Hub and Spoke Integration and Income Convergence

Masaru Umemoto
Research Assistant Professor, ICSEAD

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Abstract:

This paper considers the impact of a hub and spoke preferential trading arrangement (PTA) on real income convergence. The theoretical model developed in this paper explains how the comparative advantage of the hub country relative to each spoke country can be linked to the distribution of the trading benefits. The experiments based on the model suggest that the establishment of a hub and spoke PTA leads to a convergence in real income between the hub and higher income spoke countries, while it causes a divergence between the former and lower income spoke countries. Moreover, it is found that PTAs which include spoke countries with very different income levels from each other maximize scope for trade creation and result in a large benefit to the hub country.

Key Words: Hub and Spoke, regional integration, income convergence.

JEL classification: F15

1. Introduction

A number of regional trade agreements have been developed around the world since the 1990's and the integration system is becoming more complex. Thus, it is not rare for countries that are members of different trade agreements to form preferential trading arrangements (PTAs). For instance, Singapore has several PTAs with various countries that do not have other PTAs, such as the Southeast Asian nations and Japan. Such systems are known as "hub and spoke" integration. In the previous example, Singapore is regarded as a hub and the others are spokes. A hub country has PTAs with a number of spoke countries that maintain barriers between each other. With this kind of arrangement in place, what are the benefits and costs to the hub and spoke countries? Does a hub gain at the expense of spokes? Does a low-income hub tend to catch up with high-income spokes? And, what are the factors that make one country the best new spoke partner for any given hub? This paper will address the above questions.

Several studies have been made on the welfare effects of hub and spoke integration. The classic analysis of the real income effects of membership in hub and spoke PTAs is that of Wonnacott (1975). Kowalcyzk and Wonnacott (1992) found that the benefits to the hub country are probably greater than that to the spoke countries where there is perfect competition because the hub and spoke integration leads to trade diversion for spoke countries, but not for the hub country. Krugman (1993) and Puga and Venables (1995) also suggest that there are relatively large welfare gains to the hub country in conditions of imperfect competition because of the agglomeration of industries into the hub country.[1]

The objectives of this paper are to investigate the welfare change of each member country caused by hub and spoke integration and the consequent effects on real income convergence or divergence. This paper analyzes two issues. First, how the formation of a new integration between a member of the existing PTA and non-members of the PTA affects the distribution of trade benefits among the hub and

[1] For a survey of hub and spoke integration, see Baldwin and Venables (1995) and Venables (2002).

spoke countries. Second, whether the real incomes of the hub and spoke countries tend to converge or diverge.

The approach taken in this paper is to use the Heckscher-Ohlin model to focus on the welfare changes in the hub and spoke countries. The Heckscher-Ohlin model takes into account product differentiations between countries. By looking at the comparative advantages of hub and spoke countries relative to one another, this paper provides a basis for discussion about the distribution of gains or losses. To put it precisely, conditions that cause trade creation, trade diversion, and trade erosion are identified. This paper expands this investigation into an analysis of real income convergence or divergence among the hub and spoke countries.

The remainder of the paper is structured as follows: the next section sets up the formal model, which is based on Venables (1999, 2000); section 3 introduces concepts such as trade creation, trade diversion, and trade erosion effects, and illustrates differences in welfare changes across countries with differences in endowments; section 4 discusses real income convergence; and Section 5 concludes with a discussion of policy implications and areas of future study.

2. The model

For a rigorous examination of hub and spoke integration, this paper employs the Heckscher-Ohlin-Armington model. In this model, comparative advantage arises from differences in factor endowments as in the standard Heckscher-Ohlin model. However, this model adds an assumption of product differentiation at the national level, known as the Armington assumption, in order to maintain non-specialization of production and to allow output prices to change in each country.[2] The basis of such a model is developed and analyzed by Venables (1999, 2000) for the case of a general regional integration, and here it is extended for the hub and spoke analysis. Analysis of this model requires numerical simulation, although most of the results comes from the standard Heckscher-Ohlin model.

[2] Under the Armington assumption, products in each sector are differentiated by location of production. The elasticity of substitution between different countries' products in each sector is set to 50 in the experiments that are conducted.

