = \alpha(w(L_m) - 1), \quad \alpha > 0 .$$

That is, if manufacturing wage rate is greater than agricultural wage rate (=1), workers will move from the agricultural sector to the manufacturing sector; if it is less than 1, workers will go in the opposite direction. Equation (9) determines whether the manufacturing sector in the small economy is expanding or shrinking.

Following Puga and Venables (1997), the present paper assumes four locational forces which together determine the equilibrium distribution of firms across locations: backward linkages, forward linkages, production, and labor market competition. When there are significant economies of scale, firms are inclined to choose only one site to serve each market, and a site that offers better backward and forward linkages makes it a more attractive place for firms to locate. In the present model, forward linkages come from the assumption that firms use the output of other firms as an input ($\theta>0$). A larger number and variety of locally produced goods, all else being equal, implies a lower price index for manufactured goods (Ω_m) and, therefore, lower total and marginal costs of production-equation (1). Backward linkages arise as an increase in the number of local firms raises local expenditures on intermediates-equation (5). While forward and backward linkages tend to increase the profitability of locations that have a larger number of firms, production and labor market competition tend to make firms located in markets with many firms less profitable, thereby encouraging the geographical dispersion of industry. Product market competition is stronger in locations where more varieties of goods are produced locally; the price index of industrial goods is lower-equation (4) so, for a given price and level of expenditure, local demand for each manufactured good is smaller-equation (3). Stronger labor market competition in industrialized regions appears in equation (7) if an economy becomes specialized in the manufacturing sector, since local wages will be higher, thus increasing costs.

Compared to a small economy, a large economy can host a larger industrial agglomeration of firms, reinforce greater backward and forward linkages between firms, and abate firms' competition in product and factor markets. Therefore, when trade costs between the large and the small economy fall below a critical point, the two economies will organize themselves into an industrialized core and a deindustrialized periphery, and the preceding status of core and periphery will remain even if trade costs fall to infinitesimal level. This consequence is different from the third stage of decreasing trade costs in Krugman and Venables (1995) since, in the present model, a further reduction of trade barriers will not make the small economy—the periphery region—attractive to firms since the endless supply of labor in the large economy always offers producers the advantage of a lower wage rate. Apart from changing trade costs between the small and the large economies, if the large economy adopts a trade liberalization policy instead of autarky, and lowers its trade costs with the global consumption market, the small economy that was once specialized in manufacturing will lose a great part of its industrial agglomeration of firms even without reducing its trade costs with the large economy. Because the large economy with an abundant labor endowment serves as a better producing center for the global market than the small one, most firms will choose to locate in the large economy.

The strategies for the small economy to sustain its industrial cluster may include perform as a hub of the global trading economy or enormously slashing its trade costs with the global consumption market so firms that are located in the small economy can still realize economies of scale without moving to the large economy. In the following section, several numerical simulations are conducted to investigate the impact of changing trade costs between the small and the large economy on equilibrium distribution of firms across locations, and the strategies for the small economy to sustain its specialization in the industrial sector.

4. Policy Experiments

Five policy scenarios are conducted in this section: (i) corresponds to the periods before China's integration into the world economy, and (ii)-(v) are trade policy experiments for Taiwan. In this section China and Taiwan represent the large and the small economy, respectively. Because of asymmetry in the three regions, we use a numerical method to derive the manufacturing equilibrium for the economy. (Values of parameters underlying the figures are given in the Appendix 2.)

4.1 Scenario (i) :Trade-policy environment for Taiwan before China's integration with the world

Before China's integration into the world economy, the bilateral trade barriers between China and the other two regions were enormous, particularly in contrast with Taiwan's low level of trade costs with the global market. Fig. 1a, drawn for parameters $\tau = 7.5$, $\rho = 5$, and $\rho_c = 2$, can be used to deduce the equilibrium manufacturing employment in the small economy in this scenario. In Fig. 1a, the length of the horizontal axis is L_m, the share of industrial employment in the small economy; the vertical axis is the wage w; the horizontal line at height unity represents the agricultural wage rate; and the light curve is the demand for labor in manufacturing or the maximum wage that firms in the small economy can pay. Since manufacturing wage is greater than agricultural wage for any amount of labor, workers keep moving out from the agricultural sector until all the labor force in the small economy is working in the manufacturing sector. The increase in the industrial employment in the small economy is brought about by the increase in the size of industry. Hence, when the large economy does not open trade with the world, the small economy, with increasing manufacturing wages and employment, turns into an industrial center providing manufactured goods to the global market.

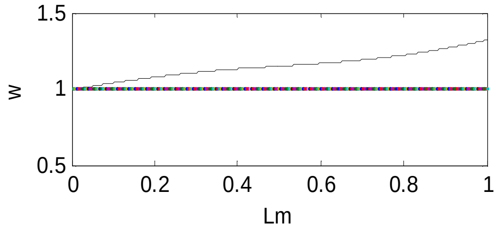

Figure 1a: τ=7.5, ρ=5, ρ_c=2

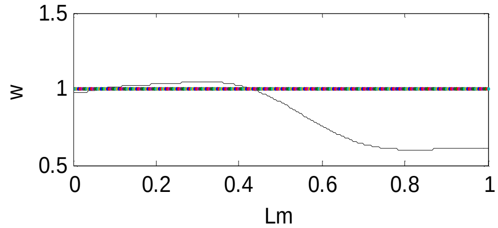

Figure 1b: τ=7.5, ρ=2, ρ_c=2

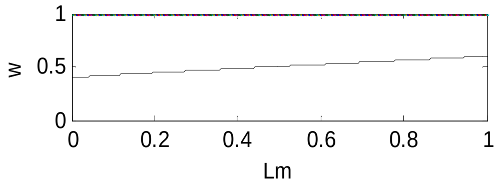

Figure 1c: τ=2, ρ=2, ρ_c=2

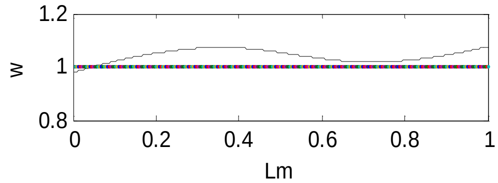

Figure 1d: τ=7.5, ρ=2, ρ_c=1.02

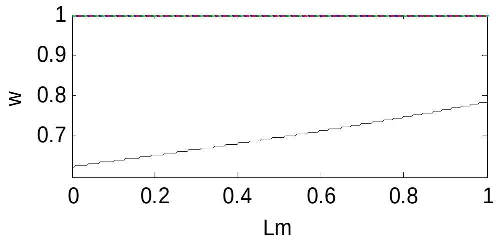

Figure 1e:τ=1.5, ρ=2, ρ_c=1.5

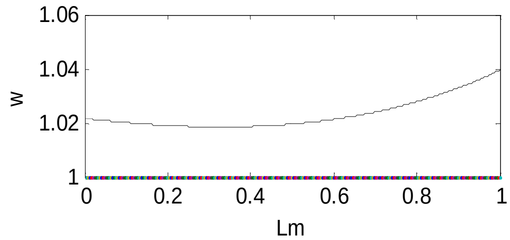

Figure 1f: τ=1.2, ρ=2, ρ_c=1.2

During this period, Taiwan implemented export-oriented policy, Taiwan's manufacturing sector kept expanding and there was a tremendous increases in trade surplus with the U.S.. The average annual economic growth rate is 9.08% during 1951-1977, and unemployment rate had been declining from 4.52% to 1.76% over the same period.

4.2 Scenario (ii): high trade barriers between Taiwan and China

Until 2010, there were still many artificial trade restrictions, other than tariffs, between Taiwan and China. However, both Taiwan and China implemented a relatively liberal trade policy toward the global market. This scenario considers what happens when high trade barriers between the large and the small economy are maintained as a trade policy experiment for Taiwan, and assesses its effects. When the parameters are given as $\tau = 7.5$, $\rho = 2$, and $\rho_c = 2$, Fig. 1b demonstrates the effects of this trade policy environment. There is an interior equilibrium where the slope of the manufacturing labor demand curve is negative, so that the equilibrium is stable. Compared to Fig. 1a, the equilibrium suggests a sharp decline in the manufacturing employment and a lower manufacturing wage, which becomes equal to the agricultural wage.[5] According to Taiwan's official statistics, Taiwan underwent continuously increasing unemployment rates, which rose from 1.51% in 1991 to 5.85% in 2009. The growth in real average wages in Taiwan's industry and services has been declining quickly, as the average annual growth rate of wages during the1980s was 7.51%, that of the 1990s was 3.12%, and during 2000-2008 the annual growth rate has been -0.23%. Moreover, the overseas production (almost three-fourths of which is in China) of Taiwan's export orders keeps rising; as a percentage of total production, overseas production was 13.3% in 2000, 42.4% in 2006, and 46.23% in

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[5] During the period 1978-2010, there are high trade barriers between Taiwan and Mainland China, but due to gradually opening policies, the trade and investment interaction between the two economies had been increasing. We can infer that the higher frequencies of factor movement across the Straits, the closer to what predicted by this NEG model, since footloose factor is one of the key assumptions of NEG model. As suggested by Taiwan's cross-strait policy by period in Appendix 4, the declining economic growth rate and increasing unemployment rate in Taiwan accompany the gradually opening polices.

