A Critique of the Gravitational Model in Estimating the Determinants of Trade Flows

Marco Mele

School of Political Science, LUSPIO University, Rome, Italy

Italian Society of Economist (S.I.E.).

Email: marco.mele@luspio.it

Paola Allegra Baistrocchi

Teaching Assistant

School of Political Science, LUSPIO University, Rome, Italy

Email: allegra.baistrocchi@gmail.com

Abstract

Research pertaining to variables that are capable of influencing trade flows has undergone a different econometric evolution if compared to other macroeconomic variables. The analysis of economic literature in this field, especially in reference to a technical approach (i.e. utilizing a co- integration or a VAR approach), has rather focused on a systemic study. In this context, the gravitational model has revolutionized the econometric process of analysis of the determinants of trade flows, highlighting numerous improvements. However, although this model is capable of also explaining international trade between economies of scale, it has always (in an econometric perspective) automatically accepted the value of the intercept as the result of the difference between $Y - ß_1X_1$*. This paper, after having defined the variables that are capable of influencing trade flows, will suggest a different method of econometric calculation of the gravitational model.*

***Keywords**: International trade, Prain-Winsten, gravitational model Jel-Code: F13, F20*

1. Introduction

In 1687, Isaac Newton, in his book "*Philosophiae Naturalis Principia Mathematica"* articulated the universal law of gravitation, which revolutionized the principles of physics and mathematics on which the entire human knowledge had been based on thus far. According to his new law, any object in the universe attracts any other body with a force directed along the line that conjoins the barycenter of the two objects. The force's intensity is directly proportional to the product of their mass and inversely proportional to the square of their distance.

The universal law of gravitation can be expressed with the equation:

$$\mathbf{F_{kz} = g\,(M_z\, M_k/D^2_{zk})} \qquad \mathbf{(1)}$$

in which F_{kz} represents the attracting force between the two objects; M_z and M_k represent respectively the mass of the two bodies, D^2_{zk} is the square distance between the two objects, whilst g is the constant of universal gravitation, equivalent to circa $6{,}67 \times 10^{-11}$ measured in N m^2/Kg^2, meaning newton per square meter divided by kilogram square.

This same principle, according to which two objects depend positively on their mass and negatively on their distance, was subsequently used in numerous international macroeconomic studies. The gravity model is, for example, adequate in explaining commercial transactions at a macroeconomic level. The hypothesis on which it is based, is that the volume of commercial transactions between two countries depends positively on the level on their GDP (Gross Domestic Product) and negatively on their distance. The total of the amount of the GDP of the two countries would be, in Newton's original equation, represented as the mass (M_1 e M_2), which can be economically interpreted as the capacity to supply and demand goods on the international market, expanding the global volume of both imports and exports.

The geographical distance between two countries would represent instead a physical measurement which can be associated, at an economic level, with transaction costs expressed by transportation costs or, at a merely physical level, by the kilometric distance between the capitals of the countries taken into consideration.

The economist Tinbergen has been proposing, since 1962, to utilize the same functional formula of the 'universal law of gravitation' to analyze international trade flows, however, the use of this equation has lacked a real theory on which to justify this choice. Its application till now has been based on mere analysis and empirical demonstrations.

Subsequently, in an attempt to formulate a theory on the universal law of gravitation as applied to international trade, in 1995 Deardorff was able to obtain, through the use of Hecksher-Ohlin's neoclassical model, a gravitational equation for international trade. Therefore, starting from Tinbergen's contribution to the gravitational model, in which bilateral trade between two countries is directly correlated to their respective GDPs and inversely proportional to the distance between them, (1) can be expressed in the general formula:

$$\mathbf{F_{kz} = \alpha\, (M_k^{\beta 1}\; M_z^{\beta 2} / D_{kz}^{\beta 3})} \qquad \textbf{(2)}$$

in which:

i) F_{kz} represents the flows of exports from Country k to Country z, or alternatively the total volume of international trade;

ii) M_k and M_z represent respectively the economic mass of the exporting country k and of importing country z (where the economic mass is given by their GDPs);

iii) D_{kz} represents the geographical distance between the two countries taken into consideration;

iv) β_1; β_2 and β_3 represent the parameters of the equation;

v) α represents instead the constant of universal gravitation.