In the model used here, there are three countries, 1, 2, and 3. Initially, countries 1 and 2 are considered to be members of a PTA while country 3 is not. Subsequently, all three counties form a hub and spoke system, with country 1 as the hub, country 2 as an old spoke, and country 3 as a new spoke. As in the standard Heckscher-Ohlin model, this model assumes that all countries have the same technology and have different endowments of two factors, referred to as capital and labor, K and L. The endowment differences are the basis of their comparative advantage.

Each country can produce two goods. Both goods are tradable and use capital and labor in different proportions. The representative consumers in all countries have identical preferences despite assuming product differentiations across countries. For ease of interpretation this paper imposes a symmetric structure on production and consumption, assuming that consumer expenditure is equally divided between the two goods, and that the factor intensity in one industry is the reciprocal of that in the other industry.[3]

In the initial equilibrium all imports face the same tariff rate regardless of source or commodity type except for the trade between members of the existing PTA, countries 1 and 2. Since the imports between countries 1 and 2 face the same preferential tariff rate, this model sets it to zero for simplicity. The internal price ratios and trade patterns of each country reflect these tariffs and each country's factor abundance. To investigate welfare changes in each country, the tariffs between the members of the newly established PTA, countries 1 and 3, are removed.

The results of the experiments are illustrated in Figures 1, 2, and 3, which give contour lines of welfare change as a function of the factor endowments of the countries except for a base country of each figure. Two bold straight lines marked 00 are the zero contour, and the plus and minus signs indicate regions of welfare gain and welfare loss respectively, resulting from the new integration formation. Each figure has axes that give the other two countries' factor endowments, expressed as deviations from their own endowments. For instance, in Figure 1, point 0 on the horizontal and vertical axes corresponds to a point where country 2's endowment ratio is K_2/L_2. To the right of this point on the horizontal axis country 1 becomes capital abundant and labor scarce

[3] Equations used in the experiments are given in the appendix.

relative to country 2. Similarly, country 3 is capital abundant and labor scarce relative to country 2 above point 0 on the vertical axis. Comparison of endowments between countries 1 and 3 is done with reference to the 45-degree line. Above this line country 3 is capital abundant relative to country 1, while below the line it is labor abundant.

3. Trade creation, trade diversion, and trade erosion

Three figures enable us to make arguments about the relative distribution of costs and benefits among the hub and spoke countries. Now, welfare changes of each country with these three figures are investigated for the case that the country 1, a member of the PTA with country 2, forms another PTA with country 3, which initially does not belong to the former PTA. There are three important concepts to explain welfare changes. They are trade creation, trade diversion, and trade erosion.

According to definitions by Viner (1950), trade creation is the replacement of expensive domestic production by cheaper imports from a partner and trade diversion is the replacement of cheaper initial imports from the outside world by more expensive imports from a partner. In the case of the hub and spoke system, trade creation occurs when a new PTA replaces expensive domestic production by cheaper imports. In contrary, trade diversion occurs when a new PTA replaces cheaper initial imports by more expensive imports from other countries. Trade creation is expected to be beneficial since lower cost imports replace higher cost (previously protected) domestic production. Trade diversion could lead to a reduction not only in the welfare of the country directly concerned but also in the welfare of the country that supplied less expensive products initially. The last concept, trade erosion, is defined here as the replacement of expensive initial imports by cheaper imports in the hub and spoke system. Because lower cost imports replace higher cost (previously protected) imports, the welfare gains of trade erosion are expected.

Before starting to analyze welfare effect of the hub and spoke integration, it must be notified that the old spoke country (country 2) never experiment the welfare gain in Figure 1 and the hub country (country 1) never experiment the welfare loss in Figure 2 by the establishment of the hub and spoke system. For the new spoke country,

there is possibility of increase and decrease in welfare on the basis of the relative factor endowment differences. The cause of this result is the assumption that all traded products are substitutes for each other. An increase in the elasticity of substitution may lead a greater reduction in the welfare of country 2.

To explain determinants of changes in trade sources and welfare among the hub and spoke countries, it is necessary to look at the comparative advantage of these countries relative to each other. Now, consider this issue from three cases.