February 2009. Meanwhile, over 81% of information and communication products are now produced overseas. While China's openness has obviously had a great impact on Taiwan's economy, as illustrated in Fig. 1b, the small economy did not completely deindustrialize because, when there are high trade barriers between the two economies, the need to be close to final consumer demand brings about domestically oriented production in the small economy. By contrast, when trade barriers fall below a critical level, the interior equilibrium ceases to be stable and the forward and backward linkages, which give higher profits to firms located in a larger country with a larger industry and overcome the advantages of access to local demand, will hollow out the industry in the small region. This is the case to be addressed in the next scenario.

4.3 Scenario (iii): full elimination of artificial trade barriers between Taiwan and China

Suppose that Taiwan and China reduce their mutual trade barriers to the same level as their trade costs with the global market. The values of the parameters are set at $\tau = 2$, $\rho = 2$, and $\rho_c = 2$, and the simulation result is illustrated in Fig. 1c. Since the manufacturing labor demand curve lies below the agricultural wage for any amount of labor, there will be no manufacturers operating in the small economy, which become a deindustrialized periphery.

This simulation result suggests that trade liberalization policy brings about a loser and a winner, which is counter to the comparative advantage's implication of both countries gaining from free trade, because comparative advantage theorem does not consider the effects of increasing returns and input-output linkages in production. These effects will result in a winner-take-all zero-sum game unless there is restriction in the movement of factors or technology between the trading partners. According to Ricci (1999), who integrated comparative advantage, absolute advantage, and agglomeration effects, a decrease in trade costs raises both the incentive to locate in large markets and the incentive to locate in markets with an absolute advantage, rather than a comparative advantage. Therefore, the small economy cannot gain from free trade with a large one unless it has an immobile absolute advantage.

We now combine the analyses of scenarios (ii) and (iii) to look at the share of industry in each economy for different levels of trade costs. Fig. 2 (drawn for parameters $\rho = 2$ and $\rho_c = 2$) plots the evolution of the share of industry, denoted by n and n_1 for the small and the large economy, respectively, located in each region as trade barriers between the two economies fall, leaving the trade barriers of the global market with the two other regions unchanged. As trade liberalization proceeds between the large and the small economy, industrial production gradually shifts from the small economy into the large one. However, when a critical level of integration is reached (τ =7.15), agglomeration in the large region increases suddenly. The small region does not produce any manufacturers at all in these equilibria with trade costs below the critical value because there is an infinite labor supply in the large country. Moreover, in contrast to the contentions of Krugman and Venables (1995) and Puga and Venables (1997), a further integration between the two economies would not allow the small economy to re-attract firms, even with its increasingly good access to the large economy, since the large one still has lower labor costs; thus, the share of industry in the small economy does not get closer to that of the large one with falling trade costs.

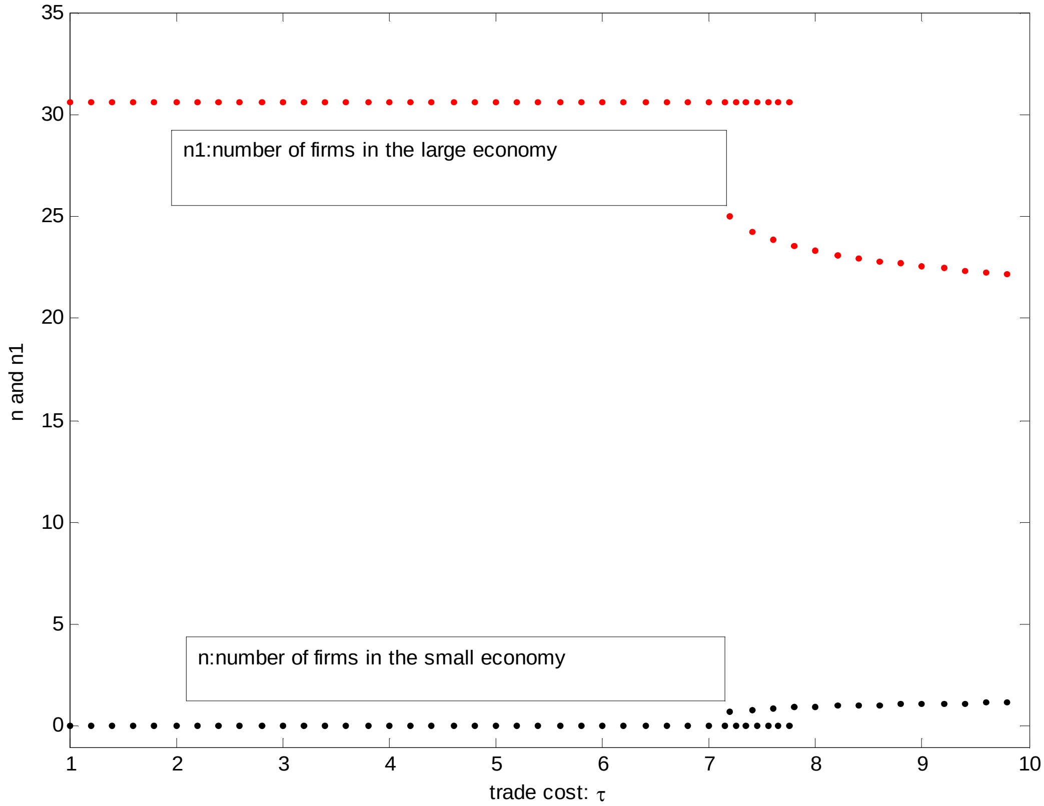

Figure 2: Number of firms in the small and the large economy

Figure 3 plots the evolution of welfare corresponding to figure 2 and only stable equilibria are demonstrated. The curves in the figure are wages divided by the price index in each country. The heavy dashed line (*V*) gives real wages in the small economy, and the light dashed line (*V1*) real wages in the large economy.

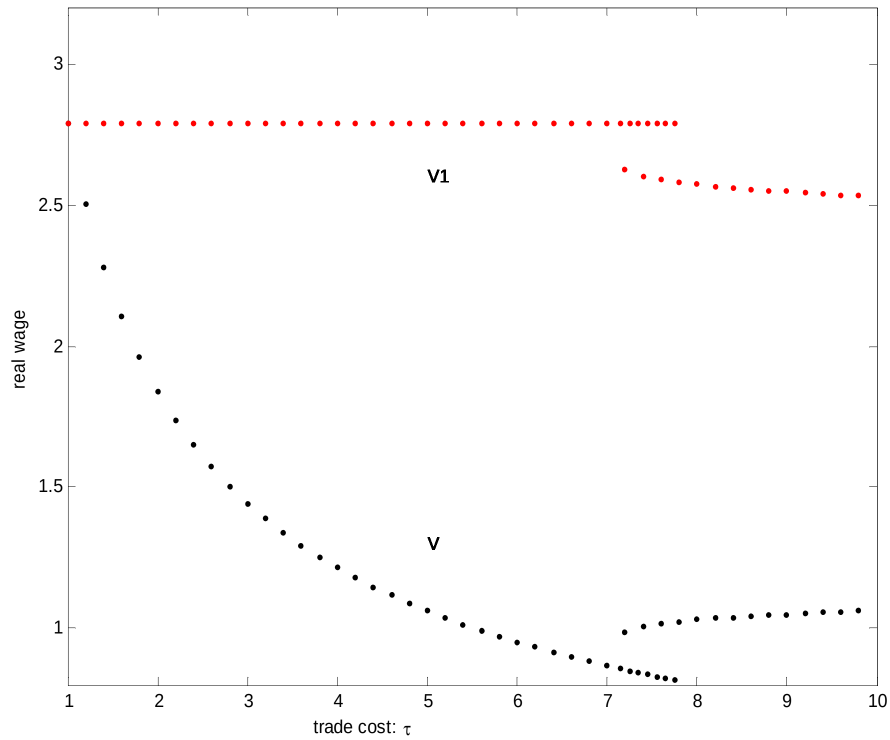

Figure 3: Real wage in the small and the large economies

The wage in the large economy is assumed to be 1. Furthermore, the wage in the small economy stays at unity in the ensuing equilibira, since it always produces some agricultural produce and even specializes in agriculture for some level of trade costs. Hence, the welfare effects are closely related with the evolution in a country's share in industry which share determines the price index level in a region. A region with more industry imports fewer varieties of goods subject to trade barriers, and that supports the real income differences depicted in Fig. 3. Until agglomeration takes place lower trade barriers between the two economies initially increases the welfare levels of the large economy as industry shifts into it, while welfare decreases in the small economy. The additional feature giving rise to the large welfare differentials in Fig. 3 is the fact that when trade barriers fall below the critical level, τ=7.15, all manufacturing is concentrated in the large economy. Since all manufactured goods are produced locally instead of being imported, the price index drops in the large economy, raising its welfare further. In the small economy welfare decreases instead. This generates an even larger real wage gap between the two regions. However, as trade barriers between the two regions continue to fall, welfare for the small economy increases, which is brought about by incurring lower trade barriers on it usage of manufacturing. Besides, real wages of the large economy are constant over this range of trade barriers since trade costs are assumed to affect only manufactured goods.

