Bilateral Trade Flows and Nontraded Goods

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Abstract: This paper develops a monopolistic competition model with nontraded goods which provides an explanation for why the real volume of trade is much lower than predicted by Helpman and Krugman's (1985) model. Furthermore, it explains the phenomenon that the volume of trade among high-income countries is relatively larger than the volume of trade between high-income and low-income countries. We also derive a testable gravity equation from this model. A sample of 1995 including 118 countries is examined. Our results show that evidence from the data is consistent with the prediction of this model. Further, the goodness-of-fit increases as nontraded goods are considered.

Keywords: Bilateral Trade Flows; Gravity Equation; and Nontraded Goods

JEL Classification: F10, F12

1. Introduction

In the last few decades, the most important development in the theory of international trade is the monopolistic competition model. Helpman and Krugman (1985) proposed a model in which monopolistically competitive firms produce differentiated goods using an increasing return to scale technology (IRS) and all individuals have identical homothetic preferences and a “love for variety”. Their model provides an explanation for the phenomenon of large volumes of trade among similar countries with a factor-proportions view of intersectoral trade flows, which could not be explained by the traditional Heckscher-Ohlin (HO) theorem.

In Helpman and Krugman's model, it is assumed that the economy has free trade, balanced trade, no transport cost, all tradeable goods, and identical production technology across countries. The monopolistic competition model yields the following equation to predict the volume of bilateral trade,

\[ M_{ij} = \frac{Y_i Y_j}{Y_w} = s_j Y_i \]  \hspace{1cm} (1)

where \( M_{ij} \) is the imports of country \( i \) from country \( j \), \( Y_i \) (\( Y_j \)) is the gross domestic product (GDP) of country \( i(j) \), \( Y_w \) is the total world income, and \( s_j = \frac{Y_j}{Y_w} \) is the share of
country $j$ in total world income. Equation (1) means that the bilateral trade flows are positively related to the product of countries' GDPs, which is the simplest form of gravity equation.

However, the volume of trade in the real world is much less than the amount predicted by equation (1). For example, the volume of trade in the world is about 5,214 billion U.S. dollars, which is much lower than the predicted number, 25,033 billion US dollars in 1995. Obviously, the bilateral trade flows are overestimated by Krugman and Helpman's model.

Many possible factors could reduce the bilateral trade flows. For example, high transport cost could decrease the volume of trade. Most countries do not have completely free trade. Further, not all goods in the real world are tradeable such as services, education, and housing. All of these facts will reduce the volume of trade. However, most of the seminal studies do pay attention to the influence of transport cost. The gravity equation, in general, shows that the volume of bilateral trade is not only positively related to both incomes, but also negatively related to the distance between the two trade partners, in which the distance is used as a proxy variable for transport costs.

The study of the gravity equation is probably the most successful empirical work in international trade. The model was first introduced by Tinbergen (1962) and Anderson (1979) was the first to derive the gravity equation theoretically. Anderson (1979) assumed that preferences are Cobb-Douglas (or CES) and the goods are differentiated by countries of origin, which is called the Armington assumption. Bergstrand (1985) used CES preferences over Armington-differentiated goods to develop a general equilibrium model of world trade, thus yielding a reduced-form gravity equation for bilateral trade involving price indices.

In this paper, the assumption that all goods are tradable is relaxed. I incorporate nontraded goods in a monopolistic competition model. This model tries to provide an explanation of why the real volume of trade is much lower than predicted. The intuition is quite simple. It is because the countries do not have so many goods that are tradable in the real world. An estimable gravity equation can be derived from this model. Moreover, since this model incorporates nonhomothetic preferences, it also can explain the phenomenon that the volumes of trade among the industrialized countries are relative large to the volumes of trade between developed and less-developed countries, which was proposed by Linder (1961) and Markusen (1986). Markusen (1986) proposed a nonhomothetic model to explain the difference between the volume of W-E trade and the volume of N-S trade. Unfortunately, his model does not offer a testable model to predict the volume of trade from his model. However, in the extension of his paper, Hunter and Markusen (1988)
proposed a nonhomothetic model and estimated a linear expenditure system (LES) to show that the demand is nonhomothetic.

The remainder of this paper is organized as follows: in Section 2, we set up the model and derive the gravity equation with nontraded goods. Section 3 describes the data sets used in this study. The empirical results are given in Section 4. They strongly support the prediction of this model in a sample of 118 countries in 1995. Section 5 concludes.

2. The Model

In this section, the model is set up. Consider an open economy which has balanced trade, no transport costs, and with identical production technologies. There are \( m \) countries and two types of goods, tradeable goods \( (x_k) \) and nontraded goods \( (z) \). The tradeable goods \( (x_k) \) are differentiated manufactured goods which are produced with production technologies with increasing returns to scale. The nontraded good is a homogeneous commodity and is produced with a constant returns to scale (CRS) technology.