Case I. $K_1/L_1>K_2/L_2>K_3/L_3$ **or** $K_3/L_3>K_2/L_2>K_1/L_1$**:**

In the upper left or lower right quadrant of Figure 1, the lower right or upper left triangle shaped regions of Figure 2, and the upper left or lower right triangle shaped regions of Figure 3, the hub and new spoke countries' endowment ratio lie on opposite sides of the old spoke country's endowment ratio. In this case, the hub country has a comparative advantage in capital intensive goods and the new spoke country has a comparative advantage in labor intensive goods relative to the other countries (or opposite orders from each other). Since the hub country will replace its imports from old spoke, which is protected by the early PTA, to imports from new spoke, this trade erosion lead to the welfare loss for the old spoke country (Figure 1) but the welfare gain for the hub country (Figure 2). On the other hand, since a new PTA between country 1 and 3 removes the trade barrier between them, the new spoke country is likely to experience the welfare gain of trade creation (Figure 3).

Case II. $K_2/L_2>K_1/L_1>K_3/L_3$ **or** $K_3/L_3>K_1/L_1>K_2/L_2$**:**

In the lower right or upper left triangle shaped regions of Figure 1, the lower right or upper left quadrant of Figure 2, and the upper right or lower left triangle shaped regions of Figure 3, both hub and new spoke countries' factor endowment ratios are on the same side of the old spoke's ratio, but country 3's is further away than country 1's. Under this endowment ratio relation, the old spoke country has a comparative advantage in capital intensive goods and the new spoke country has a comparative advantage in labor intensive goods relative to the other countries (or opposite orders from each other). In this case, the hub country replaces its previously protected domestic production to imports from the new spoke country. Thus, the hub country experiences trade creation

and welfare gain (Figure 2). In contrast, the new spoke country is likely to replace its imports from the non-member of new PTA, country 2, to the partner of new PTA, which has the comparative disadvantage in the imported products, and suffers trade diversion and welfare loss (Figure 3). This trade diversion in the new spoke country causes the reduction in imports from the old spoke and it makes welfare loss in the old spoke country (Figure 1).

Case III. $K_2/L_2>K_3/L_3>K_1/L_1$ **or** $K_1/L_1>K_3/L_3>K_2/L_2$**:**

In the lower left or upper right triangle shaped regions of Figure 1, the upper right or lower left triangle shaped regions of Figure 2, and the lower right or upper left quadrant of Figure 3, country 2 has a comparative advantage in capital (or labor) intensive goods and country 1 has a comparative advantage in labor (or capital) intensive goods relative to the other countries. Under this pattern of the endowment ratios, trade creation occurs in the new spoke country (Figure 3). It seems to happen the trade diversion in the hub country in this case. However, the hub country will not experience the welfare loss of trade diversion in Figure 2. It is because that the old spoke was already treated preferentially as an early PTA partner, and increase in imports from new spoke country does not displace lower cost imports from old spoke country. On the contrary the removal of the trade barriers between the hub and new spoke countries corrects the distortion and make the welfare of the hub country increase.

4. Income convergence and divergence

The previous section has investigated that the welfare changes in each country caused by forming hub and spoke integration. Now, this section investigates the question whether such welfare changes induce the income difference among the hub and spoke countries to converge or diverge. The experiments of this paper hold endowment of labor constant and vary the amount of capital. Thus, capital abundant (or high capital-labor endowment ratio) countries can be said relatively high income. In the same way of the previous section, the real income convergence or divergence among the hub and spoke countries is studied in the three cases.

Case I. $K_1/L_1>K_2/L_2>K_3/L_3$ **or** $K_3/L_3>K_2/L_2>K_1/L_1$**:**

In the case that the new spoke country's endowment ratio is always more extreme than the old spoke country's endowment ratio, the real incomes of the hub and new spoke countries increase and that of the old country decreases because of the trade erosion and creation effects.[4] Accordingly, the real income level of the old spoke country diverge from that of lower income country and converge to that of higher income country in the new PTA (Figure 4).

Case II. $K_2/L_2>K_1/L_1>K_3/L_3$ **or** $K_3/L_3>K_1/L_1>K_2/L_2$**:**

Although the real income of the hub country increases by the trade creation effect, the new spoke country loses its real income because of the trade diversion effect, and it causes the reduction in the real income of the old spoke country. Therefore, if the old spoke country has the highest income level and the hub country form a new PTA with a lowest income new spoke country, the old spoke converge to the lower income hub country and diverge from the new spoke country (Figure 5). To the contrary, if the old spoke country is the lowest income and the hub country form a new PTA with the highest income new spoke country, the old spoke diverge from the higher income hub country and converge to the new spoke country.