With the use of a logarithmic transformation of both members, (2) results more linear in the form:

$$\mathbf{\log F_{kz} = \log\alpha + \beta_1 \log M_k + \beta_2 \log M_z - \beta_3 \log D_{kz}} \qquad \textbf{(3)}$$

Which represents the equation on a hyperplane of the coefficients $\beta_1, \beta_2, \beta_3$ with an intercept equal to logα, in which the variables are the logarithmic transformations of the original variables F_{kz}, M_k, M_z, D_{kz}.

In the study of the relationship between these variables, the equation (3), with the addition to the second member of the error variable ε, illustrates a multi-linear regression model applied to the logarithmic transformation of the same variables.

In this model it is assumed that the mean of the logarithms of the dependent variable F_{kz}, influenced by the logarithms of the regressors M_k, M_z and D_{kz} lie on the hyperplane that appears in the second member of the equation (3). It is necessary to recall that with the addition of the error variable ε, we are introducing into the model the effects of all other factors (other than the regressors) which determine the variable F_{kz}.

2. Certain Determinants of Trade Flows

The first studies on the determinants of international trade concentrated principally on the tight relationship that subsists between geographical distance and commerce. It has been established, with good approximation, that the distance represents a strong determinant for trade flows. Countries that have a geographic proximity will trade more than countries which, on the other hand, have very distant borders (Ullman 1956, Smith 1964).

Further research has taken into consideration the determinants of international trade in a multivariate perspective. Amongst these, one of the most noteworthy studies is Linneman's research of 1966. In it, on the basis of an econometric model, he analyzed the factors which determined trade flows between eighty countries in 1959. The variables considered influential to international trade were: gross national product (GNP), population, geographic distance and a ulterior specific factors of preferential trade. Linneman noted that all the variables used in the econometric analysis showed a significant importance lying within the volume of imports and exports of the countries examined.

Subsequently, numerous scholars have extended the results obtained by Linneman, using other factors such as politics, the degree of openness to international trade and special conditions relating to culture, religion and language.

- *Culture as a determinant for trade flow*

In the past decades, encouraged by contributions of economists such as Krugman (1980), Erramilli - Rao (1990), and Evans-Mavondo (2001), the theory of international trade has begun to emphasize the importance of costs as a significant factor in trade flows. This has expanded the types of costs which may affect trade flows beyond traditional ones, such as those linked to the transport of goods. New factors came into play, such as those related to moral hazard and to uncertainty towards the outside environment, ascribable to cultural differences. Costs related to international trade can thus be classified into: costs due to geographical distance (transport costs) and costs caused by cultural diversity.

With regards to the costs arising from physical trade, these have the characteristic of possibly being reduced (at least partially) by forms of investment that improve connections between borders (such as roads, tunnels and bridges).

By contrast, the costs arising from the cultural gap between countries, present more complex difficulties which seem harder to overcome. These difficulties arise from the very definition of culture proposed, more than a century ago, by Kluckhohn (1951) and also in the most recent definition of UNESCO, in 2001, where culture is described as: "*the set of distinctive spiritual, material, intellectual and emotional features of society or a social group, that encompasses, not only art and literature, but lifestyles, ways of living together, value systems, traditions and beliefs*".

From this definition it is evident that there is a potential for "protectionism" in international trade between countries that are culturally different. In support of this thesis, pertaining to the importance of cultural distance within international trade, Johanson and Wiedersheim-Paul (1975) stated that among the various difficulties that companies may face when they decide to enter a foreign market, there is one that goes beyond normal bureaucratic and legislative procedures, as well as past the geographical distance: the so-called "psychic distance". This represents the set of all the obstacles of an informative nature that are tied to cultural diversity amongst people, so as to result inversely proportional to the distance between the countries interested in trading.

