Resource-Allocation Advantage and International Trade

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Abstract

This article demonstrates that wealthy and advanced nations have the capacity to absorb additional resources to the nontradable sectors. This absorption capacity provides them with an advantage in resource allocation, which consequently transforms to welfare gains in trade. The author builds a mathematical model that captures this institution of resource-allocation advantage and that provides a measure of its welfare effect on trade. The model also compares the relative strength of such advantage between wealthy nations. It draws three main conclusions: (1) the resource-allocation advantage makes wealthy nations better off; (2) immiserizing growth is less likely to occur to wealthy nation; and (3) some key economic parameters such as productivity and national wealth level can affect trade gains.

Key Words: resource-allocation advantage, absorption capacity, constrained Nash equilibrium, immiserizing growth, national strategy, nontradables, role of nation in trade gains

JEL: C70, F10, I31

INTRODUCTION

It is observed that nations with high income and national wealth consume certain non-tradables with systematic high quality, such as high quality of environment, high standards of healthcare, and first-class higher education that poor nations can barely afford. The demand for these nontradables highly depends on the income and wealth level of a nation. When income and wealth increase, people tend to increase demand for a better environment, healthcare system, and higher education. These specific nontradable sectors can absorb resources when demand in the tradable sector is relatively weak. The recent recession in the United States, which started in December 2007 and ended in June 2009,[1] had a peak unemployment rate at 9.8%. However, the data from the Bureau of Labor Statistics show job growth in the education and health-related sectors during the recession. The educational services sector added almost

[1] It is determined by the National Bureau of Economic Research.

114,000 jobs, a 3.82% increase, and the health care and social assistance sector added almost 492,000 jobs, a 3.17% increase.[2]

It is also observed that, on many occasions, the amount of resources allocated to these sectors is, to some extent, strategically determined or influenced by national policy. For example, in fiscal year 2010, the U.S. government spent (budget outlays) $43.7 billion on natural resources and environment; $127.8 billion on education, training, employment, and social services; $369.1 billion on health; and $451.6 billion on Medicare.[3] The reported U.S. government spending on the American Recovery and Reinvestment Act of 2009[4] shows that the Department of Health and Human Services and the Department of Education are the two agencies that have paid out the most money at $105.05 billion and $70.51 billion, respectively. The combined spending accounted for 49.4% of the total spending.

Bearing these phenomena in mind, I build a trade model that explains why the resource absorption created by these nontradable sectors provides a resource-allocation advantage and hence advantage in trade gains. The hypothetical example in the next paragraph demonstrates the basic idea of the resource-allocation advantage.

Consider a trade system of two Robinson Crusoe economies. One economy consists of a baker, and the other consists of a shoemaker. For simplicity, assume that the baker can only engage in two activities: (1) producing bread and (2) having leisure time.[5] He will not make shoes; instead he will trade bread for shoes with the shoemaker. At the beginning, the baker only engages in producing bread. In time, he becomes more skillful and increases productivity. He produces a sufficient amount of bread for his own consumption and for trading for shoes. At this point, he is able to work fewer hours in the bakery and enjoy more leisure, which yields two gains. First, the baker benefits from a better term-of-trade as a result of reduced supply of bread, compared to if he works in the bakery full time. Second, leisure generates satisfaction and health for him. The time

[2] Employment data are seasonally adjusted.
[3] Data are from Budget of the United States Government: Detailed Functional Tables Fiscal Year 2011. Data are available at http://www.whitehouse.gov/sites/default/files/omb/budget/fy2012/assets/27_14.pdf
[4] Data are updated on 01/21/2011 at recovery.gov and available at http://www.recovery.gov/Transparency/agency/Pages/AgencyLanding.aspx
[5] It refers to the additional leisure besides the necessary rest needed to reproduce his labor. If working eight hours a day is the norm, working less than eight hours a day is considered as having leisure time.

that the baker can afford to spare on leisure depends in large measure on his productivity in making bread. If his productivity is low, he has to work an adequate number of hours in the bakery to reach sufficiency in production. He may not necessarily be able to or, more precisely, be willing to have leisure time. In other words, the baker has a resource-allocation advantage if he is sufficiently productive. Further, the comparison can be made between the baker and shoemaker. If the shoemaker cannot afford to spare time on leisure while the baker can, with other things being equal, the baker definitely has an advantage in allocating his resources –an advantage then can be materialized in terms of the twofold gains mentioned earlier.

This article builds a mathematical model to capture this institution of resource-allocation advantage demonstrated by the aforementioned hypothetical example. It provides proof of its welfare effect on trade gains. The model fits the observed phenomena mentioned earlier: (1) absorption occurs in some nontradable sectors, and (2) the government strategically allocates resource to these nontradable sectors. The model highlights three main conclusions: (1) the resource-allocation advantage makes wealthy nations better off; (2) immiserizing growth is less likely to occur with wealthy nations; and (3) some key economic parameters such as productivity and national wealth level will affect trade gains by nation. Even though a large amount of interest is devoted to address trade between wealthy and poor nations, it does not undermine the fact that the proposed model can also be equally applied to trade between wealthy nations. After all, resource-allocation advantage reflects relative strength between nations. The model provides a measure of resource-allocation advantage.

The remainder of the article is organized as follows. The next section relates the proposed model with the literature. The third section lays out the framework and assumptions for the model. After that is a discussion of the terms and volume of trade. The fourth section discusses trade equilibrium, measure of resource-allocation advantage, and the effect of system parameters on national welfare. The final section concludes.

LITERATURE

First, the proposed model is compared with some key models. Second, the proposed model is compared with other models that address the role of nation in trade gains. Third, I compare the purpose of including nontradables is compared with other models.

Comparison with Key Models

Baldwin (1948) used a diagrammatic analysis to establish the optimum price and production equilibrium for a monopoly given the other trading nation's offer curve. Johnson (1953) showed trade equilibrium and welfare when both nations have market power through tariff and retaliation.[6] [7] Both models assume that nations have complete and direct market power over tradable goods, and both models demonstrate that one nation can expand its gains at the expense of the other. The proposed model shows comparable welfare effect to their models. However, it discusses a seemingly similar but completely different question. It does not address how nations can obtain additional trade gains by manipulating their trade policy. It illustrates that wealthy and advanced nations have advantage in resource allocation, which leads to gains in trade. No trade policy is associated with such gains. The proposed model is distinguished from Baldwin's and Johnson's models in two fundamental ways: (1) nations have only a confined and indirect market power on tradable goods by strategically allocating resources to the nontradable sector; and (2) most importantly, trade is still free and production of tradable goods is still efficient. The similarity of these models is that they all address how a nation can affect gains from trade (mostly at the expense of other nations compared with the situation if the specific influence of the nation does not exist). However, the role of nation can be quite (even fundamentally) different. The proposed model highlights a national advantage and active national role in resource allocation as the results of high productivity in the tradable sectors.

Johnson (1967) and Bhagwati (1958, 1969) addressed the possibility of income losses from increased efficiency. In their models, they showed that increased efficiency can increase supply and hence deteriorate the terms of trade. When this occurs,

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[6] Also see, for example, Johnson (1951, 1953, 1960, 1965a, 1965b), Hagen (1958), Syropoulos (2002), Tower (1975), and Gehrels (1971).

[7] Riezman (1982) discussed the issue through a strategic point view.

immiserizing growth will occur. The proposed model demonstrates that immiserizing growth is less likely to occur (or at least has dampened effect) to wealthy and advanced nations. This is because they have the capacity to absorb extra resources into certain nontradable sectors to reduce the stress facing the tradable sector. In contrast, this article shows the possibility of the terms of trade and income increase when productivity increases in the tradable sector for wealthy and advanced nations due to resource-allocation advantage.

The Prebisch-Singer hypothesis argued that the terms of trade between primary products and manufactured goods tend to deteriorate over time because income elasticity of demand for manufactured goods is greater than that for primary goods. Debaere and Lee (2003) argued a more realistic version of the Prebisch-Singer hypothesis on the basis of their findings of a positive correlation between a country's terms of trade and its per capita gross domestic product (GDP) or its research and development (R&D) induced productivity. Considering per capita GDP and R&D as proxy for differences in quality and variety of output, they argued that countries can avoid adverse terms of trade through quality and variety upgrading. They suggested that big countries are able to affect their own terms of trade. Hallak (2003) suggested that quality affects pattern of trade, i.e., rich countries import more from countries that produce high-quality goods. The proposed model emphasizes the systematic quality difference that occurs in the nontradable sectors across nations. The ability to sustain high-quality systems in certain nontradable sectors gives wealthy and advanced nations the capacity to absorb additional resources from the tradable sectors. However, key to sustain high-quality systems in the nontradable sectors is high productivity in tradable sectors, which consequently transforms to an advantage in resource allocation.