Case III. $K_2/L_2>K_3/L_3>K_1/L_1$ **or** $K_1/L_1>K_3/L_3>K_2/L_2$**:**

In the case that the old spoke country's endowment is always more extreme than the new spoke country's endowment, trade creation effect increases the real income level of the new spoke country and the annulment of the distortion increases the real income level of the hub country at the expense of the old country. Therefore, if the old spoke country has the highest income level and the hub country forms a new PTA with a higher income new spoke country, the old spoke converges to the lowest income hub country (Figure 6). To the contrary, if the old spoke country is the lowest income and the hub countries form a new PTA with the lower income new spoke country, the old spoke diverge from the highest income hub country (Figure 7).

There are two important points to emphasize here. First, in any cases above,

[4] Welfare levels are measured by the degree of utility, which is defined by the nominal income divided by the weighted price indexes of traded goods. See equation 2 in appendix.

to form a hub and spoke integration, the old spoke converges to the lower income hub country or diverges from the higher income hub country. Second, with the assumption that the endowments of the hub country as the standard, the country with more capital abundant than the hub country can be called as “high income” country and the country with less capital abundant than the hub country can be called as “low income” country. Then, The hub and spoke system with low income spokes causes diversion between the old spoke and hub countries. Conversely, The hub and spoke system with high income spokes causes convergence between the old spoke and hub countries. In the case that spoke countries are low and high income, a new PTA with low income spoke country will cause divergence of real income in the PTA, with the high income old spoke country losing. In contrast, a new PTA with high income spoke countries will cause convergence among the PTA members with the low income old spoke country losing.

5. Conclusion

This paper has shown that the distribution of trade benefits and the convergence of real incomes by hub and spoke integration can be linked directly to the comparative advantages of the member countries. However, this analysis does not cover all the factors for convergence or divergence of real income levels among the hub and spoke countries of the PTA. For instance, agglomeration effects may amplify the welfare changes and the income convergence or divergence that are induced by comparative advantage. In order to analyze the agglomeration forces, experiments of conditions of imperfect competition are required. This remains a matter for further discussion.

According to the results of this analysis, the original spoke country always loses out in a situation of hub and spoke integration. However, this result comes from the assumption that each product is substitutable and that there exists product differentiation at the national level. If the tradable products are complements, such as manufactured goods and their components, the resulting welfare changes are likely to be altered. In that case, trade erosion effects may not occur and the old spoke country would also tend to gain. Experiments with complementary goods is an area for further research.

The analysis in the previous sections leads to an important policy question; namely, what type of new spoke countries are the best for a hub country? Figure 2 shows that the hub country always gains in the hub and spoke system. When a greater number of countries is linked to the hub, each new spoke leads to more trade creation if the new spokes have comparative advantages in different goods from those of the old spokes. In this case the real income level of the hub country converges to that of the higher income spokes and diverges from that of the lower income spokes at the expense of the lower income spoke countries. Generally, a country is likely to obtain benefits from the forming of PTAs with countries of higher income levels. The results suggest that hub and spoke systems that include only higher income spokes cause convergence between the hub and the old spokes. It is because such systems lead an upward move in the hub's income level and a downward move in the old spokes' income levels. Consequently, making a hub and spoke integration with spoke countries that have very different endowment ratios or different levels of income from each other maximizes scope for trade creation and results in large benefits to the hub country.

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Appendix:

Technologies using Cobb-Douglas forms are described by unit cost functions,

$$c_i^x = w_i^{\lambda} r_i^{1-\lambda}, \quad c_i^y = w_i^{1-\lambda} r_i^{\lambda}. \tag{1}$$

where r_i and w_i are factor prices with respective endowments K_i and L_i in country i. The experiments of this paper set λ=0.25. Preferences are described by indirect utility functions,

$$u_i = \frac{m_i}{\left(G_i^x G_i^y\right)^{1/2}} \tag{2}$$

where m_i is income and G_i^s is the price index of good s in country i, defined by

$$G_i^s = \left[\sum_{j=1}^{3}\left(t_{ji} p_j^s\right)^{1-\sigma}\right]^{1/(1-\sigma)} \tag{3}$$

where p_j^s denotes the price of good s produced in country j, equal to unit cost, t_{ji} denotes the tariff imposed in country i on products from country j, and σ denotes the elasticity of substitution between different countries' products. Assume that t_{ji} takes initial value 1.3, t_{ij} dropping to 1 when the preferential trade arrangement is formed between country i and j.