As a matter of fact, the internationalization model developed at the University of Uppsala shows that firms tend to select markets not only in accordance with the analysis of tastes and domestic demand in that market, but especially in conformity with the psychic proximity to the country of origin.

There are also numerous studies that seem to confirm that cultural differences impede the flow of information and communications between individuals and companies from different countries (Hallen & Wiedershein 1994, Hofstede 1994, Kogut & Sing 1998).

Consequently, an analysis on the determinants of trade flows between countries cannot transcend a study and comparison of cultures and traditions of trading countries. This approach, however, is not without its difficulties. The psychic – cultural differences between states cannot be, in our opinion, subject to econometric parameterization. At most, one could experiment with the use of the variables that best represent the concept of culture. An example of this is the Hofstede Cultural Dimensions theory, which utilizes indices to parameterize culture in its statistical model.

Hofstede Geert developed in "*Culture's Consequences: Comparing Values, Behaviors, Institutions and Organizations Across Nations-2001*" a so-called "quantity", a specific numeric value attributed to the concept of culture, so as to allow an empirical-econometric analysis of the characteristic. Hofstede classified culture according to five dimensions: distance from power, individualism, masculinity, uncertainty avoidance and long-term orientation.

To each of these dimensions Hofstede has associated a numeric index so as to facilitate the comparison between different national cultures, all subsequently represented within a pentagon, in order to display the overlaps and differences.

Although Hofstede's dimensional model certainly represents an original idea regarding the possibility of "measuring" the cultural differences between countries, it seems, however, inadequate for two reasons. This is due, firstly, to the fact that wanting to contain the concept of culture in only five dimensions results in an oversimplification of cultural reality and of the complex nature of cultures. Secondly, the dimensional model is inadequate in referrence to the variable of "tradition". If traditions are to be interpreted as the *transmission, over time, within a human group, of recollections of social or historical events, customs, rituals, mythology, religious beliefs, customs, superstitions and legends*, then they cannot be the object of a superficial analysis so as to be classified as the final dimension of Hofstede's pentagon.

Furthermore, traditions also have a purely psychological component that is impossible, in our opinion, to measure by any existing technique.

For this reason, in the gravitational-econometric model that we will analyze below, we felt it appropriate to add new variables as closely related as possible to the concept of culture, which includes language and religion.

- *The degree of openness to international trade*

The economic literature that deals with the indices that can best be used in empirical studies to measure the degree of openness of a country towards international trade is very extensive. Depending on how these indices are built, it is possible to divide them into: indices that measure the volume of trade and indices based on the impact of tariff and non- tariff barriers.

The former are commonly used in empirical analyses using the ratio between the volume of trade (export + import) and the volume of wealth produced by a nation in terms of Gross Domestic Product. In particular, the first indices used mainly exports (Edwards-1980), as economic literature attributed little importance to imports, recognizing instead that only exports had the ability to stimulate economic growth, once international trade had been liberalized. Conversely, the evolution of the theory of international trade has reversed this view, arguing that the benefits of trade openness are derived from imports. This statement finds its premise in Ricardo's theory of comparative advantages, according to which, thanks to international trade exposure, a country is able to exploit their resources more efficiently, obtaining through imports the goods and services that would otherwise be produced at an increased costs. This radical changes in the economic literature encouraged the use of indices that consider (as complementary and non-differentiated) both imports and exports, so as to avoid measurement problems in contemporary empirical analyses. However, these indices still present some difficulties in estimating the value of exports, imports and GDP. For example the debate on whether to evaluate the variables in terms of purchasing power parity (F. Alcana, A. Ciccone, 2004), or whether to rely on the current prices charged on various international markets through the nominal exchange rate of the dollar (J. Frankel, D. Romer, 1999).

The incidence of tariff and non-tariff barriers on trade in a country can also be used to measure the degree of openness of a country to international trade. In referring to tariff barriers, these usually refer to duties. These represent a tax that weighs on the value of products that are imported into a particular country. The immediate consequence is a disadvantage in the market for foreign products and for companies that produce these goods, and the subsequent negative distortion to international trade.