The Role of Nation in Trade Gains

This section emphasizes the role of nation in trade gains. It relates to the existing models and adds a new dimension to this rich literature. The existing literature can be roughly categorized into three areas: (1) trade-related government strategy, such as

strategic trade policy; (2) national advantage, such as wealth and technology; and (3) competitive advantage induced by national policy and strategic planning.

Trade-related government strategy has been discussed along several different lines. One important line of argument is trade restriction and protection. Besides the literature discussed previously, some authors have addressed government protection on special occasions to obtain gains from trade. For example, Bagwell and Staiger (1990) showed that countries use special protection to exploit gain from trade when trade volume is high. Mann (1987) argued that periods of macroeconomic stress especially linked to trade imbalances decrease the benefits from free trade for the United States. Therefore, the United States, in such periods, tended to threaten its trading partners with a shift of its trade policy, which may lead to negotiations to open markets. However, the deviation from consensual international code of trade conduct by the United States on some occasions evoked tit-for-tat retaliations from its trading partners.[8]

Another influential line of argument is strategic trade or industrial policy. It emphasizes how government can use industry policy in an international oligopolistic or duopoly market to obtain comparative advantage for national industries. Trade is intervened in the sense that a nation's government supports its national firm to compete with foreign firm(s). Thus, government support provides a comparative advantage to its own national firm if other governments do not follow suit. Spencer and Brander (1983, 1985) argued that government uses industry policies to capture a larger share of international profitable industries. Thus, the gain of one nation is at the expense of other nations. Krugman (1984) proposed a different mechanism of strategic trade policy. In an international oligopolistic market with economics of scale, protecting the home market for a domestic producer will allow the domestic producer to produce more and hence reduce its marginal cost of production. At the same time, this will increase the marginal cost of production of a foreign producer as it sells less. This will lead to an increase in export by the domestic firm as a result of the opposite effect on the domestic and foreign firms' marginal cost. Therefore, Krugman argued that an import protection can be an export promotion. Eaton and Grossman (1986) provided an analysis for optimum

[8] Some authors have argued that labor standard can be used to obtain welfare gains from trade. See Brown (2001) for a comprehensive survey regarding labor standard and international trade.

trade or industrial policy under oligopoly with a variety of assumptions about market structure and conduct (i.e., Cournot and Bertrand competition). Bagwell (1991, p. 1166) "consider[ed] the role for specific export subsidies as a means to enhance export-country welfare in a new-product industry." He concluded that "an export subsidy provides a first-order benefit to export-country welfare by reducing the distortion in high-quality prices and causes only second-order losses to welfare by introducing distortion in low-quality prices and the selection of quality" (pp. 1166-7). Collie (1997) analyzes the effect of trade bloc enlargement in a multicountry version of a Brander-Spencer export subsidy game. For comprehensive surveys of literature, see Stegemann (1989) and Reimer and Stiegert (2006), where Reimer and Stiegert emphasized empirical literature.

Some authors have argued certain national advantages such as technology and wealth can be the cause of comparative advantage and trade gain. Rodriguez (1975) addressed the monopolistic position and benefit of a nation, which has exclusive technology to produce one good. He argued that the nation with exclusive technology can maximized its national welfare by charging a tariff and a rent for the use of the technology by the foreign country. Wynne (2005) argued that wealth can be a determinant of comparative advantage in the sectors facing severe financial imperfections. These sectors are typically populated by small firms and are labor intensive; wealth provides these firms better access to credit.

Some authors (e.g., Porter, 1998 and Vietor, 2007) have emphasized the national role in providing a competitive advantage. Vietor (2007) in his book *How Countries Compete* emphasized the role of government in maintaining national competitive advantage in a global economy. He argued that the government takes responsibility not only for fiscal and monetary policy, "but [also] resources for housing, education, health, research and development, and defense" (p. 2). The government provides explicit or implicit strategy for economic development (including macroeconomic and micro-economic components) and institutional structure to implement such strategy. The strategy and institutional structure together take the role of resource development and efficient use of resources. Karagiannis and Madjd-Sadjadi (2007) in the preface of their

book provided a comprehensive summary of state intervention: "[States] need to have strong policy instruments which will enable them to plan and finance their strategic goals such as job creation, higher mass living standards, endogenous competency and competitiveness, research and development, environmental protection, etc."

Compared with those in the literature, the proposed model is not involved in trade restriction and protection, and trade is still free. It is also not involved in any strategic trade policy that supports national firms to compete with foreign firms. It agrees with the literature on national roles in resource allocation and development planning. It emphasizes the effect of resource allocation on trade gains, whereas much of the literature (e.g., Ray, 1976, Melo & Robinson, 1981, and Melitz, 2003) has emphasized the effect of trade and trade policy on resource allocation. The proposed model relates to the literature regarding government spending on nontraded goods. Nakibullah and Cho (1993) discussed how government spending affects the relative price and output of nontraded goods. Brennan and Pincus (1983) discussed how government expenditure affects resource allocation.

Nontradables

Much of the literature's main concern is how the introduction of nontradable goods affects the qualitative results from models with only tradable goods through the linkage between goods prices and factor prices. For example, Jones (1974), ignoring the underlying factor market, built a model that each nation only produces two goods: a nontradable and an exportable good. He further assumes that there is no domestic demand for the exportable good, and exportable goods are only a means to obtain importable goods. Consequently, real income in his model is determined by the terms of trade. David Lebow (1993) argued that a strengthening dollar leads to a decline in the demand for labor among tradable goods producers, and an increase in the demand for labor among nontradable goods producers. Therefore, the aggregate real wage and real wage in tradable sectors are ambiguous. Cassing (1977) argued that the presence of monopoly in nontraded goods sector modifies the Stolper-Samuelson result. The real

income of the factor intensively used to produce the favored goods (i.e., goods with a price increase) may fall depending on its preference to consume nontraded goods. [9]

This article demonstrates a relation between productivity in the tradable sector and the demand in the nontradable sector. It argues that the demand for certain non-tradables depends on income derived from the tradable sector and accumulated national wealth. Thus, it establishes a size linkage between the nontradable sector and the tradable sector. That is the size of the nontradable sector depends on the size and productivity of the tradable sector and it, in turn, constrains the amount of resources available to the tradable sector. High productivity in the tradable sector will allow a nation to absorb additional resources into the nontradable sector, which creates an absorption capacity. This absorption capacity provides the wealthy and advanced nation a resource-allocation advantage. Through a simplification assumption (see the next section), nontradable goods do not appear in the national welfare function. Thus, the model can be compared with models without nontradables. To the best of my knowledge, the role of the nontradables in this model is novel.

FRAMEWORK AND ASSUMPTIONS

Nontradables and Absorption Capacity

In the hypothetical example, the idea of resource-allocation advantage is illustrated with a simple nontradable good –leisure. This section extends the discussion to address the types and nature of nontradable goods and their effect on resource-allocation advantage. Depending on the mechanism that nontradable goods create absorption capacity, I categorized them into three types. The first type is those nontradables that can be equally produced across nations. The Harrod-Balassa-Samuelson effect shows that wealthy nations have higher wage in the nontradable sector because of higher productivity in the tradable sector. This higher wage tends to attract labor, and thus the nontradable sector will grow over time. This is a size effect associated with higher productivity in the tradable sector. The absorption can occur without government intervention.

[9] For two factor models, also see, for example, Melvin (1968); Komiya (1976); McDougall (1965); Pattanaik (1970); Cassing (1978); Ethier (1972); and Goldstein et al. (1980).

The second type is the nontradables that are exclusively produced in some wealthy and advanced nations as a result of production ability. Producing these nontradables requires a number of factors such as cutting-edge technological know-how, enormous initial investment, and perhaps even the most innovative ideas. There are many of these nontradables, for example, nuclear power plants, spacecraft, and some military equipment such as aircraft carrier (nontraded for national security reason). The purpose of this article is not to provide a complete list of what these nontradables may be. The ability to produce these nontradables exclusively provides an additional dimension for resource allocation and creates absorption capacity. Even though poor nations may eventually catch up and have the ability to produce these nontradables, the technological and innovative frontier may have already moved forward by then. The chance is there may always be some nontradables that only wealthy and advanced nations can produce exclusively.

The third type is the nontradables that are produced with a systematic-quality difference across nations. For example, wealthy and advanced nations may have high quality of environment, high standards of healthcare, and first-class higher education. Data presented at the beginning of this article show that these sectors can absorb a large amount of resource. Consider that a high-quality system can somehow be divided into a basic quality part and a high-quality part. The basic quality part is equally produced across nations.[10] Thus, the basic quality part is equivalent to the first type of nontradables discussed earlier, and the absorption is merely a size effect. It is the high quality part that draws extra resources and creates absorption capacity. The absorption capacity created by this quality effect is the main emphasis of this article.