4.4 Scenario (iv): global-market priority trading arrangement

Suppose that the small economy focuses on getting its domestic industry better access to the global market than to the market of the large economy. The simulation result of a representative example, $\tau = 7.5$, $\rho = 2$, and $\rho_c = 1.02$, is presented in Fig. 1d. As this figure shows, such an arrangement can effectively enhance firms' incentive to locate in the small economy, as long as the initial share of manufacturing employment exceeds the level of the interior unstable equilibrium, that is, the intersection of the two curves. However, as suggested in scenario (iii), the small economy's reducing trade costs with the large economy will result in its deindustrialization, while its reducing trade costs with the global market will not. What is the difference for the small economy between lowering trade barriers with the large economy and with the global market?

The simulation result is the consequence of the assumptions regarding firms' mobility. In this model, firms are mobile between the small and the large economy, but firms will not choose to locate in the global market since the global market, with higher labor costs, consumes but does not produce manufacturers' products. Because we refer to the small economy, the large economy and the global market as Taiwan, China and the advanced countries in the world, respectively, the assumptions are not far from the real world and neither is our argument, as suggested by Korea's experiences. Korea has adopted a global-market priority trade policy, resulting in its per-capita GDP's outpacing Taiwan's since 2004 and its average unemployment rate being 3.5% during 2001-2009, compared to Taiwan's 4.6% during the same period.

4.5 Scenario (v): Taiwan serving as a hub

This situation is characterized as a bilateral trade liberalization between Taiwan and the other two regions ($\tau < 2, \rho_c < 2$), leaving unchanged barriers between China and the global market ($\rho = 2$). If Taiwan's trade costs as they relate to the other two regions are not low enough, Taiwan still becomes a deindustrialized periphery. However, when a critical level of integration is reached, agglomeration in the hub takes place. Consider two representative examples—one for parameters $\tau = 1.5$, $\rho_c = 1.5$, and the other for parameters $\tau = 1.2$, $\rho_c = 1.2$—whose simulation results are illustrated in Fig. 1e and Fig. 1f, respectively. When the hub has low trade efficiency of $\tau = 1.5$ and $\rho_c = 1.5$, the maximum wage firms can pay is lower than the agricultural wage, so there is no industrial production in the small economy. This result is similar to those of Forslid (2004) and Baldwin, Forslid, Martin, Ottaviano and Robert-Nicoud (2003, CH 17). Both studies indicated that a small region with less than average endowments may lose industry if it becomes a hub. By contrast, when the hub has high trade efficiency such that $\tau = 1.2$ and $\rho_c = 1.2$, industrial production shifts into the small economy.[6] Therefore, Singapore's experience may imply its high trade efficiency as a hub; Singapore's average unemployment rate and average annual growth rate were 3% and 4.21%, respectively, during 2001-2009, better than Taiwan's 4.6% and 3.12%, respectively, over the same period.

5. Industrial location and China's rising wages

6 On the contrary, Baldwin, Forslid, Martin, Ottaviano and Robert-Nicoud (2003, CH 14) suggests that ,when the spokes maintain very high levels of protection but trade between hub and spoke is quite free, then there will be proportionally less share of world industry in hub, assuming that each nation accounts for equal share of world expenditure,. However, if the differential in the trade freeness between hub-spoke and spoke-spoke is small, hub has a share of world industry larger than it share of world expenditure.

Having discussed the impacts of different policy scenarios in the preceding section, let us now turn to analyze the industrial location effects resulting from the rise of wages in China, since that wages in China have been increasing significantly in recent years.[7] In this section, we assume all manufacturing is initially concentrated in the large country. This is not far from the reality, since China has become workshop of manufactures to the world. To address the issue of re-attracting firms to locate in the smaller region, we will derive the appropriate features for trade barriers between the two regions to achieve this goal. Three cases regarding the change of wages in China will be analyzed. First, both the wages in the large and small economy stay at 1, which is presented as a baseline case. Second, wages in China increase, while leaving that in the small economy unchanged. Third, both regions have the same increases in wages.

Given that all the firms are initially clustered in the large region, the profit for a defecting firm to relocate its production in the small region must be nonnegative. The nonnegative profit condition for firms can be derived from equation (6), details shown in Appendix 3, which is

$$\text{(10)} \qquad \tau^{\theta\delta} \leq \frac{\tau^{1-\delta} E_1 + (\frac{\rho_C}{\rho})^{1-\delta} E_0 + \tau^{\delta-1} E}{w_1 \cdot L_{m,1} / 1-\theta} \cdot (\frac{w_1}{w})^{\sigma(1-\theta)}$$

[7] China's manufacturing wage has been increased by 260 percent in terms of US dollars between 2000 and 2007.

$$E = \upsilon \cdot w \cdot L = \upsilon \cdot w$$

where $$E_1 = (\upsilon(1-\theta)+\theta) \cdot \frac{w_1 \cdot L_{m,1}}{1-\theta}$$

In Fig. 4 (drawn for parameters $\rho_c = 2$ and $\rho = 2$), curve $L_{m,1}$ illustrates the relationships between the trade barriers between the two economies (τ) and the manufacturing employment in the large economy ($L_{m,1}$) given equality in equation (10) (representing the zero profit condition) , where $w = 1$ and w_1 =1 are sustained. In the area above (below) curve $L_{m,1}$, an individual firm relocating in the small economy will earn negative (positive) profits, denoted by $\pi_S < 0$. Likewise the zero profit condition for firms producing in the large region can be represented by the horizontal line, $L_{m,1,0}$. The level of $L_{m,1,0}$ can be given by $L_{m,1,0} = \frac{\upsilon \cdot w \cdot L + E_0}{w_1 \cdot (1-\upsilon)}$, which denotes the manufacturing employment level of the large economy where all manufacturing firms had agglomerated. The area above (below) line $L_{m,1,0}$ gives negative (positive) profits to firms located in the large economy, indicated by $\pi_L < 0$.

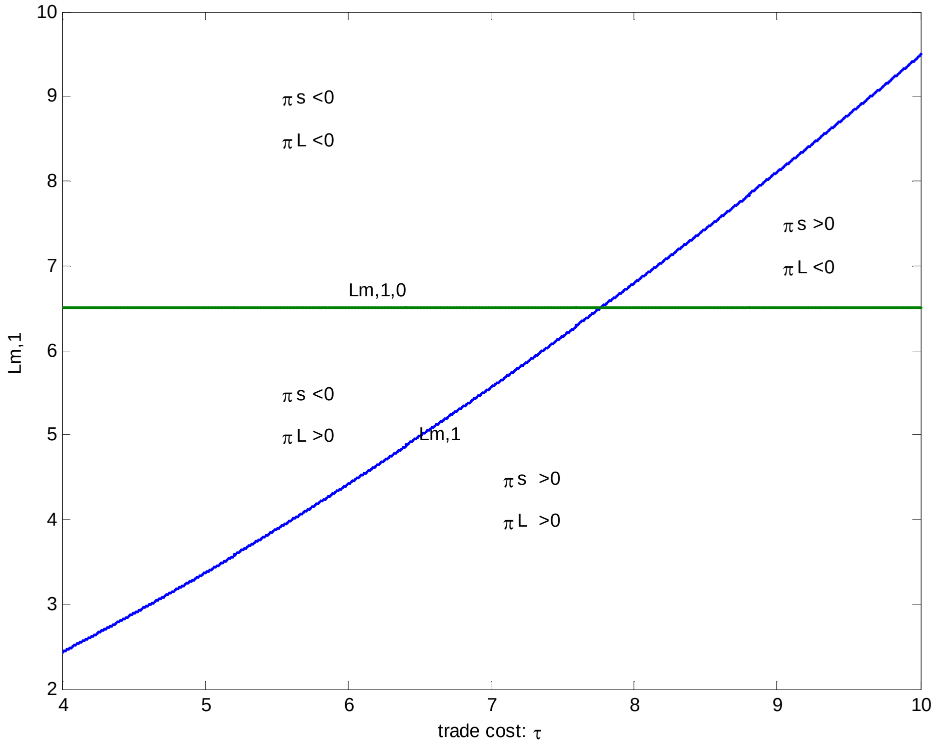

Figure 4: Trade costs and profits in the small and the large economy

Fig. 4 shows that if firms originally agglomerated in the large economy with abundant labor supply (at least larger than 6.5 in the setting of the present simulation) and a constant wage rate, then the trade costs between the small and the large economy must be high enough (suggested by the trade costs at the intersection of curve $L_{m,1,0}$ and $L_{m,1}$) for firms to relocate in the small one.

Next, suppose that there is a rise of wage in the large economy, while that in the small economy remain unchanged. In Fig. 5, an upward shifting of line $L_{m,1}$ and a downward movement of line $L_{m,1,0}$ [8] denote the present scenario. The rising wage in the large economy provides incentives for firms to relocate in the smaller economy so

[8] The downward shift of line $L_{m,1,0}$ occurs as the manufacturing employment in the large economy shrinks due to its rising wage.

that the area with both positive profits for firms in the small economy, $\pi_S > 0$, and negative profits for those in the large one, $\pi_L < 0$, depicted in Fig. 5, enlarges. Hence, the wage effect leads to a smaller labor employment in the large economy and the lower trade barriers required for the small region to sustain the production of manufactures.