However, duties are not the only tariff barriers that are able to disrupt the normal process of internationalization of goods. Other barriers include quota restrictions, commodity agreements (agreements aimed at stabilizing the prices of certain products in the long term) and administrative barriers (state holdings, and the definition of technical standards).

It is clear that the transition from a situation of high tariff barriers to a situation with fewer restrictions denotes a greater degree of openness of a country to foreign trade. Nonetheless, indices of this type may present measurement errors and distortions, the most important of which is the so-called downward bias. This phenomenon consists in, once the ratio of revenues from customs duties and total imports is calculated, that some goods (for internal market reasons) are subject to excess taxation so as to discourage the normal import.

Although some economists (F. Rodriguez, D. Rodik, 2001) state that the effects of this distortion have not yet been fully identified, in our study we will use the index based on the volume of trade measured in current prices, as this method ensures a greater ease and precision, so as to avoid complications to the analysis (A.Harrison-2004).

- Political Factors

There are also political variables that are considered significant within an empirical analysis of trade flows, and these are the political instability of the exporting country and the existence of colonial relations between the exporting country and the importing country.

Specifically, it is widely accepted that high levels of political instability within the exporting country are associated with a low volume of trade. According to studies conducted by the "Business International Corporation", this is true for the majority of traded goods, whilst for energy goods (for example, oil, gas, and coal), the "political instability" variable seems be irrelevant (Rajendra K. Srivastava and Robert T. Green, 1986).

With regard to the second political variable (trade relations between colony and mother-country), the colonial legacy tends to be regarded as decisive and meaningful to the analysis of the intensity of trade. Although ex-colonial countries have obtained political independence from the so-called "mother-country", they seem to maintain commercial interdependence due to the persistence of strong political and cultural links, proving to be influential for international trade.

3. An Econometric Limitation to The Gravitational Model

Referring to (3), including the error variable, this paper aims at presenting a mathematical critique. In particular, from Tinbergen's contribution and onwards, economic literature pertaining to gravitational models has failed to provide an explanation for the adaptation of the gravitational constant in a regression, considering the logarithmic transformation of that variable, such as the simple intercept of a straight line. However, the transformation of Newton's original equation – on a mathematical level – should take into consideration the theoretical value of the gravitational constant itself, thus delineating the subsequent regressions:

$\log F_{kz} = \log (6{,}67 \times 10^{-11}) + \beta_1 \log M_k + \beta_2 \log M_z - \beta_3 \log D_{kz}$ ossia:

$\log F_{kz} = \log (9{,}822) + \beta_1 \log M_k + \beta_2 \log M_z - \beta_3 \log D_{kz}$ da cui ne deriva:

$\log F_{kz} = 0{,}992 + \beta_1 \log M_k + \beta_2 \log M_z - \beta_3 \log D_{kz}$.

Within an econometric context, the above-mentioned considerations would bring about different results than those expected on a theoretical level. In other words, this would signify that it would be necessary to take into consideration for analysis the predetermined intercept of the regression and the positive value. However, thus far, econometric-gravitational studies have aimed at ensuring the normal calculation of the constant ($a = y - \beta x$). Thus they have preferred to adapt the gravitational acceleration g to the econometric constant α, committing (in our opinion) an implicit " error acceptance".

To avoid accepting the perpetration of this error, in our gravitational model applied to Chinese trade flows , we not only consider α as an econometric constant, but also as the result of the logarithmic transformation of Newton's original equation. In analyzing Chinese trade flows, our dependent variable in our multiple regression in relation to a group of countries (Taiwan, Singapore, Japan, and South Korea), we are able to affirm that these flows are positively influenced by the "economic mass" of their trading partners and their degree of openness to international trade, whilst being negatively influenced by their physical and cultural distance.