The income is given by

$$m_i = w_i L_i + r_i K_i + \sum_{j=1}^{3}\sum_{s=x,y} p_j^s q_{ji}^s \left(t_{ji} - 1\right) \tag{4}$$

where q_{ji}^s denotes the quantity of good s produced in j and sold in i. The Marshallian demand functions for each country's goods are derived from utility maximization,

$$q_{ji}^s = \left[p_j^s t_{ji}\right]^{-\sigma}\left(G_i^s\right)^{\sigma-1}\frac{m_i}{2}. \tag{5}$$

Finally, factor market clearing conditions take the form

$$K_i = \frac{\partial c_i^x}{\partial r_i} q_i^x + \frac{\partial c_i^y}{\partial r_i} q_i^y, \quad L_i = \frac{\partial c_i^x}{\partial w_i} q_i^x + \frac{\partial c_i^y}{\partial w_i} q_i^y \tag{6}$$

where q_i^s denotes the quantity of good s produced in country i. The total demand of good s produced in j is the sum of the Marshallian demand functions for country j

$$q_j^s = \sum_{i=1}^{3} q_{ji}^s = \sum_{i=1}^{3} \left(p_j^s t_{ji}\right)^{-\sigma} \left(G_i^s\right)^{\sigma-1} \frac{m_i}{2}. \qquad (7)$$

In Figures 1 endowments vary in the interval K_i/L_i= [0.50, 1.50], i=1,3 with K_2/L_2=1.
In Figures 2 endowments vary in the interval K_i/L_i = [0.50, 1.50], i=2,3 with K_1/L_1=1.
In Figures 3 endowments vary in the interval K_i/L_i= [0.50, 1.50], i=1,2 with K_3/L_3=1.