There are a number of reasons that wealthy and advanced nations may sustain a high-quality system in these nontradable sectors. First, they can afford the cost to build and maintain a high-quality system. It is important that a high-quality system is affordable; otherwise, it cannot be sustained in the long run. Pauly (2004) reviewed the relation between marginal benefit of quality and marginal cost. Second, they are wealthy enough (as a result of high productivity in tradable sector) to create sufficient market

[10] If a nation has a poor-quality system, its situation will be worse.

demand for a high-quality system. The demand for a high-quality system greatly depends on income and wealth level. When income and wealth increase, the desire for high quality will become increasingly important. The theoretical framework for such demand behavior can be found in Abraham Maslow's (1943) famous theory, the hierarchy of human needs. The general idea of his theory is that human needs have different layers: some needs are higher than others. Only when more basic needs are satisfied can a higher level of needs then emerge to the fore.[11] Third, they have the technology in building equipment and facilities and the knowledge in creating efficient and effective social organizations, which serves as the foundation for a high-quality system.

The ongoing healthcare reform in the United States is an example of government's strategic involvement in improving the quality of the healthcare system. In his speech at the National Press Club, Ben Barnake (2011) addressed, "Indeed, the CBO projects that federal spending for health-care programs –which includes Medicare, Medicaid, and subsidies to purchase health insurance through new insurance exchanges – will roughly double as a percentage of GDP over the next 25 years. The ability to control health-care costs, while still providing high-quality care to those who need it, will be critical for bringing the federal budget onto a sustainable path." Here, he emphasized two important issues: first, the large amount of resources (high cost) needed to sustain a high-quality healthcare system, and second, the importance of affordability for long-term budget health.

In general, wealthy nations, as a result of high productivity in their tradable sectors, can absorb additional resources to the nontradable sectors especially those sectors with high systematic quality. The additional resources that can be absorbed into the non-tradable sectors measure a relative strength in absorption capacity between two trading nations. Such difference in relative strength can exist between wealthy and poor nations, wealthy and wealthier nations, and poor and poorer nations. Therefore, for welfare comparison purpose, it is reasonable to define a zero absorption capacity. Define a representative poor nation: it has basic quality of nontradable sectors such as

[11] The scope of human needs that Maslow discussed is much broader than the consumption case discussed here.

healthcare and higher education,[12] and it does not produce any nontradables exclusively. Its absorption capacity is defined as *zero*. Then, compared with this representative poor nation, the maximum amount of additional resources that a wealthy nation can absorb to these nontradable sectors is defined as the absorption capacity for that wealthy nation. Although absorption capacity is the maximum extra resources that may be allocated to these nontradable sectors by a nation, such allocation may not actually occur. A wealthy nation does not have to use all of its absorption capacity, and the availability of such capacity per se constitutes an advantage.

Because the purpose of this article is to demonstrate the welfare effect of the absorption capacity, it is unnecessary to model nontradables in the representative poor nation that has zero absorption capacity. To include those nontradables that do not create absorption capacity will not change qualification results.

Resource-Allocation Advantage

In the hypothetical example, when his productivity increases to a certain level, the baker gains freedom to work fewer hours in the bakery. The maximum number of hours that he can free himself from the bakery to enjoy leisure depends on the level of his productivity. He may not maximize his leisure time. Instead, he will choose a suitable amount of leisure time to maximize his total satisfaction. The freedom that he obtains in allocating his leisure time is an advantage in resource allocation, in comparison with the situation in which he does not have such freedom because of low productivity.

Likewise, wealthy nations have the capacity to absorb extra resources into the non-tradable sectors due to high productivity in the tradable sector. In particular, those non-tradable sectors with a systematic high quality become a major source of creating absorption capacity. Given absorption capacity, national policies strategically allocate resource into these sectors to maximize national welfare in the long run. In situation of market stress, the absorption effect can mitigate the negative effect in the tradable sector as a result of supply increase or demand weakness. Therefore, resource-

[12] Given that the systematic quality of these nontradable sectors is linked to productivity in the tradable sector, this indirectly defines productivity in the tradable sector and the consumption of the first type of nontradables.

allocation advantage refers to the ability to allocate extra resources, in comparison with its trading partner, to its nontradable sector as a result of higher productivity in tradable sector.

Resource-allocation advantage is a relative advantage. Its welfare effect depends on the difference in absorption capacity between trading nations. When a wealthy nation trades with a poor nation, the wealthy nation will have resource-allocation advantage. The same can occur when two wealthy nations or two poor nations trade with each other as long as productivity difference exists. Therefore, how nations are classified whether as wealthy or not is not important, what important is the existence of difference in absorption capacity between trading nations.

Market Structure

This section uses the standard two-by-two Ricardian framework with the capacity to allocate resources to the nontradable sector by wealthy nation. Tradable goods are produced with one factor of production and constant production cost. The markets for tradable goods are perfectly competitive.

The section models only the nontradables that create absorption capacity and omits the nontradables that do not do so. This approach simplifies the discussion but does not change the qualification results. Resources allocated to the nontradable sector therefore all contribute to the creation of utilized absorption capacity. On the one hand, absorption capacity is endogenously modeled. It depends on income derived from the tradable sector and national wealth (i.e., cumulated past income). It is the maximum resources that can be allocated to the nontradable sector and the system is still sustainable. In other words, the nontradable sector cannot infinitely shrink the size of the tradable sector. On the other hand, the amount of resources allocated to the nontradable sector is strategically determined by a nation's decision makers to maximize its national welfare, but constrained by the absorption capacity of the nontradable sector. Thus, resource allocation to the nontradable sector is "regulated and balanced" by both market force and government strategy.

There are three main reasons to use an exogenous factor (i.e., national strategic resource allocation) to provide optimal resource allocation to the nontradable sector. First, the article intends to build a model that reflects the reality that governments play an important role that affects national resource allocation and national welfare (Porter, 1998; Vietor, 2007; and Karagiannis and Madjd-Sadjadi, 2007). Because some of the nontradables, such as environment, healthcare, and higher education, have positive externalities and semipublic good nature, market alone may not provide optimal resource allocation. As the data given at the beginning of the paper show, resource allocation in these areas is strongly influenced by national policies. Second, the modeling approach derives a general solution set which includes the solution that may be derived from an endogenous approach. This general solution set includes all possible trade equilibriums, which have their intrinsic value for theoretical discussion. Third, I have built a two-factor model with increasing opportunity cost and uses endogenous factor to drive terms of trade. The attempted modeling approach provides an alternative mathematical method to study equilibrium solutions. It is my hope that it can be applied to study other issues with similar nature.

If the amount of resources allocated to the nontradable sector is modeled endogenously, two possible options exist. The first option is that market determines an allocation, which provides a welfare gain (compared with the representative poor nations) but may not maximize national welfare. The second option is to make some assumptions about market demand for nontradables, which will lead to an optimum resource allocation that maximize national welfare. Similar conclusion can be drawn to show that wealthy nations are better off in trade.

Assumptions for Simplicity of Discussion

Denote tradable goods as Good 1 and Good 2. Assume Country I has a comparative advantage in producing Good 1, and Country II in Good 2. Country I is used as an example for discussion, and the case of Country II can be discussed similarly. In Figure 1, the straight line AB is Country I's transformation curve between two tradable goods, Good 1 and Good 2. If there is no nontradable good, Country I will completely specialize

in producing Good 1 at point A, and it will produce OA amount of Good 1. Consider that some amount of resources is pulled out of tradable sectors to produce nontradables, and the amount of Good 1 produced now becomes OG. The amount of labor that can produce GA amount of Good 1 is now employed to produce nontradables.

To be comparable to the standard two-by-two Ricardian model,[13] assume that national welfare does not change when nontradables are producedThat is a nation will have the same welfare if GX amount of Good 2 are produced than if nontradables are produced using the same amount of resources, with other things being equal. If a nation is better off without accounting the welfare gain by consuming the nontradables, surely it will be true if such welfare gain is accounted. Thus, the problem can be discussed as if an OG amount of Good 1 is produced, and a GX amount of Good 2 is produced, as if the production point has now moved from A to X. Depending on the amount of nontradable goods produced, X can be anywhere between EA, where E is self-sufficiency equilibrium.[14]

The merit for this assumption is as follows. First, it does not change qualitative results, but rather it greatly simplifies the discussion and graphic presentation. Second, the nontradable goods will not appear in the national utility function, and standard utility functions with only tradable goods can be used. Third, the qualification results can be compared with models with only tradable goods. Fourth, the welfare discussion and results will be the same if some Good 2 (tradable) is actually produced domestically as a result of market imperfection.[15]

Determination of Terms and Volume of Trade

In Figure 2, under complete specialization, Curve I is the excess demand curve for Good 2 of Country I, and Curve II is the excess supply curve of Good 2 of Country II, respectively. Corresponding to production point E (self-sufficiency), point X, and point A

[13] See, for example, Bhagwati and Srinivasan (1983) and Chacholiades (1978).
[14] Country I will not produce at a point on the left of E (in Figure 1), as it contradicts the assumption that Country I has a comparative advantage in producing Good 1.
[15] Market imperfection can due to, for example: (1) product differentiations, (2) specific factor in production, (3) partial labor mobility (Grossman, 1987), (4) factor price rigidity, (5) people's preference of domestic products (e.g., geographic identity), and (6) domestic network protecting domestic products (Ranch 2001; Brander and Spencer 1985).