It is assumed that all individuals consume tradeable goods as well as nontraded goods. Consumers have the following identical nonhomothetic preferences, which are given by

\[
U = \left( \sum_k x_k^{\alpha} \right)^{\frac{1}{\alpha}} + u(z) \quad 0 < \alpha < 1
\]

where \( u(\cdot) \) is a strictly concave function.

All individuals maximize their utility subject to their income. Since the subutility function for differentiated goods is homogeneous of degree one, we can use a two-stage budgeting procedure to solve this utility maximization problem. The consumer's problem can be rewritten as:

\[
\begin{align*}
\text{Max} & \quad U = N + u(z), \\
\text{s.t.} & \quad P \cdot N + P_z z = I,
\end{align*}
\]

where \( I \) is individual income, \( N = \left( \sum_k x_k^{\alpha} \right)^{\frac{1}{\alpha}} \) is the quantity index for differentiated goods, \( P = \left( \sum_k p_k^{\frac{\alpha}{\alpha-1}} \right)^{\frac{\alpha-1}{\alpha}} \) is the price index for \( N \), \( P_z \) and \( p_k \) for good \( z \) and \( x_k \), respectively. If we consider \( N \) as the numeraire, the utility can be considered as a quasi-linear utility function. According to the property of quasi-linear utility function, the consumption of \( z \) is constant which is determined by

\[
u'(z) = \frac{p_z}{P}
\]
for all consumers if the income is big enough. There is no income effect for $z$. Increasing individual income does not change the quantity of demand for good $z$ at all, and all the extra income goes entirely to the consumption of differentiated goods. Let $z = z^*$ satisfy equation (4) which means that $z^*$ is the demand quantity of notraded good for every consumer in every country and thus is independent of individual income and the prices of the differentiated commodities. Furthermore, it is also assumed that the individual's income in every country is bigger than $z^*$. Due to this special property of the nonhomothetic preference, the production of nontraded good for country $i$ is $Z_i = n_i z^*$ and is produced first in country $i$, where $n_i$ is the population of country $i$.

In addition, the differentiated manufactured goods are produced and freely traded. Just like the imperfect competition model proposed by Helpman and Krugman (1985) and Helpman (1987), a number of firms produce one differentiated commodity in a monopolistically competitive market. Also, all firms are equipped with identical IRS technology, and free entry leads to zero profit in equilibrium.

In this model, the volume of trade is different from the result of Helpman and Krugman (1985) but similar. Since this property of nonhomothetic preference is “love for variety” for differentiated goods, each country will demand all foreign varieties according to the country's share of world value of differentiated goods. Therefore, the value of differentiated goods that country $i$ imports from $j$, denoted $M_{ij}$, is

$$M_{ij} = \frac{X_j X_j}{X_w}$$  \hspace{1cm} (5)

where $X_j$ is the value of a differentiated good produced in country $j$, and $X_w = \sum_j X_j$ is the world output of differentiated goods.

Let $Y_i = X_i + Z_i$ denote the GDP of country $i$. Rearranging equation (5), $M_{ij}$ can be rewritten as

$$M_{ij} = \frac{(Y_i - Z_i)(Y_j - Z_j)}{\sum_j(Y_j - Z_j)} = \frac{(Y_i - n_i z^*)(Y_j - n_j z^*)}{X_w}. \hspace{1cm} (6)$$

Taking natural logarithms of both sides of equation (6), it follows that

$$\ln(M_{ij}) = -\ln(X_w) + \ln((Y_i - n_i z^*)(Y_j - n_j z^*))$$

$$= -\ln(X_w) + \ln \left( Y_i Y_j - n_j z^* Y_i - n_i z^* + n_i n_j (z^*)^2 \right), \hspace{1cm} (7)$$

where $\ln(X_w)$ is a constant.
In order to derive an estimable gravity equation, it is necessary to linearize the last term of equation (7). Applying the first order Taylor series approximation at \( z^* = 0 \), it yields the following estimable gravity equation:

\[
\ln(M_{ij}) = -\ln(X_{ij}) + \ln(Y_i Y_j) - \frac{n_i Y_j + n_j Y_i}{Y_i Y_j} z^* + \varepsilon
\]

\[
= c + \ln(Y_i) + \ln(Y_j) - \left( \frac{1}{Y_i} + \frac{1}{Y_j} \right) Z^* + \varepsilon \tag{8}
\]

where \( Y_i \) is per capita income of country \( i \), \( \varepsilon \) is the disturbance term.

Comparing the new gravity equation to the conventional gravity equation, there is a new item, \(- \left( \frac{1}{Y_i} + \frac{1}{Y_j} \right) Z^* \), in this model. It shows that the bilateral trade flow is not only related to the GDP of both countries, but also related to the demand for nontraded goods and the per capita incomes in both countries. According to the above equation, bilateral trade flow decreases if the consumption of nontraded goods increases or the per capita income decreases. It explains that the volume of trade between two rich countries is larger than that between two lower-income countries.