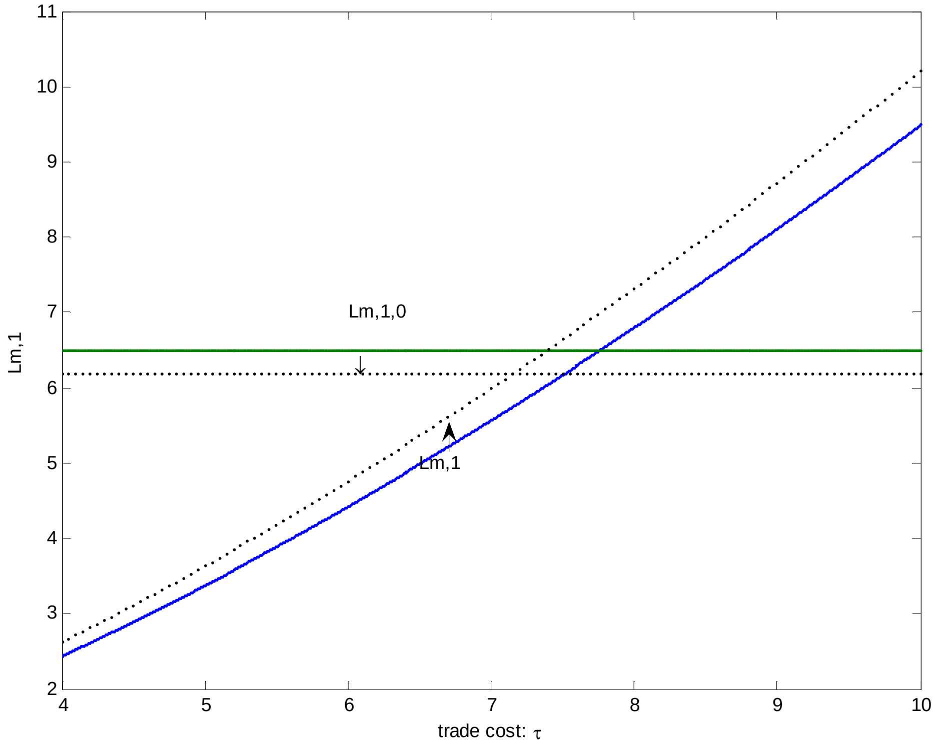

Figure 5: The effect of a 5% increase in the wage of large economy

Moreover, there may be the same increase in wages in the small economy coupled with that in the large economy, since, with a smaller labor endowment, a lower wage in the small economy than that in the large one will not be sustained. Thus, a result of factor price equalization will result. As illustrated in Fig. 6, the simulation of an equivalent increase in the wage of both economies shows that line $L_{m,1}$ shifts downward as in the previous case, while the shift of line $L_{m,1}$ is negligible since the profits of firms in the small economy is hardly affected. However, due to the shrinkage of the industrial production and employment in the large economy, the required trade barriers for the small economy to keep its manufactured production are reduced.

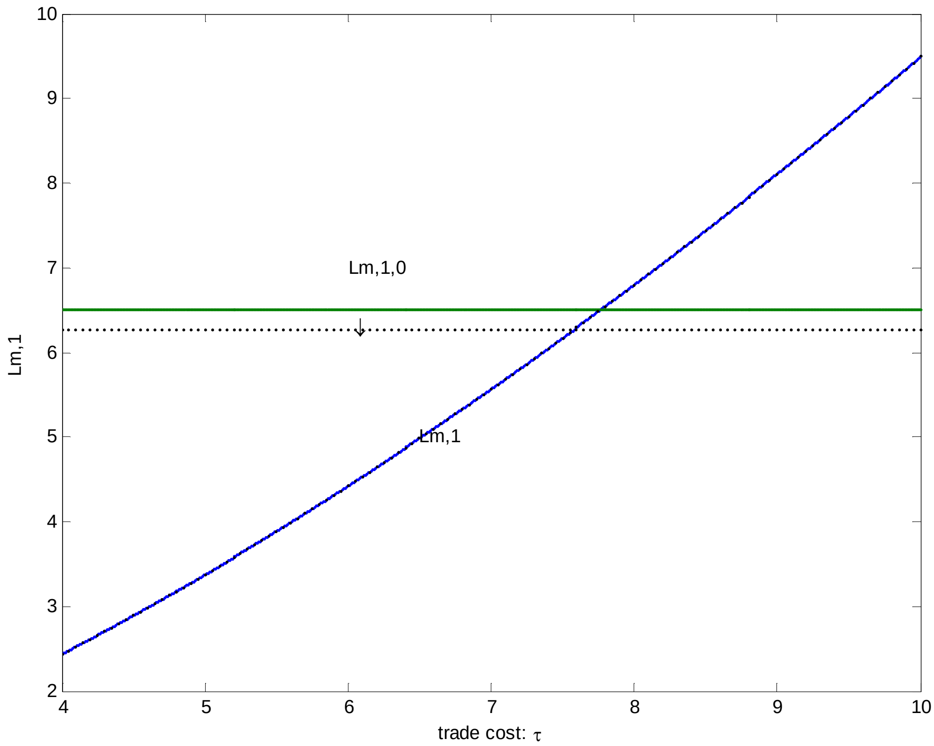

Figure 6: The effect of a 5% increase in the wage of both the small and the large economy

The simulations in this section show that the required level of trade barriers between the two economies for the small one to hold its industry is reduced under the circumstance of a higher wage rate in the large economy since the higher labor costs reduce the profitability of firms producing manufactures in the large one. It is worth noting that although an increase in wage (e.g. 5%) in the large economy gives rise to the incentive for firms to relocate in the small economy, whereas this effect will not change the location of manufacturing firms over a wide range of trade cost. This means that the large economy can maintain its agglomeration of industry even with a higher wage rate and the small economy remains as a deindustrialized periphery if the trade barriers across economies are not high enough. In this case, whether firms already located in China will shift their production to back to Taiwan depends on the level of trade barriers between China and Taiwan. If the level of trade barriers across Straits is high enough, the incentive to supply Taiwan's domestic market locally and the rising labor costs in China will draw industry into Taiwan. However, with low cross-strait trade costs, it is more profitable for firms continuing to located production in China and export manufactures to Taiwan since China has a larger market which provides better market access and input-output linkages between firms. That is to say, high trade barriers between the trading partners with extremely asymmetric size continue to be the requisite for the small one to retain its industrial production.

6. Conclusion

This analysis draws a picture of how cross-strait industrial location may change in response to different trading arrangements. Under a trading system with three regions, the simulation results show that, without reducing the trade costs between

Taiwan and the global market, Taiwan will become a deindustrialized periphery if integration proceeds between Taiwan and China. However, if the trade costs between Taiwan and the global market, the third region, are reduced low enough either through a trading arrangement of global-market priority or of a hub, agglomeration of industry takes place in Taiwan. Lowering trade costs with different trade partners has different impacts on industry located in Taiwan because the degree of firms' mobility across the Straits is greater than that between Taiwan and the global market, as suggested by the fact that more than 60% of Taiwan's outward FDI has gone to China. When firms are highly mobile across the Straits and trade barriers between China and Taiwan fall, the profitability of firms located in the larger economy rises relative to those in the small one since the former provides larger demand by both consumers and firms. That situation shifts industry into China and, under the circular process of agglomeration created by input-output links, endogenously produces a core-periphery structure across the Straits. By contrast, falling trade costs between Taiwan and the global market help firms located in Taiwan realize economies of scale without being driven to move outward since the global market, representing advanced countries with higher labor costs, imports but does not produce manufactured goods. Therefore, Taiwan's share of industry and manufacturing employment expands.

Turning to the effects of a rising wage in China, with equal trade barriers with the global market for Taiwan and China, the required cross-strait trade barriers to keep Taiwan's industrial production falls, since the higher labor costs reduce the profitability of firms producing manufactures in China. However, whether firms already located in China will shift their production to back to Taiwan depends on the level of trade barriers between China and Taiwan. If the level of trade barriers across Straits is high enough, the incentive to supply Taiwan's domestic market locally and the rising labor costs in China will draw industry into Taiwan. However, with low cross-strait trade costs, it is more profitable for firms continuing to located production in China and export manufactures to Taiwan since China has a larger market which provides better market access and input-output linkages between firms.

Appendix 1 : The equations of the model for three-region trading system

The system of equations representing the small economy is as follows:

(A1) $$p(1-1/\delta) = w^{1-\theta}\Omega_m^{\theta} b\,,$$

(A2) $$\Omega_m = (np^{1-\delta} + n_1(p_1\tau)^{1-\delta})^{1/(1-\delta)},$$

(A3) $$E = \upsilon \cdot w \cdot L + \theta \cdot n \cdot p\,,$$

(A4) $$1 = p^{-\delta}(\tau^{1-\delta}\Omega_{m,1}^{\delta-1}E_1 + (\rho_c)^{1-\delta}\Omega_{m,0}^{\delta-1}E_0 + \Omega_m^{\delta-1}E)\,,$$

(A5) $$w \cdot L_m = (1-\theta) \cdot n \cdot p\,,$$

The system corresponding to the large economy is presented in the following:

(A6) $$p_1(1-1/\delta) = w_1^{1-\theta}\Omega_{m,1}^{\theta} b$$

(A7) $$\Omega_{m,1} = (n(\tau \cdot p)^{1-\delta} + n_1 p_1^{1-\delta})^{1/(1-\delta)}$$

(A8) $$E_1 = \upsilon \cdot w_1 \cdot L_{m,1} + \theta \cdot n_1 \cdot p_1$$

(A9) $$1 = p_1^{-\delta}(\tau^{1-\delta}\Omega_m^{\delta-1}E + (\rho)^{1-\delta}\Omega_{m,0}^{\delta-1}E_0 + \Omega_{m,1}^{\delta-1}E_1)$$

(A10) $$w_1 \cdot L_{m,1} = (1-\theta) \cdot n_1 \cdot p_1$$

The price index of the global market can be expressed as

(A11) $$\Omega_{m,0} = (n(\rho_c \cdot p)^{1-\delta} + n_1(\rho \cdot p_1)^{1-\delta})^{1/(1-\delta)}.$$

Notice that L, w_1, and E_0 are assumed to be constant in this model. The system of equations can be simplified into six equations to solve n, p, w, $n_1, p_1, L_{m,1}$ numerically. By substituting equations (A2), (A3), (A7), (A8), (A11) into equations (A1), (A4), (A5), (A6), (A9) and A (10), we can trace out manufacturing equilibrium as a function of L_m.