The multivariate-regression results reported below where obtained through the use of the statistical-econometric software STATA S.E. v.11, utilizing longitudinal data that varies both in time and space (cross-section time-series). The analysis of our panel, a dataset containing 375 observations, divided into 25 groups, for a period t of 15 years, is usually carried out employing the estimation method with fixed effects. Therefore it is on a hyperplane, with n different intercepts that can be represented by a group of binary variables able to capture the effects of each variable while remaining constant in time, so as to satisfy both econometric logic as well as economic theory.

From a technical standpoint, the Hausman test rejects the alternative method, the GLS random effects method, resulting in a p-value equal to 0.0000, thus providing a clear justification for the use of a Fixed Effect model.

On a purely theoretical level, international trade between countries have complex relationships that, in the long run, may be influenced by various factors. Although these have been included in our model in the form of regressors, nothing excludes the presence of other likely causes exogenous to the model. This causes, according to the Ramsey test, distortions caused by omitted variables. However, this will not necessarily hinder our research, if we follow the theoretical indications of Hsiao (2003), which expresses the possibility of using a fixed effects model in cases in which the effects of possible distortions by exogenous factors can conveniently be considered stable.

Furthermore, since our dataset is characterized by a relatively small N (Ni = China, Taiwan, Singapore, Japan, and South Korea) and a substantially larger T (Ti = 1986,1987,1988 ... 2000), we calculated “panels corrected standard errors” (PCSEs) according to the Beck and Katz approach (1995), so as to address issues related to the presence of heteroskedasticity in the model.

Finally, to estimate the invariant variables, excluded from the fixed-effects model - as can be inferred from the results of the variables of distance and language (which were “dropped” by the software) – we regressed these variables onto the previously estimated Fixed effect model, with the aid of a “Prais-Winsten regression, Correlated panels corrected standard errors" (PCSEs-AR1).

4. Results

Model 1 = Fixed effects model (estimator within)

Model 2 = Prais-Winsten autocorrelated regression (AR1)

Dependent Variable "Trade Flows" ($logF_{cz}$)

Variables	**Model 1**	**Model 2**
Ln of:		
GDPp.cap(lnmcmz)	.3125978*	.2035311*
	(.01432)	(.0253)
Openness (lnopenness)	.8806445*	1.085652*
	(.01736)	(.0267)
Hofstede (loghfste)	2.904465*	.7270207**
	(.18244)	(.2859)
Religio ($logrel_{cz}$)	-.0854668*	-.0829758*
	(.00780)	(.0148)
Distance (logdist)	(dropped)	-.0005888*
		(.00006)
Language(Dlang)	(dropped)	-.9737968*
		(.0626)
const. (cons)	-6.141703*	2.576997*
	(.63341)	(.8340)
R^2	.986	.999
Observations	375	375

$*p<0.01$; $**p<0.05$

- Model 1 F test : F(24,346)=13.28 con Prob>F=0.0000

-Model 2: Wald chi^2 = 2655.55 con Prob> chi^2 = 0.0000

As is easily observable when dealing with a regression model of this type

$$Y_{it}=2,5769+0,2035GDPp.cap+1,085Open-0,082Rel-0,005Dist-0.973Lang+E_{it} \quad \textbf{(4)}$$

The constant is automatically generated for a value of 2.5769. However, if we were to consider instead the real logarithmic transformation of the gravitational equation, the regression model would show:

$$Y_{it}=(0,992\pm 2,5769)+0,2035GDPp.cap+1,085Open-0,082Rel-0,005Dist-0.973Lang+E_{it} \quad \textbf{(5)}$$

Which would affect not only the intercept of the straight line, but also the quality (goodness) of the model itself, given by the R-squared value.

5. Conclusions

Despite its wide spread use in estimating numerous economic determinants, the gravitational model has presented numerous discrepancies over the years. Amongst these, the most critical problem has certainly been (from the practical point of view of compiling a data-set) that of defining the parameters involved in Newton's original formulation. It is of utmost important to have a rich set of data that can then be "personalized" by the researcher. To remedy the difficulties in the definition of Newton's parameteres, an alternative model has been developed (CNISM and INFN, 2010), the so-called radiation model, which is based exclusively on data pertaining to population density and therefore on Linder's representative demand, which can be estimated relatively accurately around the world.