(complete specialization) in Figure 1, (part of) Country I's excess demand curve is JV, JKT, and JHY in Figure 2, respectively. When nontradable goods are produced, the production point of Country I will move from A to E (in Figure 1), and the corresponding excess demand curve will shift leftward from JHY to JV (in Figure 2).

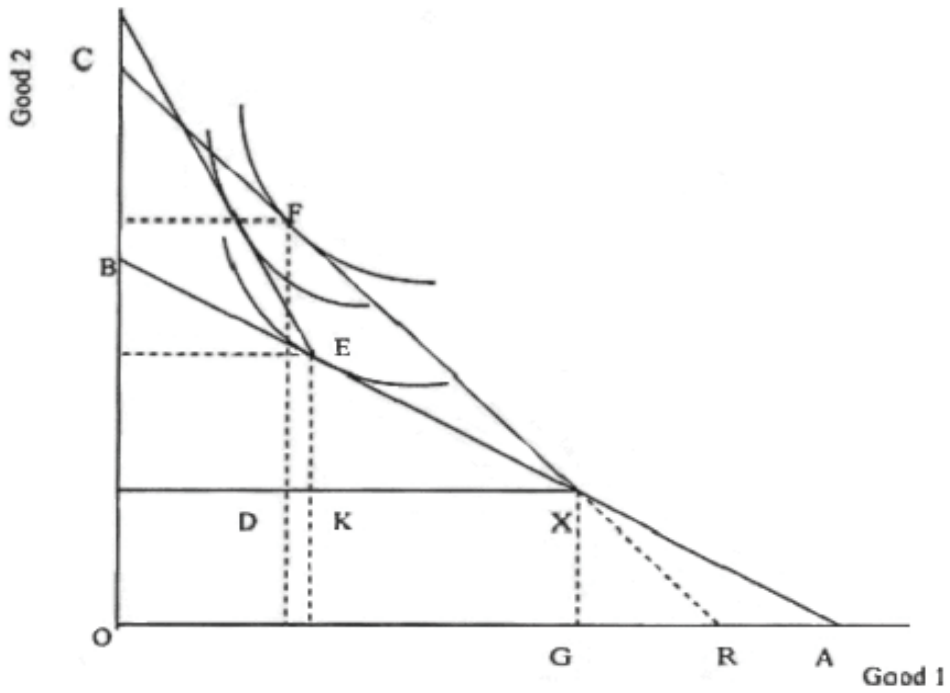

Figure 1. Transformation Curve

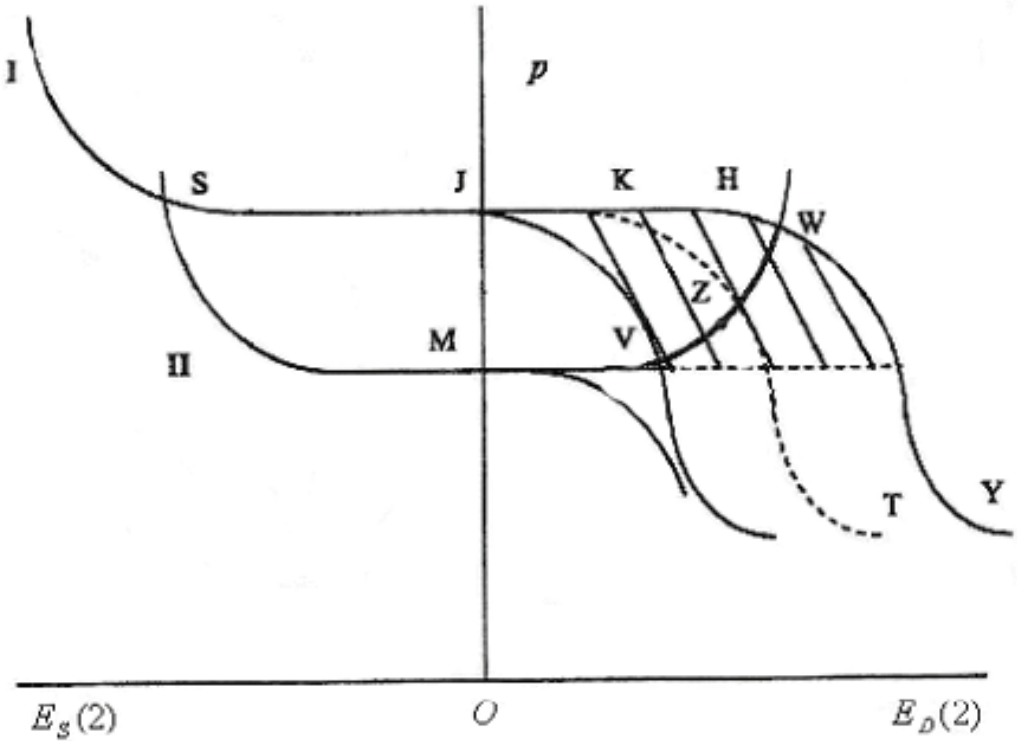

Figure 2. Excess Demand Curve

Terms and Volume of Trade When Only One Country Has Absorption Capacity

This is the case of a wealthy nation that trades with a representative poor nation that has zero absorption capacity. Assume that Country I is the wealthy nation with absorption capacity. It has comparative advantage in producing Good 1. It strategically adjusts the amount of resources allocated to the nontradable sector to maximize its national welfare. At this stage, ignore any limitation on the feasibility of the amount of resources that can be allocated to the nontradable sector, and leave the discussion of the constraints for later sections. Thus, in Figure 2, the shaded area is the feasible excess demand for Good 2 of Country I. Assume that Country II is the representative poor nation with zero absorption capacity. It completely specializes in producing Good 2. The excess supply curve of Country II is MS, and its mirror image is MW. The VW segment of the MW curve (shown in bold) intercepts the shaded feasible excess demand area. Therefore, the VW is the loci of feasible trade equilibrium points where excess demand is equal to excess supply. The welfare maximization of Country I is subsequently derived.

In autarky, Country I produces at its self-sufficiency equilibrium (point E) using L_1 units of labor in producing Good 1 (q_1), and L_2 units of labor in producing Good 2 (q_2). Let l_1 be the labor input to produce one unit of Good 1; l_2 be the labor input to produce one unit of Good 2. Denote p as the price of Good 2 in terms of the numeraire Good 1. The self-sufficiency commodity–price ratio is $p = \frac{l_2}{l_1}$.

Using point E (in Figure 1) as reference,[16] define $\widetilde{L}$ as the increment of labor used to produce Good 1, when Country I produces at an arbitrary point X (in Figure 1). When $\widetilde{L} = 0$, the production point will be at point E (in Figure 1), and the trade equilibrium will be at point V (in Figure 2); when $\widetilde{L} = L_2$, the production point will be at point A (in Figure 1), and the trade equilibrium is at point W (in Figure 2). Write Country II's excess supply function of Good 2 as $g_B(p)$. (Subscript A denotes functions for Country I and subscript B for Country II.) If point W is on the horizontal part of curve I, the maximum value that $\widetilde{L}$ can take is $l_2 g_B(\frac{l_2}{l_1})$. This can be shown as follows. Expression $\widetilde{L}/l_2$ is the amount of Good 2 that Country I can produce if it does not transfer this amount of labor to produce Good 1, and $g_B(\frac{l_2}{l_1})$ is the amount of Good 2 that it can trade for at the price ratio $\frac{l_2}{l_1}$. At this price ratio, Country I does not benefit from trade at all, so that the forgone opportunity cost, $\widetilde{L}/l_2$, should be equal to the return from trade, $g_B(\frac{l_2}{l_1})$.[17] Thus, we have $\widetilde{L} \in [0, l_2 g_B(\frac{l_2}{l_1})]$, $l_2 g_B(\frac{l_2}{l_1}) \le L_2$.

[16] It will be no difference to use point A as reference.

[17] Another way to look at it is that the amount of labor transferred should be able to produce enough of Good 1 to exchange $g_B(\frac{l_2}{l_1})$ amount of Good 2 at the price $\frac{l_2}{l_1}$, yielding $\frac{\widetilde{L}}{l_1} = \frac{l_2}{l_1} g_B(\frac{l_2}{l_1})$.