Appendix 2 : Parameter values

The simulation sets $L = 1, w_1 = 1, E_0 = 2, \upsilon = 0.6, \theta = 0.5, \delta = 5,$ and $b = 0.8$ except that the value of w_1 has been changed in Fig. 5 and 6. In Fig. 1a, $\tau = 7.5, \rho = 5, \rho_c = 2$. In Fig. 1b, $\tau = 7.5, \rho = 2, \rho_c = 2$. In Fig. 1c, $\tau = 2, \rho = 2, \rho_c = 2$. In Fig. 1d, $\tau = 7.5, \rho = 2, \rho_c = 1.02$. In Fig. 1e, $\tau = 1.5, \rho = 2, \rho_c = 1.5$. In Fig. 1f, $\tau = 1.2, \rho = 2, \rho_c = 1.2$. In Fig. 2, 3, 4, 5 and 6, $\rho = 2$, $\rho_c = 2$. Fig. 5 sets $w = 1, w_1 = 1.05$. Fig. 6 sets $w = 1.05, w_1 = 1.05$.

Appendix 3: The conditions for manufacturing concentration in the large economy

Suppose that all manufacturing is located in the large economy and therefore *n*=0. In the small economy, its price index will be τ times that of the large economy. Let zero profit condition, (A9), sustains in the large economy, and by using (A3), (A8), and (A10), we then have

(A13) $$E_1 + E_0 + E = \frac{w_1 \cdot L_{m,1}}{1-\theta}, \quad E = \upsilon \cdot w \cdot L, \ \ E_1 = (\upsilon(1-\theta) + \theta)\frac{w_1 \cdot L_{m,1}}{1-\theta}.$$

Applying (A13) yields

(A14) $$L_{m,1,0} = \frac{\upsilon \cdot w \cdot L + E_0}{w_1 \cdot (1-\upsilon)}, \ \ E = \upsilon \cdot w \cdot L, \ \ E_1 = (\upsilon(1-\theta) + \theta) \cdot \frac{\upsilon \cdot w \cdot L + E_0}{(1-\theta)(1-\upsilon)},$$

where $L_{m,1,0}$ is the employment in the large economy while all manufactures cluster there and is demonstrated as the horizontal curve $L_{m,1,0}$ in Fig. 4. However, whether this agglomeration equilibrium is stable depends on the profitability of a firm shifting its production to the small economy. If a firm can commence production with positive profit in the small economy, then the agglomeration of firms in the large one is unstable.

Let firms in the small economy make negative profits, and rewriting equation (A4) yields

(A15) $$1 > p^{-\delta}(\tau^{1-\delta}\Omega_{m,1}^{\delta-1}E_1 + (\rho_c)^{1-\delta}\Omega_{m,0}^{\delta-1}E_0 + \Omega_m^{\delta-1}E).$$

The following condition can be derived from (A15)

(A16) $$\tau^{\theta\delta} > \frac{\tau^{1-\delta}E_1 + (\frac{\rho_C}{\rho})^{1-\delta}E_0 + \tau^{\delta-1}E}{w_1 \cdot L_{m,1}/1-\theta} \cdot (\frac{w_1}{w})^{\sigma(1-\theta)} \quad .$$

The line $L_{m,1}$ in Fig.4 indicates loci along which firms in the small economy earn zero profits, so that the relationship, (A16), is illustrated as the area above curve $L_{m,1}$ in the same figure. Specifically, as the large economy agglomerates all the manufacturing production and the amount of employment equals $L_{m,1,0}$, it is not profitable for any firm to start producing in the small economy if the trade cost across the two economies, τ, is smaller than the level of trade costs at the intersection of the two curves $L_{m,1,0}$ and $L_{m,1}$.

Appendix 4: Taiwan's cross-strait policy by period

Taiwan's cross-strait policy by period	Economic growth rate	Unemployment rate
1978-1996: the early phase of interaction across Straits	7.71%	1.88%
1997-2000: "no haste, be patient" policy	5.18%	2.80%
2001-2006: "proactive liberalization with effective management"	3.76% (2001-2008)	4.41% (2001-2008)
2006 : "proactive management and effective liberalization"		
2008: Direct cross-strait flights and transportation		
2010: Financial Memorandum of Understanding (MOU) with mainland China	10.82% (2010) (2009-1.93%)	5.21% (2010)
2011: ECFA		

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The Derivation of Fomulae

(1) $TC = w^{1-\theta}\Omega_m^{\theta}(a + b\cdot(x_1 + x_0 + d))$

Proof:

The fundamental ingredient of production is composed of $L^{1-\theta}m^{\theta}$. If a producer intends to produce the quantity of $x_1 + x_0 + d$, the required amount of fundamental ingredient is $a + b(x_1 + x_0 + d)$. Since there is a fixed cost of a, the production is subject to increasing returns to scale. The constraint function takes the form of

$a + b(x_1 + x_0 + d) = B\cdot L^{1-\theta}m^{\theta}$ and the price of L and m is w and Ω_m, respectively.

Solve the following problem to obtain the minimal cost by choosing L and m.

$$\min \quad TC = wL + \Omega_m m$$

$$\text{s.t.} \quad B\cdot L^{1-\theta}m^{\theta} = a + b(x_1 + x_0 + d)$$

Let $\Gamma = wL + \Omega_m m + \lambda(a + b(x_1 + x_0 + d) - B\cdot L^{1-\theta}m^{\theta})$

The first order conditions are :

$$\frac{\partial\Gamma}{\partial L} = w - \lambda B(1-\theta)L^{-\theta}m^{\theta} = 0$$

$$\frac{\partial\Gamma}{\partial m} = \Omega_m - \lambda B\theta L^{1-\theta}m^{\theta-1} = 0$$

Taking the ratio gives

$$\frac{w}{\Omega_m} = \frac{(1-\theta)L^{-\theta}m^{\theta}}{\theta L^{1-\theta}m^{\theta-1}} = \frac{(1-\theta)m}{\theta L}$$

$$m = \frac{w\theta}{\Omega_m(1-\theta)}L$$

Substituting this expression into the constraint function yields

$$B\cdot L^{1-\theta}m^{\theta} = a + b(x_1 + x_0 + d)$$

$$B\cdot L^{1-\theta}\left(\frac{w\theta}{\Omega_m(1-\theta)}L\right)^{\theta} = a + b(x_1 + x_0 + d)$$

$$B\cdot L\left(\frac{w\theta}{\Omega_m(1-\theta)}\right)^{\theta} = a + b(x_1 + x_0 + d)$$

$$L = B^{-1}\left(\frac{w\theta}{\Omega_m(1-\theta)}\right)^{-\theta}(a+b(x_1+x_0+d))$$. Substituting it to m we have

$$m = \frac{w\theta}{\Omega_m(1-\theta)}\ B^{-1}\left(\frac{w\theta}{\Omega_m(1-\theta)}\right)^{-\theta}(a+b(x_1+x_0+d))$$

$$= B^{-1}\left(\frac{w\theta}{\Omega_m(1-\theta)}\right)^{1-\theta}(a+b(x_1+x_0+d))$$

Introducing L and m into TC, we have

$$TC = wL + \Omega_m m$$

$$= w\ B^{-1}\left(\frac{w\theta}{\Omega_m(1-\theta)}\right)^{-\theta}(a+b(x_1+x_0+d))$$

$$+ \Omega_m B^{-1}\left(\frac{w\theta}{\Omega_m(1-\theta)}\right)^{1-\theta}(a+b(x_1+x_0+d))$$

$$= B^{-1}\left(\frac{\theta}{(1-\theta)}\right)^{-\theta} w^{1-\theta}\ \Omega_m{}^{\theta}\ \ (a+b(x_1+x_0+d))$$

$$+ B^{-1}\left(\frac{\theta}{(1-\theta)}\right)^{1-\theta} w^{1-\theta}\ \Omega_m{}^{\theta}\ \ (a+b(x_1+x_0+d))$$

$$= B^{-1}\left(\left(\frac{\theta}{(1-\theta)}\right)^{-\theta} + \left(\frac{\theta}{(1-\theta)}\right)^{1-\theta}\right) w^{1-\theta}\ \Omega_m{}^{\theta}\ \ (a+b(x_1+x_0+d))$$

$$(\text{Let } B = \left(\frac{\theta}{(1-\theta)}\right)^{-\theta} + \left(\frac{\theta}{(1-\theta)}\right)^{1-\theta})$$

$$TC = w^{1-\theta}\ \Omega_m{}^{\theta}\ \ (a+b(x_1+x_0+d))$$

End of the proof of Equation (1).