3. Data

There are three databases used in this study. The world bilateral trade flows data is originally obtained from the CD-ROM “World Trade Flows, 1980-1997, with Production and Tariff Data.” The data used to test this model is from the year of 1995. There are 182 countries or regions in this database. In Feenstra (2000), it indicated that the main source for bilateral trade data is the United National Statistical Office. Another data set used in the study is the GDP and per capita income data which is downloaded from Harvard University, CID (Center for International Development). The GDP and per capita income are PPP-adjusted. In Gallup and Sachs (1999), it indicated that most of the GDP and per capita income data are from the World Bank. For countries which are missing in the World Bank, the data is obtained from CIA (1996, 1997).

In order to compare this nontraded goods model and the conventional gravity model, a distance data set is also employed. The distance data set is downloaded from Purdue University. This data set contains 137 countries and it provides the distance between capital cities in kilometers. Combining the above three data sets, there are 118 countries employed in this paper.
4. Empirical Results

In this section, the gravity equations derived from the nonhomothetic model are estimated by using the above data set. Based on equation (8), the gravity equation can be specified as the following two forms

\[
\ln(M_{ij}) = \alpha + \beta_1 \ln(Y_i) + \beta_2 \ln(Y_j) - z^* \left( \frac{1}{Y_i} + \frac{1}{Y_j} \right) + \varepsilon
\]  

(9)

where \( \alpha, \beta \) and \( z^* \) are the coefficients to be estimated. Theoretically, \( \hat{\alpha} \) is expected to be negative, \( z^* \) should be positive, and \( \hat{\beta}_1 \) and \( \hat{\beta}_2 \) should be around 1.

In order to demonstrate the advantage of this new model, the conventional gravity equation is also to be estimated, which is

\[
\ln(M_{ij}) = \alpha + \beta_1 \ln(Y_i) + \beta_2 \ln(Y_j) + \varepsilon
\]  

(10)

Ordinary Least Square (OLS) estimation is employed to estimate the above regressions. The estimation results are shown in Table 1. There are 13,806 observations in this sample. In Table 1, it shows all of the estimated coefficients in equation (9) and (10) are significant at 1% significant level. The most important is that all of the signs of the estimated coefficients coincide with our expectation. In particular, \( \hat{z}^* \) is around $1,053 in this model, which means that all individuals consume at least about $1,053 goods produced by their country every year. It can be found that the estimated coefficients of GDPs in Equation (9) are significant closer to unity than in Equation (10) which means that this new model has a theoretical advantage. This nontraded goods gravity equation is more consistent with the data than the conventional gravity model. The \( R^2 \) of Equation (9) is about 0.60, which is bigger than the \( R^2 \) in Equation (10). That shows that the goodness-of-fit of this new model is better than the conventional model.

Next, this paper examines the performance of this model when a distance term exists and compare the traditional gravity equation with a distance term. The results are also given in Table 1 where Equation (9') and Equation (10') are Equation (9) and Equation (10) with distance term, respectively. The \( \delta \) is the coefficient of the distance term in each model. Just like the results above, the signs of estimated coefficients are as expected and significant. We also can find that the estimated coefficients of GDPs are also much closer to unity than the result of Equation (10').
Table 1: Estimation Results

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Equation (9)</th>
<th>Equation (10)</th>
<th>Equation (9')</th>
<th>Equation (10')</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(0.317)</td>
<td>(0.235)</td>
<td>(0.416)</td>
<td>(0.361)</td>
</tr>
<tr>
<td>(\beta_1)</td>
<td>1.51</td>
<td>1.68</td>
<td>1.52</td>
<td>1.71</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.015)</td>
<td>(0.016)</td>
<td>(0.014)</td>
</tr>
<tr>
<td>(\beta_2)</td>
<td>1.14</td>
<td>1.32</td>
<td>1.15</td>
<td>1.34</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.015)</td>
<td>(0.016)</td>
<td>(0.014)</td>
</tr>
<tr>
<td>(z^*)</td>
<td>1053.34</td>
<td>1163.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(47.272)</td>
<td>(44.606)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\delta)</td>
<td>-1.41</td>
<td>-1.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.034)</td>
<td>(0.034)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(R^2)</td>
<td>0.603</td>
<td>0.588</td>
<td>0.647</td>
<td>0.630</td>
</tr>
</tbody>
</table>

Note: Standard errors are given in parentheses

5 Conclusions

In this paper, we tried to provide an alternative explanation of why the real volume of trade is much less than the volume predicted by Helpman and Krugman's model. We consider nontraded goods as an important impact on bilateral trade flows. Furthermore, this model explains why the volume of trade between N-S is much less than the volume among developed countries.

We developed a model with nontraded goods and nonhomothetic preferences and derived an estimable gravity equation. The model tries to make a connection to bridge the gap between theory and empirical work on the role of nontraded goods. This model finds that bilateral trade flows are not only related to the GDP of two countries, but also related to the per capita income of the two countries. The individual consumption level of nontraded goods can be estimated, which is also related to bilateral trade flows. In the empirical work of this study, we employed a sample of 1995 data with 118 countries to test this model. The empirical results are consistent with the expectations from this model.

References