If the production point is now at X (in Figure 1), the trade-price ratio is CR, and the utility maximization point is at F, we have the following coordinates: X($\frac{L_1+\widetilde{L}}{l_1}, \frac{L_2-\widetilde{L}}{l_2}$), E($\frac{L_1}{l_1}, \frac{L_2}{l_2}$), and F($q_1$, q_2). The excess supply of Good 1 for Country I is $\frac{L_1+\widetilde{L}}{l_1} - q_1$, and the excess demand for Good 2 is $q_2 - \frac{L_2-\widetilde{L}}{l_2}$. The trade condition gives the following identity:

$$(\frac{L_1+\widetilde{L}}{l_1} - q_1)/(q_2 - \frac{L_2-\widetilde{L}}{l_2}) = p \qquad (1)$$

Meanwhile, for a balanced trade, the excess demand for Good 2 by Country I will be equal to the excess supply of Good 2 by Country II, yielding the following:

$$q_2 - \frac{L_2-\widetilde{L}}{l_2} = g_B(p) \qquad (2)$$

Solving Equation 1 and 2 yields the following results:

$$q_1 = \frac{L_1+\widetilde{L}}{l_1} - pg_B(p) \qquad (3)$$

$$q_2 = \frac{L_2-\widetilde{L}}{l_2} + g_B(p) \qquad (4)$$

From Figure 2, it is known that for each value of $\widetilde{L}$, there is a unique *p* value, $p(\widetilde{L})$, which can clear the market –that is, the price where the excess demand curve intercepts with the excess supply curve.[18] As such, the equilibrium quantities can be written as follows: $q_1^* = \frac{L_1+\widetilde{L}}{l_1} - p(\widetilde{L})g_B(p(\widetilde{L}))$ and $q_2^* = \frac{L_2-\widetilde{L}}{l_2} + g_B(p(\widetilde{L}))$ —both q_1^* and q_2^* are only function of $\widetilde{L}$. Therefore, we have the following:

$$U_A(q_1^*, q_2^*) = u_A(\widetilde{L}) \mid g_B, \ \forall \widetilde{L} \in [0, L_2] \qquad (5)$$

[18] See Appendix A for a simple mathematical proof of this relation.

given ordinal social utility function $U_A(q_1, q_2)$. This derived trade utility function gives the utility of trade equilibriums of Country I, given Country II's excess supply function. The utility maximization condition for Country I is as follows:

$$Max_{\widetilde{L}}\{u_A(\widetilde{L}) \mid g_B : \widetilde{L} \in [0, L_2]\} \qquad (6)$$

Note that better terms of trade may not necessarily lead to a higher utility indifference curve. This is shown, in Figure 1, by the price line that goes through point E, which is tangent to a lower indifference curve than the price line (XC) that goes through point X. Assume that there are no multiple equilibriums.[19] Point Z in Figure 2 represents the utility maximization trade equilibrium.

Terms and Volume of Trade When Both Countries Have Absorption Capacity

This is the case of two wealthy nations. Figure 3 shows the case when both countries have absorption capacity. Ignoring any limitation on the feasibility of the excess supply and demand, the area between the rays JRV and JHW is the possible excess demand for Good 2 for Country I. Similarly, the area between rays MRY and MVW is the possible excess supply of Good 2 by Country II. The shaded area YHWVR, resulting from the interception of the excess demand and the excess supply, gives the feasible trade outcomes.

Repeating the optimization procedure described earlier for each possible excess supply function of Country II it yields the set of utility maximization trade outcomes for Country I, which is shown in Figure 4 as segment AB. Similarly, we can obtain the set of utility-maximization trade outcomes for Country II, shown as segment CD. The intersection of segment AB and CD, point N, is the trade equilibrium.

[19] Because in this case better terms of trade are associated with low trade volume, a large terms-of-trade effect will be offset by low underlying trade volume. It is, therefore, reasonable to assume a concave derived trade utility function, i.e., a unique utility-maximization equilibrium.

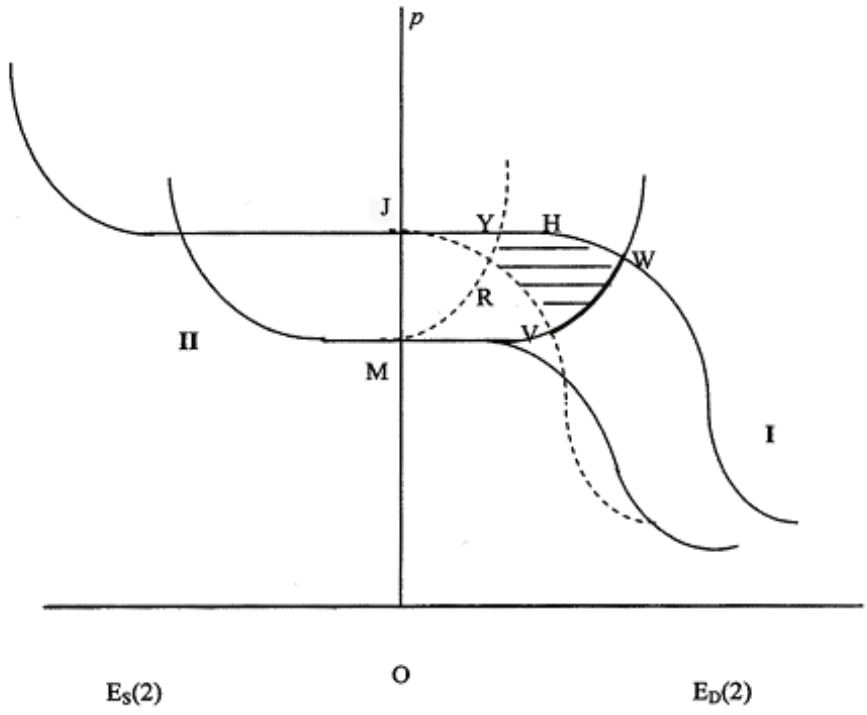

Figure 3. Trade Outcomes

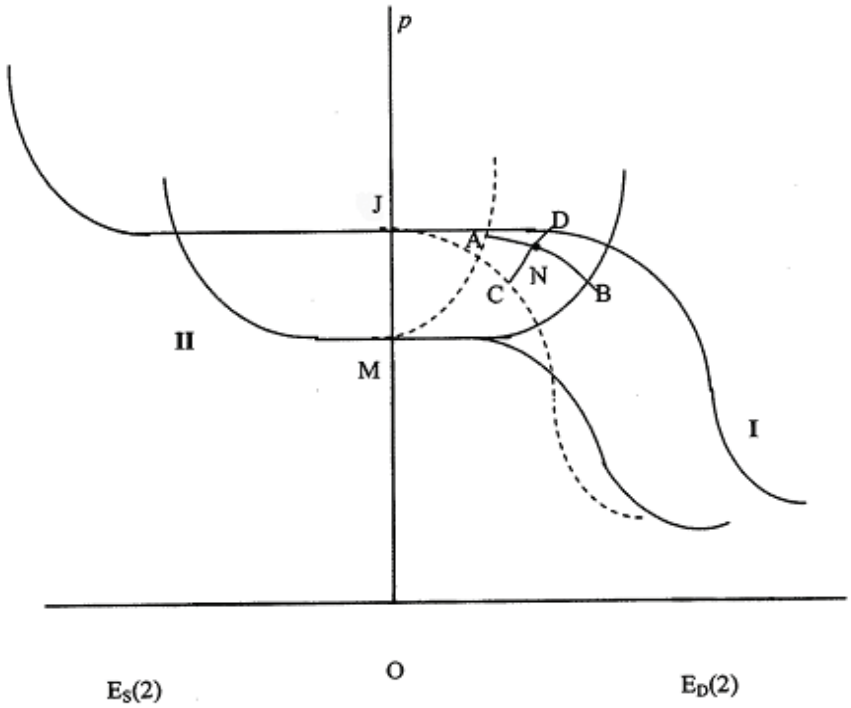

Figure 4. Unconstrained Trade Equilibrium

TRADE EQUILIBRIUM AND RESOURCE-ALLOCATION ADVANTAGE

This section first defines the unconstrained equilibrium. Then it discusses the absorption capacity and the constraint trade equilibrium. Trade equilibrium is compared with the Ricardian equilibrium where no nations have resource-allocation advantage. Last, a measure of resource-allocation advantage is provided.

Unconstrained Equilibrium

Using the self-sufficiency production equilibrium as a reference, each production point of Country I can be measured by variable $\widetilde{L}$, where $L_1 + \widetilde{L}$ amount of labor is used to produce Good 1, and $L_2 - \widetilde{L}$ amount of labor for nontradables. Use variable $\widetilde{L}$ to define the strategic allocations of resources in the nontradable sector of Country I; write $S_A = \{\widetilde{L} : \widetilde{L} \in [0, L_2]\}$ for the set of all possible strategic allocations in the nontradable sector of Country I (short as strategies of Country I). Denoted by using the prime sign,

the variables for Country II are defined the same way as Country I. Similarly, write $S_B = \{\widetilde{L}' : \widetilde{L}' \in [0, L_1']\}$ for the set of all possible strategies of Country II. (Subscript A denotes sets for Country I, and subscript B for Country II.) The Cartesian product $S_A \times S_B$ is the set of all strategy profiles for the two-country trade system.