(2) $p = \frac{\delta}{\delta - 1} w^{1-\theta} \Omega_m^{\theta} b$: mark-up pricing by firms in monopolistic competitive market.

Proof:

To begin with, let's calculate the price elasticity of consumer's demand.

The consumer's demand function is $y_i = p_i^{-\delta} \, \Omega_m^{\delta-1} \upsilon \cdot w \cdot L$ (See the proof of Equation (3)). Differentiating yi, we have

$$\frac{\partial y_i}{\partial p_i} = (-\delta) \, p_i^{-\delta-1} \, \Omega_m^{\delta-1} \, \upsilon \cdot w \cdot L$$

Then we can obtain the price elasticity of consumer demand.

$$\begin{aligned} -\frac{\partial y_i}{\partial p_i} \frac{p_i}{y_i} &= [\,(-\delta) \, p_i^{-\delta-1} \, \Omega_m^{\delta-1} \, \upsilon \cdot w \cdot L \,)] \, p_i \, (\, p_i^{-\delta} \, \Omega_m^{\delta-1} \, \upsilon \cdot w \cdot L \,)^{-1} \\ &= \delta \end{aligned}$$

Applying rule of markup pricing,

$$MR = MC\,,$$

and derived by (1) $TC = w^{1-\theta} \Omega_m^{\theta} (a + b \cdot (x_1 + x_0 + d))$, we have

$$p_i (1 - \frac{1}{\delta}) = w^{1-\theta} \Omega_m^{\theta} \cdot b$$

End of the proof of Equation (2).

Equation (3), (4), (5), and (7)

$$
\begin{aligned}
& d = p^{-\delta}\Omega_m^{\delta-1}E \\
(3)\quad & x_1 = p^{-\delta}\cdot\tau^{1-\delta}\cdot\Omega_{m,1}^{\delta-1}\cdot E_1 \\
& x_0 = p^{-\delta}\cdot\rho_c^{1-\delta}\cdot\Omega_{m,0}^{\delta-1}\cdot E_0
\end{aligned}
$$

The demand from consumers:

Since the expenditure by a consumer is $wL = \Omega_a^{1-\upsilon}\Omega_m^{\upsilon}V$, a consumer spends $m\cdot\Omega_m = \upsilon\cdot w\cdot L$ on manufactured good.

Consumer's optimization problem:(Because consumer's utility function take the form of $U = A\cdot a^{1-\upsilon}m^{\upsilon}$ ， the larger m is , the higher utility is.)

$$\max_{y_i}\quad m = \left(\sum_{i=1}^{n} y_i^{\frac{\delta-1}{\delta}} + \sum_{j=1}^{n_1}\left(\frac{y_j}{t}\right)^{\frac{\delta-1}{\delta}}\right)^{\frac{\delta}{\delta-1}}$$

(y_i and y_j denote the production from a domestic and a foreign firm, respectively.

When the good is sold abroad, only y_j /t arrives. p_j is the f.o.b. price of foreign product)

$$s.t.\quad \sum_{i=1}^{n} p_i y_i + \sum_{j=1}^{n_1} p_j y_j = \upsilon\cdot w\cdot L$$

$$\text{Let}\quad L = \left(\sum_{i=1}^{n} y_i^{\frac{\delta-1}{\delta}} + \sum_{j=1}^{n_1}\left(\frac{y_j}{t}\right)^{\frac{\delta-1}{\delta}}\right)^{\frac{\delta}{\delta-1}} - \lambda\left(\sum_{i=1}^{n} p_i y_i + \sum_{j=1}^{n_1} p_j y_j - \upsilon\cdot w\cdot L\right).$$

First order conditions are:

$$\frac{\partial L}{\partial y_i} = \left(\sum_{i=1}^{n} y_i^{\frac{\delta-1}{\delta}} + \sum_{j=1}^{n_1}\left(\frac{y_j}{t}\right)^{\frac{\delta-1}{\delta}}\right)^{\frac{\delta}{\delta-1}-1}\frac{\delta}{\delta-1}\, y_i^{((\delta-1)/\delta)-1}\,\frac{\delta-1}{\delta} - \lambda\, p_i$$

$$= \left(\sum_{i=1}^{n} y_i^{\frac{\delta-1}{\delta}} + \sum_{j=1}^{n_1}\left(\frac{y_j}{t}\right)^{\frac{\delta-1}{\delta}}\right)^{\frac{1}{\delta-1}} y_i^{-1/\delta} - \lambda\, p_i = 0$$

$$\frac{\partial L}{\partial y_j} = \left(\sum_{i=1}^{n} y_i^{\frac{\delta-1}{\delta}} + \sum_{j=1}^{n_1}\left(\frac{y_j}{t}\right)^{\frac{\delta-1}{\delta}}\right)^{\frac{\delta}{\delta-1}-1}\frac{\delta}{\delta-1}\, t^{-((\delta-1)/\delta)} y_j^{((\delta-1)/\delta)-1}\,\frac{\delta-1}{\delta} - \lambda\, p_j$$

$$=(\sum_{i=1}^{n} y_i^{\frac{\delta-1}{\delta}} + \sum_{j=1}^{n_1}(\frac{y_j}{t})^{\frac{\delta-1}{\delta}})^{\frac{1}{\delta-1}} t^{-((\delta-1)/\delta)} y_j^{-1/\delta} - \lambda\ p_j = 0$$

Taking the ratio gives

$$[(\sum_{i=1}^{n} y_i^{\frac{\delta-1}{\delta}} + \sum_{j=1}^{n_1}(\frac{y_j}{t})^{\frac{\delta-1}{\delta}})^{\frac{1}{\delta-1}} y_i^{-1/\delta}]/[(\sum_{i=1}^{n} y_i^{\frac{\delta-1}{\delta}} + \sum_{j=1}^{n_1}(\frac{y_j}{t})^{\frac{\delta-1}{\delta}})^{\frac{1}{\delta-1}} t^{-((\delta-1)/\delta)} y_j^{-1/\delta}] = \frac{p_i}{p_j}$$

$$y_i^{-1/\delta} / \ t^{-((\delta-1)/\delta)} y_j^{-1/\delta} = \frac{p_i}{p_j}$$

$$t^{((\delta-1)/\delta)} (y_i / y_j)^{-(1/\delta)} = \frac{p_i}{p_j}$$

$$y_i^{\ -(1/\delta)} = \frac{p_i}{p_j}\ y_j^{\ -(1/\delta)}\ t^{(1-\delta)/\delta}$$

$$(*)\quad y_i = (\frac{p_i}{p_j})^{-\delta}\ y_j\ \ t^{\delta-1}$$

Applying the expression above to budget constraint and given all the differentiated good with the same price, we have

$$n \cdot p_i y_i + n_1 p_j y_j = \upsilon \cdot w \cdot L$$

$$n \cdot p_i\ \ (\frac{p_i}{p_j})^{-\delta}\ y_j\ \ t^{\delta-1} + n_1 p_j y_j = \upsilon \cdot w \cdot L$$

$$p_j y_j [n \frac{p_i}{p_j}\ (\frac{p_i}{p_j})^{-\delta}\ t^{\delta-1} + n_1] = \upsilon \cdot w \cdot L$$

$$p_j y_j [n\ (\frac{p_i}{p_j})^{1-\delta}\ t^{\delta-1} + n_1] = \upsilon \cdot w \cdot L$$

$$p_j y_j [n\ (p_i)^{1-\delta}\ (p_j t)^{\delta-1} + n_1] = \upsilon \cdot w \cdot L$$

$$p_j y_j\ (p_j t)^{\delta-1}\ \ [n\ (p_i)^{1-\delta} + n_1\ (p_j t)^{1-\delta}] = \upsilon \cdot w \cdot L$$

$$y_j\ \ p_j^{\delta}\ t^{\delta-1}\ \ [n\ (p_i)^{1-\delta} + n_1\ (p_j t)^{1-\delta}] = \upsilon \cdot w \cdot L$$

The demand of domestic consumers for foreign goods is

$$y_j = p_j^{-\delta}\ t^{1-\delta}\ \ (n\ (p_i)^{1-\delta} + n_1\ (p_j t)^{1-\delta})^{-1}\ \upsilon \cdot w \cdot L$$

$$= p_j^{-\delta}\ t^{1-\delta}\ \{\ (n\ (p_i)^{1-\delta} + n_1\ (p_j t)^{1-\delta})^{1/(1-\delta)}\}^{\delta-1}\ \upsilon \cdot w \cdot L\ .$$

Based on the definition of Equation (4) $\Omega_m = (np^{1-\delta} + n_1 (p_1\tau)^{1-\delta})^{1/(1-\delta)}$,we have

$$= p_j^{-\delta} \ t^{1-\delta} \ \Omega_m^{\ \delta-1} \upsilon \cdot w \cdot L$$

Substituting it to (*) yields the demand of consumers for domestic goods

$$y_i \ = (\frac{p_i}{p_j})^{-\delta} \ y_j \ \ t^{\delta-1}$$

$$= (\frac{p_i}{p_j})^{-\delta} \ p_j^{-\delta} \ t^{1-\delta} \ \Omega_m^{\ \delta-1} \upsilon \cdot w \cdot L \ t^{\delta-1}$$

$$= \ p_i^{\ -\delta} \ \Omega_m^{\ \delta-1} \upsilon \cdot w \cdot L$$

The demand from producers:

Based on Equation (1) $TC = w^{1-\theta} \ \Omega_m^{\ \theta} \ \ (a + b(x_1 + x_0 + d))$, we can obtain the demand for intermediate good, $m = B^{-1} (\frac{w\theta}{\Omega_m (1-\theta)})^{1-\theta} (a + b(x_1 + x_0 + d)$.).