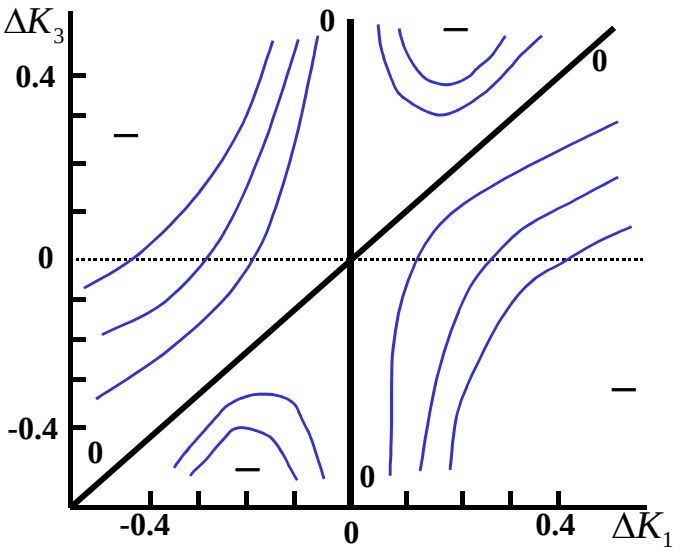

Figure 1: the old spoke welfare change contours

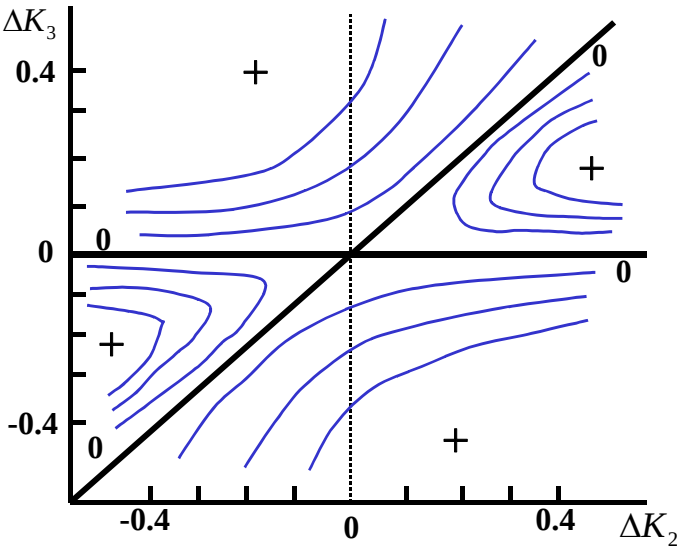

Figure 2: the hub welfare change contours

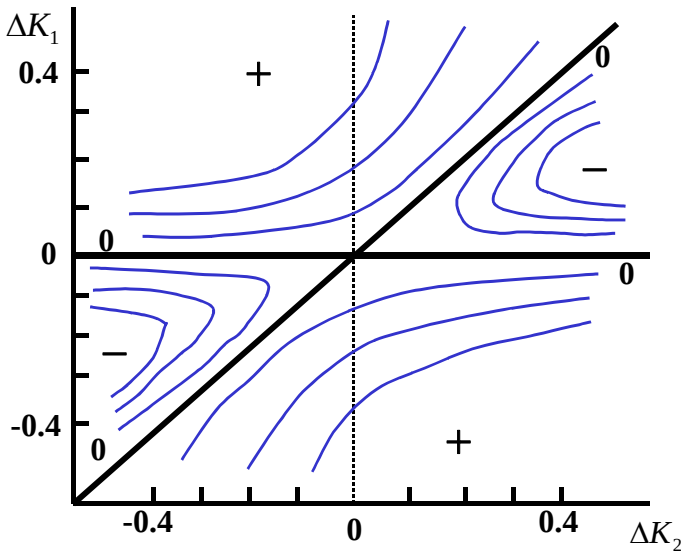

Figure 3: the new spoke welfare change contours

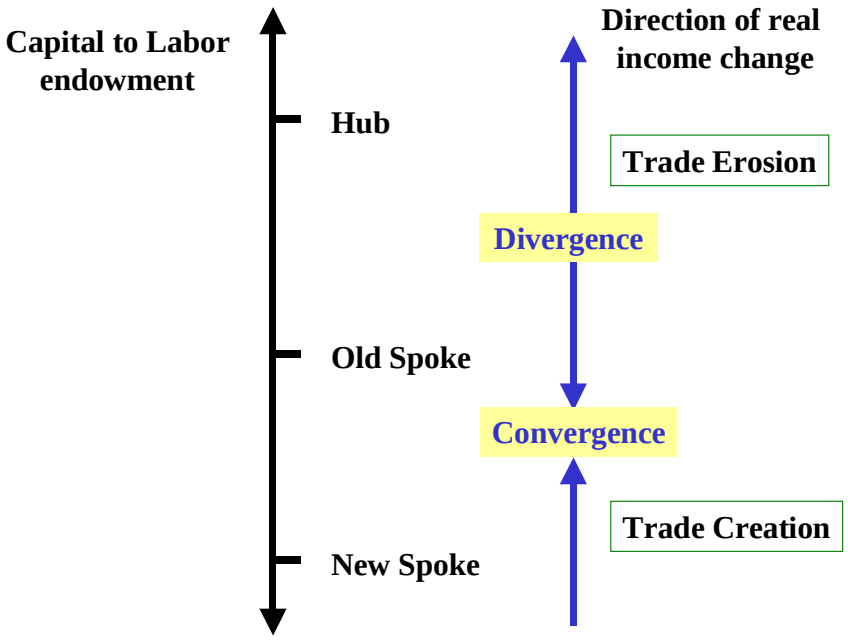