Write set $A = \{(Q_2, p) : Q_2(p, \widetilde{L}, U_A) \wedge \widetilde{L} \in S_A\}$ as the excess demand function of Good 2 of Country I; write set $B = \{(Q_2, p) : Q_2(p, \widetilde{L}', U_B) \wedge \widetilde{L}' \in S_B\}$ as the excess supply function of Good 2 of Country II. Write set *D* for $A \bigcap B$ –the set of all feasible trade outcomes –including all pairs of quantity and price of Good 2 for which trade will be balanced. In Figure 3, it is shown as the shaded area YHWVR. There is a one-to-one mapping from the set of strategy profiles to the set of trade outcomes, written as $S_A \times S_B \mapsto A \bigcap B$. For a fixed $\widetilde{L}'$ value of L_1', write $B \mid L_1'$ for the subset of *B* –that is $\{(Q_2, p) : Q_2(p, L_1', U_B)\}$ –which is the excess supply function of Country II given its strategy L_1'. Write set $D \mid L_1'$ for $A \bigcap (B \mid L_1')$; hence set $D \mid L_1'$ is the attainable trade outcomes for Country I given Country II's strategy L_1'. For instance, the bold curve VW in Figure 3 is the set of attainable trade outcomes for Country I if Country II completely specializes in producing Good 2.

Write set $H_A \mid L_1'$ for $\underset{u_A}{Max}\, D \mid L_1' = \{x \in D \mid L_1' : u_A(x) \geq u_A(y) \forall y \in D \mid L_1'\}$; that is the set of utility-maximizing trade outcomes of Country I. Write the corresponding resource allocation in Country I as $L^*(L_1')$. If L^* is known, define the inverse injection as $L'(L^*)^{-1}$. Similar relations can be defined for Country II. (These notations are used later for welfare analysis). Set $H_A = \bigcup_{\widetilde{L}' \in S_B} \underset{u_A}{Max}\, D \mid \widetilde{L}'$ is the set of all national welfare-maximizing trade outcomes for Country I, given Country II's various possible strategies. Similarly, the set of all national welfare-maximizing trade outcomes for Country II, given Country I's various possible strategies, is $H_B = \bigcup_{\widetilde{L} \in S_A} \underset{u_B}{Max}\, D \mid \widetilde{L}$. At $H_A \bigcap H_B$, both countries maximize their welfare given the other country's strategy; that is, one country will not be better off by changing its strategy if the other stays with its original strategy (Nash,

1951). Therefore, $N = H_A \bigcap H_B$ is the set of unconstrained equilibrium. There will always be $N \in D$. In other words, H_A will always intercept H_B within the feasible trade outcomes region. This is explained in Figure 6. On the right-side boundary of set *D*, N_A (i.e., the welfare maximization point for Country I) will be no higher than *W* along $N_A W$ line. Similarly, N_B (i.e., welfare maximization point for Country II) will be no lower than *W* along $N_B W$ line. On the left-side boundary of set *D*, it is the opposite case. Therefore, H_A and H_B must intercept within *D*.

Absorption Capacity

Under full employment, the available labor for the nontradable sector is as follows:

$$\widetilde{L}_n^S = \overline{L} - L_1 - \widetilde{L}\,, \tag{7}$$

where subscript *n* stands for nontradable goods and superscript *S* stands for supply. Notation $\overline{L}(= L_1 + L_2)$ is the total labor force. When $\widetilde{L}$ increases, $\widetilde{L}_n^S$ decreases; i.e., it is downward sloping with respect to $\widetilde{L}$.

The absorption capacity of the nontradable sector depends on real income in tradable sector and national wealth. Write real income in tradable sector of Country I as $y = (L_1 + \widetilde{L})\frac{1}{l_1}\frac{1}{p}$, where $\frac{1}{p}$ is the terms of trade for Country I. Instead of using current price, it is better to use an expected price, p_e, [20] given that investment decision making is forward looking. Thus, the income can be written as follows:

$$y_e = (L_1 + \widetilde{L})\frac{1}{l_1}\frac{1}{p_e}\,. \tag{8}$$

Therefore, the absorption capacity can be defined as follows:

$$\widetilde{L}_n^D = \theta\ [(L_1 + \widetilde{L})\frac{1}{l_1}\frac{1}{p_e} + w]\ \ \forall\ y_e + w \geq \delta\,,\ \widetilde{L} \leq L_2\,, \tag{9}$$

[20] Using adaptive expectation model (Parkin, 1998), the expected price can be written as $p_e = \sum_{i=0}^{\infty} \lambda(1-\lambda)^i p_{t-i}\,, \quad 0 < \lambda < 1$.

where θ is the coefficient and w is the national wealth. (Superscript D stands for demand.) Given prices, $\widetilde{L}_n^D$ increases when $\widetilde{L}$ increases, i.e., it is upward sloping with respect to $\widetilde{L}$. The relation between $\widetilde{L}_n^S$ and $\widetilde{L}_n^D$ is shown in Figure 5. Constant δ is the threshold to obtain absorption capacity, when income derived in tradable sector and cumulated wealth reaches a certain level.

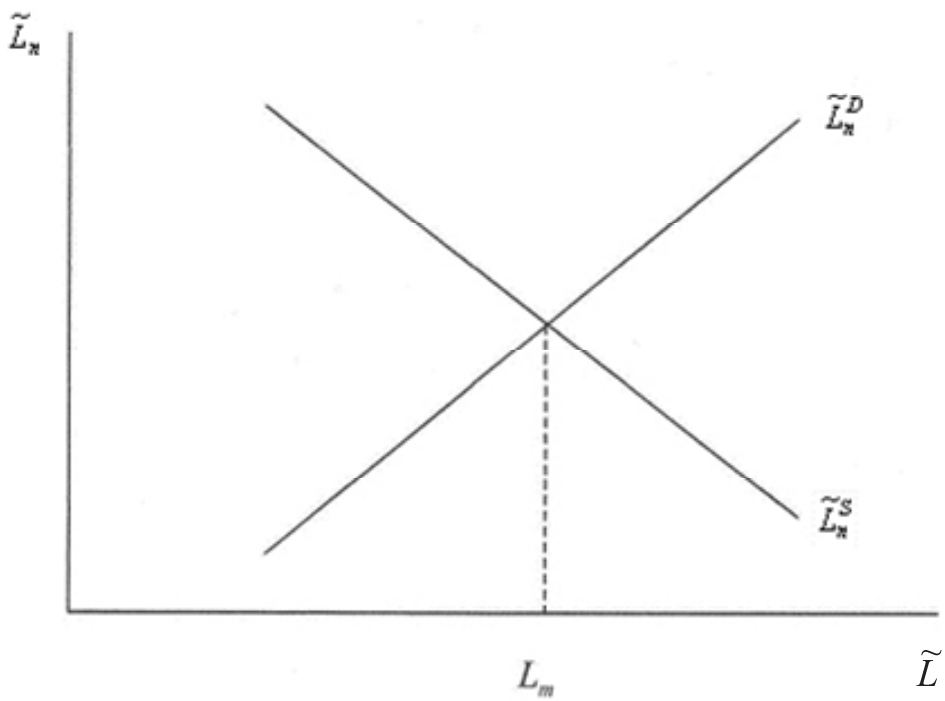

Figure 5. Stable Condition

The amount of resources can be allocated to the nontradable sector is constrained by the absorption capacity, yielding $\widetilde{L}_n^D \geq \widetilde{L}_n^S$, which gives the following:

$$\theta[(L_1 + \widetilde{L})\frac{1}{l_1}\frac{1}{p_e} + w] \geq \overline{L} - L_1 - \widetilde{L}\,. \tag{10}$$

Solving Equation 10 yields the following:

$$\widetilde{L} \geq [\overline{L} - (1 + \theta\frac{1}{l_1}\frac{1}{p_e})L_1 - \theta w]/(1 + \theta\frac{1}{l_1}\frac{1}{p_e})\,. \tag{11}$$

The right side of the inequality is a constant, and it can be written as L_m:

$$L_m = [\overline{L} - (1+\theta\frac{1}{l_1}\frac{1}{p_e})L_1 - \theta w]/(1+\theta\frac{1}{l_1}\frac{1}{p_e}). \quad (12)$$

$L_1 + L_m$ gives the minimum size of the tradable sector. It is reasonable that the absorption by the nontradable sector cannot indefinitely shrink the size of the tradable sector. The demand for nontradables depends on the income derived from the tradable sector. Therefore, the stable condition shown by Equation 11 can be rewritten as follows:

$$\widetilde{L} \geq L_m. \quad (13)$$

Thus, the maximum amount of labor that can be absorbed in the nontradable sector is $\overline{L} - L_1 - L_m$. Accordingly, the constrained strategy set can be written as $S_A^c = \{\widetilde{L} : \widetilde{L} \in [L_m, L_2]\}$ (in comparison with S_A), where superscript *c* refers to constraint.