(note that $B \ = (\frac{\theta}{(1-\theta)})^{-\theta} + (\frac{\theta}{(1-\theta)})^{1-\theta})$

Therefore, the expenditure of an individual firm on intermediate goods is

$$\Rightarrow \Omega_m \ m = \Omega_m \ B^{-1} (\frac{w\theta}{\Omega_m (1-\theta)})^{1-\theta} (a + b(x_1 + x_0 + d)).$$

$$= \Omega_m^{\ \theta} \ w^{1-\theta} ((\frac{\theta}{(1-\theta)})^{-\theta} + (\frac{\theta}{(1-\theta)})^{1-\theta})^{-1} (\frac{\theta}{(1-\theta)})^{1-\theta} (a + b(x_1 + x_0 + d))$$

$$= \frac{(\theta/(1-\theta))^{1-\theta}}{(\theta/(1-\theta))^{-\theta} + (\theta/(1-\theta))^{1-\theta}} \ \Omega_m^{\ \theta} \ w^{1-\theta} (a + b(x_1 + x_0 + d))$$

Using the definition of TC yield

$$= \frac{1}{(\theta/(1-\theta))^{-1} + 1} \ TC$$

$$= \frac{1}{((1-\theta)/\theta) + 1} \ TC$$

$$= \frac{\theta}{1-\theta+\theta} \ TC$$

$$= \theta \quad TC$$

(As zero profit condition sustains, $TC \ = \ p(x_1 + x_0 + d)$)

$$= \theta \ \ p(x_1 + x_0 + d)$$

The sum of the expenditure on intermediate goods for all firms is $\theta\ n\, p\,(x_1 + x_0 + d)$.
Likewise, firms expenditure on labor employment is $w L = (1-\theta)\ n\, p\,(x_1 + x_0 + d)$.
End of proof of Equation (7)

Applying the consumer expenditure function yields $\Omega_m m = \upsilon w L$.

Adding up the expenditure on manufactured goods of consumers and producers, we have

$$E = \upsilon \cdot w \cdot L + \theta \cdot (x_1 + x_0 + d) \cdot n \cdot p$$

End of the proof of Equation (5).

By analogy of the derivation of consumer's demand, we can infer that the intermediate demand of producer for domestic and foreign manufactured good equals $p_i^{-\delta}\ \Omega_m^{\ \delta-1}\ \theta\ n\, p\,(x_1 + x_0 + d)$ and $p_j^{-\delta}\ t^{1-\delta}\ \Omega_m^{\ \delta-1}\ \theta\ n\, p\,(x_1 + x_0 + d)$, respectively.

Combining the demand from consumers and producers gives Equation (3).
End of the proof of Equation (3).

$$(6)\quad (x_1 + x_0 + d) \equiv p^{-\delta} (\tau^{1-\delta} \Omega_{m,1}^{\delta-1} E_1 + (\rho_c)^{1-\delta} \Omega_{m,0}^{\delta-1} E_0 + \Omega_m^{\delta-1} E) = \frac{(\delta-1)a}{b}$$

Using zero profit condition $(x_1 + x_0 + d) \cdot p = TC$ and applying Equation(1) we have

$$(x_1 + x_0 + d) \cdot p = w^{1-\theta} \Omega_m^{\theta} (a + b \cdot (x_1 + x_0 + d))$$

$$(x_1 + x_0 + d) \cdot (p - w^{1-\theta} \Omega_m^{\theta} \cdot b) = w^{1-\theta} \Omega_m^{\theta} a$$

Introducing Equation (2) $p(1-1/\delta) = w^{1-\theta} \Omega_m^{\theta} b$ yields

$$(x_1 + x_0 + d) \cdot (w^{1-\theta} \Omega_m^{\theta} \cdot b \cdot (\frac{\delta}{\delta-1}) - w^{1-\theta} \Omega_m^{\theta} \cdot b) = w^{1-\theta} \Omega_m^{\theta} a$$

$$(x_1 + x_0 + d) \cdot w^{1-\theta} \Omega_m^{\theta} \cdot b \cdot ((\frac{\delta}{\delta-1}) - 1) = w^{1-\theta} \Omega_m^{\theta} a$$

$$(x_1 + x_0 + d) \cdot b(\frac{1}{\delta-1}) = a$$

$$(x_1 + x_0 + d) = \frac{a(\delta-1)}{b}$$

Let $\frac{a(\delta-1)}{b} = 1$, we have

$$(x_1 + x_0 + d) = 1$$

End of proof of Equation (6).

$$(10)\,\tau^{\theta\delta} \le \frac{\tau^{1-\delta}E_1 + (\frac{\rho_C}{\rho})^{1-\delta}E_0 + \tau^{\delta-1}E}{w_1 \cdot L_{m,1} / 1-\theta} \cdot (\frac{w_1}{w})^{\sigma(1-\theta)}$$

Equation (10) is derived from firm's positive profit condition in the small country.

$\pi_S = TR - TC$ (Applying Equation (1) we have)

$= p(x_1 + x_0 + d) - w^{1-\theta}\Omega_m^{\theta}(a + b\cdot(x_1 + x_0 + d))$ (Applying Equation (2) yields)

$= -a\ w^{1-\theta}\Omega_m^{\theta} + (p - w^{1-\theta}\Omega_m^{\theta}b)\cdot(x_1 + x_0 + d)$

$= -a\ w^{1-\theta}\Omega_m^{\theta} + (\frac{\delta}{\delta-1}\ w^{1-\theta}\Omega_m^{\theta}b\ \text{ - }\ w^{1-\theta}\Omega_m^{\theta}b)\cdot(x_1 + x_0 + d)$ Using (A1) yileds

$= -a\ w^{1-\theta}\Omega_m^{\theta} + \frac{1}{\delta-1}\ w^{1-\theta}\Omega_m^{\theta}b\cdot(x_1 + x_0 + d)$

$= w^{1-\theta}\Omega_m^{\theta}(-a + a\cdot(x_1 + x_0 + d))$

Because we choose $\frac{(\delta-1)a}{b} = 1$ at Equation (6), $b = (\delta-1)a$.

$= w^{1-\theta}\Omega_m^{\theta}\ a\ (-1 + (x_1 + x_0 + d))$

If $(x_1 + x_0 + d) > 1$, then $\pi_S > 0$. We can rewrite (A4) as

$$1 < p^{-\delta}(\tau^{1-\delta}\Omega_{m,1}^{\delta-1}E_1 + (\rho_c)^{1-\delta}\Omega_{m,0}^{\delta-1}E_0 + \Omega_m^{\delta-1}E)$$

As we know, if n=0, then $\Omega_{m,1} = n_1^{1/(1-\delta)}p_1$,

$\Omega_m = n_1^{1/(1-\delta)}(p_1\tau) = \tau\ \Omega_{m,1}$, and

$\Omega_{m,0} = n_1^{1/(1-\delta)}(p_1\rho) = \rho\ \Omega_{m,1}$).

$$1 < p^{-\delta}(\tau^{1-\delta}\Omega_{m,1}^{\delta-1}E_1 + (\rho_c)^{1-\delta}(\rho\,\Omega_{m,1})^{\delta-1}E_0 + (\tau\,\Omega_{m,1})^{\delta-1}E)$$

$$1 < p^{-\delta}\Omega_{m,1}^{\delta-1}(\tau^{1-\delta}E_1 + (\rho_c)^{1-\delta}(\rho)^{\delta-1}E_0 + (\tau)^{\delta-1}E)$$

$$1 < p^{-\delta}\Omega_{m,1}^{\delta-1}(\tau^{1-\delta}E_1 + (\rho_c/\rho)^{1-\delta}E_0 + (\tau)^{\delta-1}E)$$

(Due to (A1), $p(1-1/\delta) = w^{1-\theta}\Omega_m^{\theta}b$.

$$p = \frac{\delta}{\delta - 1} w^{1-\theta} \Omega_m^{\theta} b$$

$$= \frac{\delta}{\delta - 1} w^{1-\theta} (\tau \Omega_{m,1})^{\theta} b$$

$$= \tau^{\theta} w^{1-\theta} \frac{\delta}{\delta - 1} \Omega_{m,1}{}^{\theta} b$$

$$= \tau^{\theta} (\frac{w}{w_1})^{1-\theta} \frac{\delta}{\delta - 1} w_1^{1-\theta} \Omega_{m,1}{}^{\theta} b$$

By using (A6), $p_1(1 - 1/\delta) = w_1^{1-\theta} \Omega_{m,1}^{\theta} b$

$$= \tau^{\theta} (\frac{w}{w_1})^{1-\theta} p_1 \quad)$$

Substituting it into the following equation yields

$$1 < p^{-\delta} \Omega_{m,1}^{\delta-1} (\tau^{1-\delta} E_1 + (\rho_c / \rho)^{1-\delta} E_0 + (\tau)^{\delta-1} E)$$

Let $(\tau^{1-\delta} E_1 + (\rho_c / \rho)^{1-\delta} E_0 + (\tau)^{\delta-1} E) = B$

$$1 < (\tau^{\theta} (\frac{w}{w_1})^{1-\theta} p_1)^{-\delta} \quad \Omega_{m,1}^{\delta-1} \cdot B$$