Figure 4: Convergence and Divergence of Real Incomes in Case I

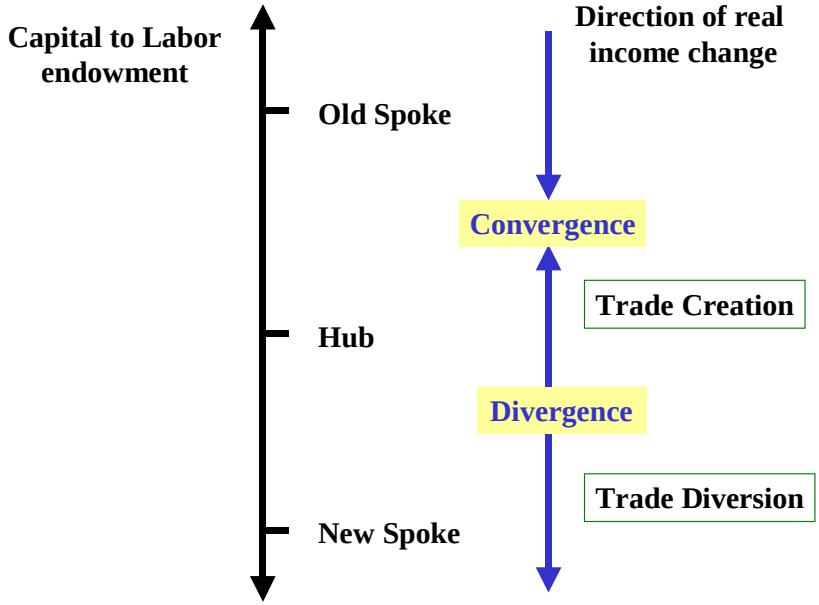

Figure 5: Convergence and Divergence of Real Incomes in Case II

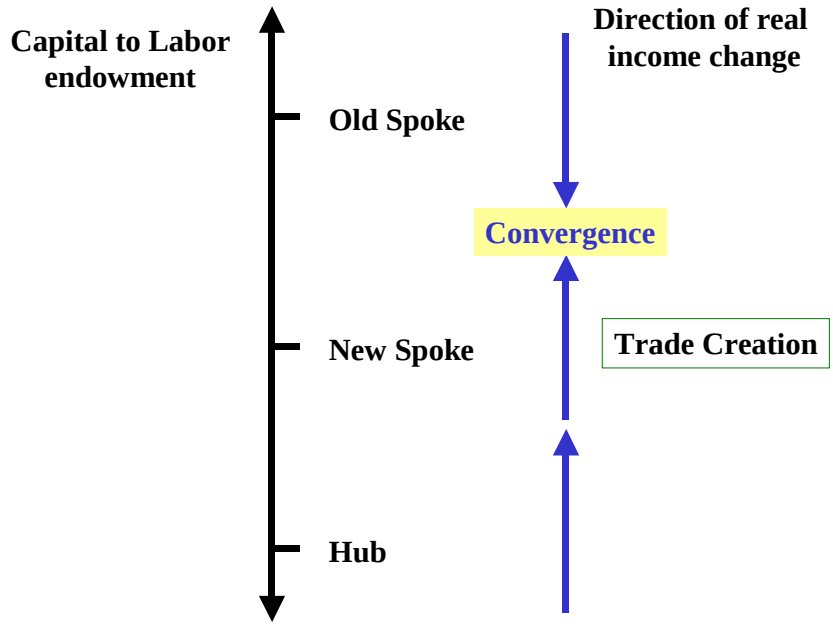

Figure 6: Convergence of Real Incomes in Case III

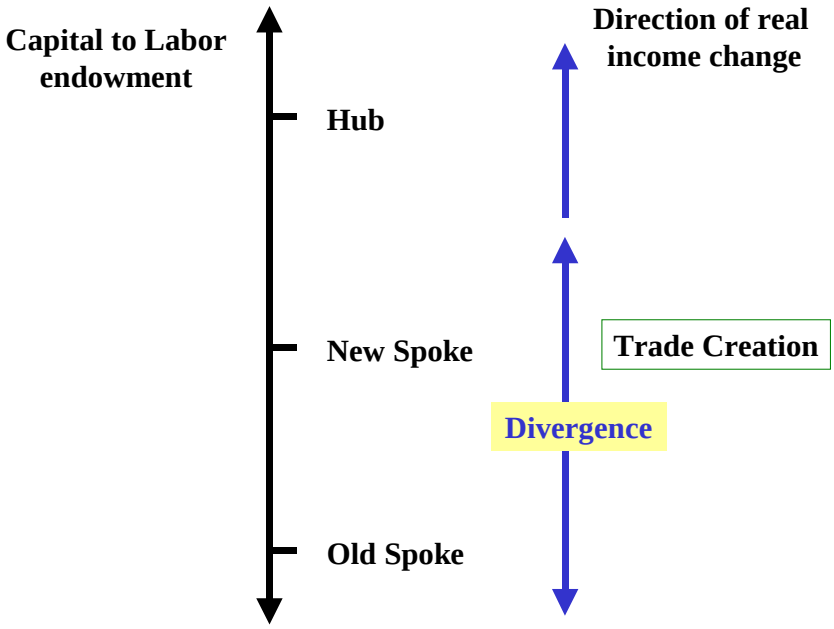

Figure 7: Divergence of Real Incomes in Case III