Similarly, Country II yields the following:

$$L'_m = [\overline{L}' - (1+\theta\frac{1}{l'_2}p_e)L'_2 - \theta w']/(1+\theta\frac{1}{l'_2}p_e). \quad (14)$$

By using the same coefficient θ, we assume that Country II has an identical preference for nontradables as Country I. Thus, only income and wealth level will affect absorption capacity and preference difference for nontradables is not considered. The strategy set for Country II can be written as $S_B^c = \{\widetilde{L}' : \widetilde{L}' \in [L'_m, L'_1]\}$ (in comparison with S_B). The stable condition for Country II can be written as follows:

$$\widetilde{L}' \geq L'_m. \quad (15)$$

Further, the constrained excess demand function of Good 2 for Country I can be written as $A_c = \{(Q_2, p) : Q_2(p, \widetilde{L}, U_A) \wedge \widetilde{L} \in [L_m, L_2]\}$. The constrained excess supply function of Good 2 of Country II is $B_c = \{(Q_2, p) : Q_2(p, \widetilde{L}', U_B) \wedge \widetilde{L}' \in [L'_m, L'_1]\}$.

Constrained Trade Equilibrium and Measure of Resource-Allocation Advantage

The trade equilibriums can be discussed in three major scenarios and graph presentation is shown in Figure 6. The first scenario is the basic case to show resource-

allocation advantage. It involves a wealthy nation (Country I) with absorption capacity and a representative poor nation (Country II) without absorption capacity. In Figure 6, the trade equilibrium is N_A for $N_A \in A_c$. At point N_A, Country I maximizes its potential benefit from the resource-allocation advantage. However, the wealthy nation may not necessary benefit the full potential if it itself only have limited absorption capacity. If $N_A \notin A_c$, the equilibrium will be $A \mid L_m \cap B \mid L_1'$, i.e., a point along the $N_A W$ line depending on Country I's absorption capacity. Note that national welfare for Country II increases from N_A to *W* along the $N_A W$ line, where *W* stands for the maximum welfare for Country II.

Resource-allocation advantage measures a relative advantage between two nations at given situation. At point N_A, Country I's welfare is maximized at its current strategy and it has no potential to increase, while Country II's welfare can potentially increase to point *W*'s level. Using the potential welfare increase for Country I (zero) to minus the potential welfare increase for Country II (with a minus sign), we can obtain a measure of the resource-allocation advantage:

$$R1a = 0 - [u_B(L_1') \mid g_A(L^*(L_1')) - u_B(L_1') \mid g_A(L_2)]$$

$$= u_B(L_1') \mid g_A(L_2) - u_B(L_1') \mid g_A(L^*(L_1')) \qquad (16a)$$

Expression $u_B(L_1') \mid g_A(L^*(L_1'))$ is Country II's utility at N_A and $u_B(L_1') \mid g_A(L_2)$ is its utility at *W* (referring to Equation 5). By this measure, *R*1*a* is positive, which reflects Country I's advantage in trade. Similarly, if the equilibrium is at $A \mid L_m \cap B \mid L_1'$ for $L_m < L^*(L_1')$, the measure of the resource-allocation advantage can be written as follows:

$$R1b = 0 - [u_B(L_1') \mid g_A(A \mid L_m) - u_B(L_1') \mid g_A(L_2)]$$

$$= u_B(L_1') \mid g_A(L_2) - u_B(L_1') \mid g_A(L_m) \qquad (16b)$$

In this situation, Country I's absorption capacity is limited and it fails to obtain the full potential benefit of the resource-allocation advantage. Nonetheless, it still has advantage and *R*1*b* is positive. Both *R*1*a* and *R*1*b* measure the welfare lost for Country II, compared with the Ricardian equilibrium. It clearly shows a disadvantage in trade for poor nations.

The second scenario is that both nations are wealthy nations, and one nation's absorption capacity is larger enough to benefit the full potential of the resource-allocation advantage. This is equivalent to no constraint for that nation. Thus, the equilibrium is one-constrained Nash equilibrium. If Country I is the nation with no constraint, the equilibrium will be $N_c^1 = H_A \mid L'_m \quad \forall N \notin B_c$. (Subscript *c* refers to constraint and superscript '1' refers to one constraint.) Country II's absorption capacity is shown by L'_m. Equilibrium N_c^1 is on Country I's welfare maximization line H_A. An extreme situation is that N_c^1 coincide with N_A, that is the case in which Country II is a representative poor nation. At N_c^1, Country I's welfare is maximized. Country II's welfare is $u_B(L'_m) \mid g_A(L^*(L'_m))$ and can potentially increase to $u_B(L'_m) \mid g_A(L(L'_m)^{-1})$ at point $H_B \mid L(L'_m)^{-1}$. Thus, the resource-allocation advantage can be measured as follows:

$$R2 = 0 - [u_B(L'_m) \mid g_A(L^*(L'_m)) - u_B(L'_m) \mid g_A(L(L'_m)^{-1})]$$

$$= u_B(L'_m) \mid g_A(L(L'_m)^{-1}) - u_B(L'_m) \mid g_A(L^*(L'_m)) \qquad (17)$$

If $B \mid L'_m$ intercepts WN_B (equilibrium still at N_c^1), i.e., $B \mid L'_m$ does not intercepts line H_B, use L_2 to replace $L(L'_m)^{-1}$. Extending the definition of $L(L'_m)^{-1}$, let $L_2 = L(L'_m)^{-1}$ when $B \mid L'_m$ intercepts WN_B. Thus, Equation 17 covers all situations. In this scenario, *R*2 is positive, and Country I has relative advantage.

The third scenario is that both nations face constraints and none of the nation can benefit the full potential of the resource-allocation advantage. For $N \notin A_c$, $N \notin B_c$, $H_A \mid L'_m \notin A_c$ (or $N_c^1 \notin A_c$) and $H_B \mid L_m \notin B_c$, the two-constrained Nash equilibrium is $N_c^2 = A \mid L_m \cap B \mid L'_m$. At point N_c^2, the utility of Country I is $u_A(L_m) \mid g_B(L'_m)$ and of Country II is $u_B(L'_m) \mid g_A(L_m)$. At given strategy, Country I's utility can potentially increase to $u_A(L_m) \mid g_B(L'(L_m)^{-1})$ or $u_A(L_m) \mid g_B(L'_1)$. Extending the definition of $L'(L_m)^{-1}$, let $L'_1 = L'(L_m)^{-1}$ when $H_B \mid L_m$ intercepts WN_A. Country II's utility can potentially increase to $u_B(L'_m) \mid g_A(L(L'_m)^{-1})$, including the same extended definition earlier. The resource-allocation advantage can be measured as follows:

$$R3 = [u_A(L_m) \mid g_B(L'_m) - u_A(L_m) \mid g_B(L'(L_m)^{-1})]$$
$$-[u_B(L'_m) \mid g_A(L_m) - u_B(L'_m) \mid g_A(L(L'_m)^{-1})] \quad (18)$$

If *R*3 is positive, Country I has advantage; if *R*3 is negative, Country II has advantage.

In summary, the set of trade equilibrium is the closed area of NN_AWN_B. Write this set as *Γ*. *N* is the unconstrained equilibrium. NN_A is one-constrained equilibrium, where Country I has relative advantage. N_AW is the poor nation case, where Country II is the poor nation. Similarly, WN_B is the poor nation case, where Country I is the poor nation. NN_B is the one-constrained equilibrium, where Country II has relative advantage. Area closed by NN_AWN_B is the two-constrained equilibrium. If $R3 > 0$, Country I has relative advantage; if $R3 < 0$, Country II has relative advantage.