Using the relationship of (A7), $\Omega_{m,1} = n_1^{1/(1-\delta)} p_1$, we have

$$1 < (\tau^{\theta} (\frac{w}{w_1})^{1-\theta} p_1)^{-\delta} \quad (n_1^{1/(1-\delta)} p_1)^{\delta-1} \cdot B$$

$$1 < \tau^{-\theta\delta} (\frac{w}{w_1})^{-\delta(1-\theta)} p_1^{-\delta} \quad n_1^{-1} p_1^{\delta-1} \cdot B$$

$$1 < \tau^{-\theta\delta} (\frac{w}{w_1})^{-\delta(1-\theta)} p_1^{-1} \quad n_1^{-1} \cdot B$$

$$\tau^{\theta\delta} < (\frac{w}{w_1})^{-\delta(1-\theta)} p_1^{-1} n_1^{-1} \cdot B$$

$$\tau^{\theta\delta} < \frac{B}{n_1 p_1} (\frac{w}{w_1})^{-\delta(1-\theta)}$$

Using (A10) $w_1 \cdot L_{m,1} = (1-\theta) \cdot n_1 \cdot p_1$ and the expression of B, we have

$$\tau^{\theta\delta} < \frac{\tau^{1-\delta} E_1 + (\frac{\rho_C}{\rho})^{1-\delta} E_0 + \tau^{\delta-1} E}{w_1 \cdot L_{m,1} / 1-\theta} \cdot (\frac{w_1}{w})^{\sigma(1-\theta)}$$

End of the proof of Equation (10)

(A13) $E_1 + E_0 + E = \dfrac{w_1 \cdot L_{m,1}}{1-\theta}, \quad E = \upsilon \cdot w \cdot L, \ \ E_1 = (\upsilon(1-\theta)+\theta)\dfrac{w_1 \cdot L_{m,1}}{1-\theta}$.

For the small country, we have

(A1) $p(1-1/\delta) = w^{1-\theta}\Omega_m^{\theta} b$

(A2) $\Omega_m = (np^{1-\delta} + n_1(p_1\tau)^{1-\delta})^{1/(1-\delta)}$

(A3) $E = \upsilon \cdot w \cdot L + \theta \cdot n \cdot p$

(A4) $1 = p^{-\delta}(\tau^{1-\delta}\Omega_{m,1}^{\delta-1}E_1 + (\rho_c)^{1-\delta}\Omega_{m,0}^{\delta-1}E_0 + \Omega_m^{\delta-1}E)$

(A5) $w \cdot L_m = (1-\theta) \cdot n \cdot p$.

For the large country, we have

(A6) $p_1(1-1/\delta) = w_1^{1-\theta}\Omega_{m,1}^{\theta} b$

(A7) $\Omega_{m,1} = (n(\tau \cdot p)^{1-\delta} + n_1 p_1^{1-\delta})^{1/(1-\delta)}$

(A8) $E_1 = \upsilon \cdot w_1 \cdot L_{m,1} + \theta \cdot n_1 \cdot p_1$

(A9) $1 = p_1^{-\delta}(\tau^{1-\delta}\Omega_m^{\delta-1}E + (\rho)^{1-\delta}\Omega_{m,0}^{\delta-1}E_0 + \Omega_{m,1}^{\delta-1}E_1)$

(A10) $w_1 \cdot L_{m,1} = (1-\theta) \cdot n_1 \cdot p_1$,

Let $w_1 = 1$.

For the global market, we have

(A11) $\Omega_{m,0} = (n(\rho_c \cdot p)^{1-\delta} + n_1(\rho \cdot p_1)^{1-\delta})^{1/(1-\delta)}$

(A12) E_0 =constant.

The derivation of (A13):

Suppose that all firms cluster in the large country, we have n=0.

To begin with, let's rearrange (A8) $E_1 = \upsilon \cdot w_1 \cdot L_{m,1} + \theta \cdot n_1 \cdot p_1$.

Using (A10) $w_1 \cdot L_{m,1} = (1-\theta) \cdot n_1 \cdot p_1$, we can rewrite (A8) as

$$E_1 = \upsilon \cdot w_1 \cdot L_{m,1} + \theta \frac{w_1 \cdot L_{m,1}}{1-\theta}$$

Rearranging it yields $E_1 = (\upsilon(1-\theta) + \theta) \frac{w_1 \cdot L_{m,1}}{1-\theta}$, which is the third item of (A13)

Applying (A3) $E = \upsilon \cdot w \cdot L + \theta \cdot n \cdot p$ and n=0, we have $E = \upsilon \cdot w \cdot L$, which is the second item of (A13).

The Equation (A9), $1 = p_1^{-\delta} (\tau^{1-\delta} \Omega_m^{\delta-1} E + (\rho)^{1-\delta} \Omega_{m,0}^{\delta-1} E_0 + \Omega_{m,1}^{\delta-1} E_1)$, comes from $\pi_L = 0$, the zero profit condition in the large country.

Since by applying n=0, we can rewrite (A7) as $\Omega_{m,1} = n_1^{1/(1-\delta)} p_1$,

(A2) as $\Omega_m = n_1^{1/(1-\delta)} (p_1 \tau) = \tau\ \Omega_{m,1}$, and

(A11) as $\Omega_{m,0} = n_1^{1/(1-\delta)} (p_1 \rho) = \rho\ \Omega_{m,1}$,

(A9) can then be simplified.

If we rearrange $\pi_L > 0$, we have

$$1 < p_1^{-\delta} (\tau^{1-\delta} (\tau\ \Omega_{m,1})^{\delta-1} E + (\rho)^{1-\delta} (\rho\ \Omega_{m,0})^{\delta-1} E_0 + \Omega_{m,1}^{\delta-1} E_1)$$

$$1 = p_1^{-\delta} (\tau^{1-\delta} (\tau\ \Omega_{m,1})^{\delta-1} E + (\rho)^{1-\delta} (\rho\ \Omega_{m,0})^{\delta-1} E_0 + \Omega_{m,1}^{\delta-1} E_1)$$

$$1 = p_1^{-\delta} (\ \Omega_{m,1}^{\delta-1} E + \Omega_{m,0}^{\delta-1} E_0 + \Omega_{m,1}^{\delta-1} E_1)$$

$$1 = p_1^{-\delta}\ \Omega_{m,1}^{\delta-1} (E + E_0 + E_1)$$

$$1 = p_1^{-\delta}\ \Omega_{m,1}^{\delta-1} (E + E_0 + E_1) \quad \text{(where } \Omega_{m,1} = n_1^{1/(1-\delta)} p_1 \text{)}$$

$$1 = p_1^{-\delta}\ (n_1^{1/(1-\delta)} p_1)^{\delta-1} (E + E_0 + E_1)$$

$$1 < p_1^{-1}\ n_1^{-1}(E + E_0 + E_1)$$

Applying (A10) yields

$$(E + E_0 + E_1) > p_1\ n_1 = w_1 \cdot L_{m,1} /(1-\theta)$$

$(E + E_0 + E_1) > \dfrac{w_1 L_{m,1}}{1-\theta}$, which is the inequality version of the first item in (A13).

If we want to prove (A13), just change the inequality sign to equality one.

End of the proof of Equation (A13).

(A14) $$L_{m,1,0} = \frac{\upsilon \cdot w \cdot L + E_0}{w_1 \cdot (1-\upsilon)}, \quad E = \upsilon \cdot w \cdot L, \quad E_1 = (\upsilon(1-\theta)+\theta) \cdot \frac{\upsilon \cdot w \cdot L + E_0}{(1-\theta)(1-\upsilon)},$$

Using the first item of (A13), $(E + E_0 + E_1) = \frac{w_1 L_{m,1}}{1-\theta}$,

the second item, $E = \upsilon \cdot w \cdot L$, and

the third item $E_1 = (\upsilon(1-\theta)+\theta)\frac{w_1 \cdot L_{m,1}}{1-\theta}$, we can solve $L_{m,1}$.

Substituting the second and the third item into the first one yields

$$E + E_0 + E_1 \equiv \upsilon wL + E_0 + (\upsilon(1-\theta)+\theta)\frac{w_1 L_{m,1}}{1-\theta} = \frac{w_1 L_{m,1}}{1-\theta}$$

$$\upsilon wL + E_0 = \frac{w_1 L_{m,1}}{1-\theta}(1-\theta-\upsilon(1-\theta))$$

$$\upsilon wL + E_0 = \frac{w_1 L_{m,1}}{1-\theta}(1-\theta)(1-\upsilon)$$

$$\upsilon wL + E_0 = w_1 L_{m,1}(1-\upsilon)$$

$L_{m,1} = \frac{\upsilon wL + E_0}{w_1(1-\upsilon)}$, which is the first item of (A14).

Substituting the expression above to the third item of (A13), we have

$$E_1 = (\upsilon(1-\theta)+\theta)\frac{w_1 \cdot L_{m,1}}{1-\theta} = (\upsilon(1-\theta)+\theta)\frac{w_1 \cdot}{1-\theta}\,\frac{\upsilon wL + E_0}{w_1(1-\upsilon)}$$

$= (\upsilon(1-\theta)+\theta)\frac{\upsilon wL + E_0}{(1-\theta)(1-\upsilon)}$ which is the third item of (A14).

End of the proof of Equation (A14).