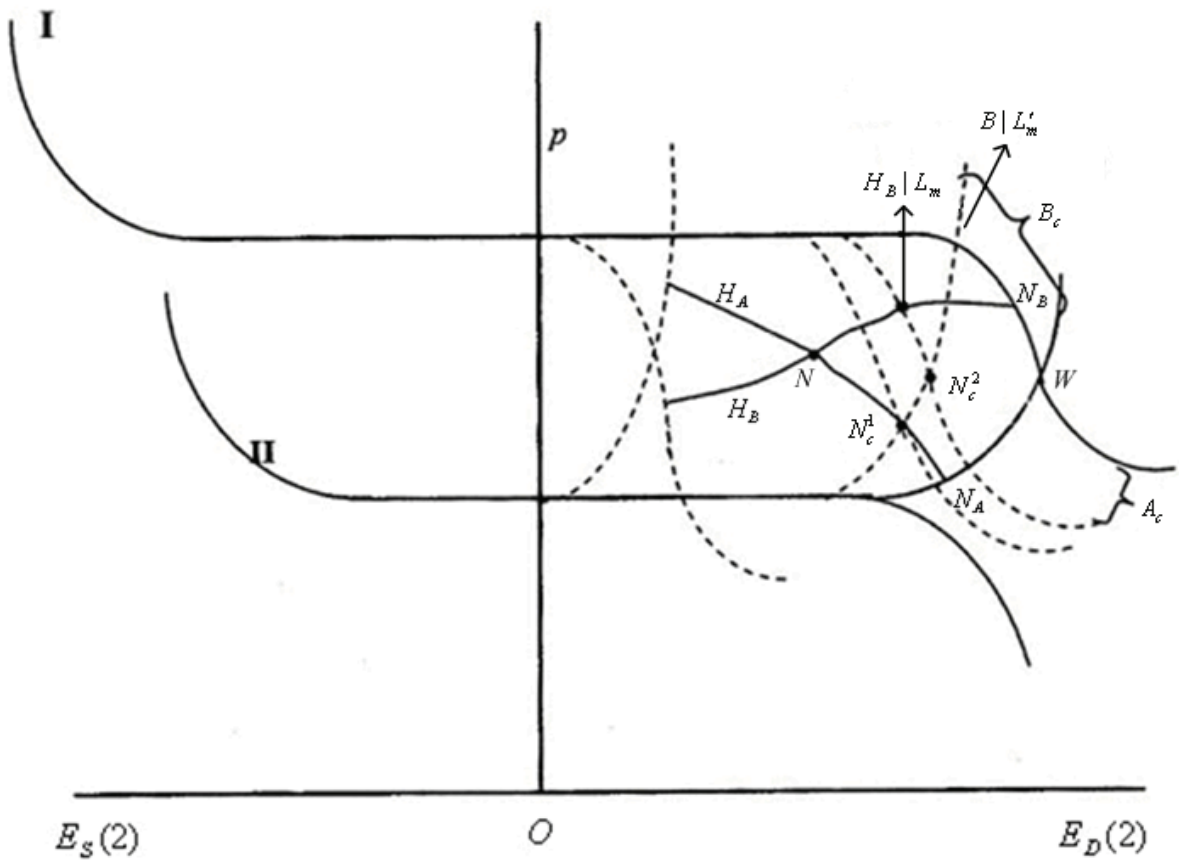

Figure 6. Constrained Trade Equilibrium

EFFECT OF SYSTEM PARAMETERS ON ABSORPTION CAPACITY

From the previous section, it is known that a large absorption capacity may allow a nation to obtain the full potential of resource-allocation advantage, other things being equal. Equation 12 illustrates that the absorption capacity is affected by two system parameters: (1) productivity of tradable sector, $\frac{1}{l_1}$; and (2) national wealth, *w*.

First, a productivity increase not only boosts output within the tradable sector but also augments the amount of labor that can be employed in the nontradable sector (job creation). Given the expected price, a productivity increase shifts the demand curve for nontradable upward (refer to Figure 5), while the supply curve of nontradable remains unchanged. Thus, L_m will decrease, which means a larger absorption capacity. From Equation 12, the productivity elasticity of job creation in the nontradable sector can be derived as follows:

$$\varepsilon_l = -\frac{\partial \ln L_m}{\partial \ln(\frac{1}{l_1})} = \frac{\theta(\overline{L} - \theta w)\frac{1}{l_1}\frac{1}{p_e}}{[\overline{L} - (1+\theta\frac{1}{l_1}\frac{1}{p_e})L_1 - \theta w](1+\theta\frac{1}{l_1}\frac{1}{p_e})} > 0 \qquad (19)$$

From $L_m \geq 0$, it is known that Equation 19 is larger than zero. This is consistent with job creation. In addition, consumption of certain nontradable goods may help increase productivity in tradable sector.[21] For example, a high quality of environment and high standards of healthcare make people healthier and hence lead to higher productivity. A first-class higher education makes labor force more knowledgeable and skillful, which directly contributes to higher productivity. This high productivity, in turn, increases absorption capacity in the nontradable sector. This process provides a dynamic, positive feedback on the absorption capacity and national welfare.

Second, when wealth increases, it can also increase the amount of labor that can be employed in the nontradable sector. The wealth elasticity of job creation can be written as follows:

[21] Alcala and Ciccone (2004) found that international trade has a positive effect on productivity.

$$\varepsilon_w = -\frac{\partial \ln L_m}{\partial \ln w} = \frac{\theta w}{\overline{L} - (1+\theta \frac{1}{l_1}\frac{1}{p_e})L_1 - \theta w} > 0 . \quad (20)$$

Equation 20 has a positive sign, which clearly indicates that increase in wealth boosts absorption capacity.

Immiserized Growth Is Less Likely to Happen

From Equation 19, we know that when productivity in tradable sector increases, the job creation effect in nontradable sector is positive, which means some resource will be absorbed into the nontradable sector. The absorption effect will dampen the effect of immiserized growth. Therefore, immiserized growth is less likely to occur, and its effect is mitigated.

CONCLUDING REMARKS

This article argues that wealthy and advanced nations have resource-allocation advantage in international trade. Resource-allocation advantage stems from a nation's capacity to absorb extra resources to produce nontradables as a result of high productivity in the tradable sector. This advantage allows wealthy nations to be better off in trade, while trade is free and production of tradable goods is efficient.

First, when a wealthy nation trades with a representative poor nation, the wealthy nation obtains larger gains in trade compared to the Ricardian equilibrium. Second, resource-allocation advantage measures a relative strength between nations. When two wealthy nations trade with each other, the nation with larger absorption capacity tends to have relative advantage. Third, the model explains why immiserized growth is less likely to happen for wealthy nations. Fourth, the model shows some key economic parameters such as productivity and national wealth level can affect trade gains by nation. In addition, the consumption of certain nontradables may have a positive effect on productivity in tradable sector, which will help to create absorption capacity in the long run.

The model illustrates the situation where nations can maximize their gains. In reality, nations may not necessarily be able to perform as ideally as the model indicated.

Nevertheless, it suffices to say wealthy nations are better off than if resource-allocation advantage is not present. Also, we can envisage a long-run gradual adjustment process, which leads to welfare maximization.

In the era of globalization, government policies relevant to national resource allocation become increasing important. As Karagiannis and Madjd-Sadjadi (2007, p. 7) indicated, "State supervision of national development, investment coordination among potential competitors within key dynamic sectors, 'socialising risk' through technically proficient industrial planning, and focus on targeted investments, capacity, skills and research and development (R&D) can help the economy achieve faster industrial growth and structural change." A direction of further research is to study the type and effectiveness of policy tools that can be used by government in the content of resource-allocation advantage. Is it possible to create new policy tools to help nations to fully take advantage of the resource-allocation advantage that they possess? Another future direction for research is to empirically test the proposed model. Debaere and Lee (2003) suggested that a country's terms of trade are positively correlated to its per capita GDP. A similar approach is to test the relation between terms of trade and per capita spending in those nontradable sectors in which systematical quality difference exists among nations. A different approach is to estimate the contribution to per capita GDP by the terms of trade and the relative size of some specific nontradable sectors.

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APPENDIX: TERMS OF TRADE IS A FUNCTION OF $\widetilde{L}$

Proof

Form Lagrange function:

$$S = U(q_1, q_2) + \lambda y(q_1, q_2; p, \widetilde{L}) \tag{A.1}$$

where $y(q_1, q_2)$ is the implicit function of the consumption possibilities frontier.

The first-order condition gives the following equations:

$$\frac{\partial S}{\partial q_1} = \frac{\partial U}{\partial q_1} - \lambda \frac{\partial y}{\partial q_1} = 0 \tag{A.2}$$

$$\frac{\partial S}{\partial q_2} = \frac{\partial U}{\partial q_2} - \lambda \frac{\partial y}{\partial q_2} = 0 \tag{A.3}$$

$$\frac{\partial S}{\partial \lambda} = y(q_1, q_2; p, \widetilde{L}) = 0 \tag{A4}$$

Solving the equations, we obtain the ordinary demand functions:

$$q_1 = f(p, \widetilde{L}) \tag{A.5}$$

$$q_2 = h(p, \widetilde{L}) \tag{A.6}$$

The value of *p* is not arbitrary. It has to be a price that can clear the world market. From trade condition, we have

$$\left(\frac{L_1 + \widetilde{L}}{l_1} - q_1\right) / \left(q_2 - \frac{L_2 - \widetilde{L}}{l_2}\right) = p \tag{A.7}$$

$$q_2 - \frac{L_2 - \widetilde{L}}{l_2} = g(p) \tag{A.8}$$

Substituting equation A.6 into equation A.8 (or A.7), we derive $p = p(\widetilde{L})$.