The gravitational approaches can also be exposed to further criticism because, in them, the concept of utility maximization can be applied to only part of the studied phenomena, giving recourse to "ad hoc" hypotheses about individual behavior related to the perception of the advantages / disadvantages of the international mobility of goods. Therefore, in numerous analyses, other models have been preferred, in connection with the study of spatial interaction deduced from the application of the second law of thermodynamics (in other words, the principle of entropy). The spatial interaction model which is based on the thermodynamic approach would thus represent a specification of the gravitational model.

Bearing in mind the limitations of the gravitational model, another consideration has to be made. This purely mathematical consideration pertains to the "incorrect" result of the logarithmic transformation of the gravitational constant. This observation leads us to state that the formulas derived by analogy from the celestial phenomena and the laws of physics, could be used to describe empirical phenomena. But despite the good results achieved in econometric statistical applications, they are not adequate to provide acceptable theoretical explanations.

References

Anderson J.E. 1979 "*A Theoretical Foundation for the Gravity Equation",* The American Economic Review, March 1979, pp. 106-116.

Anderson, T.W., and C. Hsiao 1982, *"Formulation and Estimation of Dynamic Models Using*

P anel Data." Journal of Econometrics, vol 18, pp. 47-82

Armington, P. 1969, *"A Theory of Demand for Products Distinguished by Place of Production."* IMF Staff Papers, vol. 16, pp. 159-176.

Baier, S.L. and J.H. Bergstrand 2001, "*The Growth of World Trade: Tariffs, Transport Costs, and Income Similarity*", Journal of International Economics, 53, pp 1-27.

Baltagi B. H. 2001, "*Econometric Analysis of Panel Data"*, John Wiley & Sons Ltd, NY.

Beck, Nathaniel e Jonathan Katz 1996 "*What to do (and not to do) with Time-Series Cross Section Data.*" America Political Science Review,89(3): 634-47

Bergstrand, J 1985. "*The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence."* Review of Economics and Statistics, Vol. 69, pp. 474-481.

"*Controlling for Heterogeneity in Gravity Models of Trade" 2001*, Federal Reserve Bank of St. Louis Working Paper 1999-010B.

Deardorff, Alan, 1993 "*Testing Trade Theories and Predicting Trade Flows*". in Jones and Kenen (eds) Handbook of International Economics, vol 1. North Holland.

Deardoff A. 1995 "*Determinants of Bilateral Trade: does Gravity Work in a Neo-Classical World ?* NBER Working Paper.

Evans, Carolyn 2000, "*National Border Effects, Heterogeneous Fixed Costs of International Trade, and Variety Availability*", mimeo.

Evenett, Simon and Wolfgang Keller 1997, "*On Theories Explaining the Success of the Gravity Equation.*" NBER Working Paper.

Frankel J., Romer D., 1999 "*Does Trade Cause Growth?*", in "America Economic Review" , vol. 89, num.3 , pp. 379-399.

Gary Koop 2000, "*Logica statistica del dati economici*", John Wiley & Sons, Ltd

Greene W.1997 "*Econometric Analysis",* Macmillan Publishing Company, New York

Grossman, Gene. 1998 *"Comment on `Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World?"'* in Jeffrey Frankel (ed.), The Regionalization of the World Economy University of Chicago Press: Chicago

Haveman, J. and D. Hummels 2001 "*Alternative Hypotheses and the Volume of Trade: The Gravity Equation and the Extent of Specialization*," mimeo Purdue University.

Hsiao, Cheng 2003 "*Analysis of Panel Data"*. Cambridge-New York: Cambridge University Press.

J. Soderstrom (2008), " *Cultural Distance: An Assetment of Cultural Effect of Trade Flows*", Jonkomping International Business School, Jonkomping University;

Jensen, Paul 2000, "*Analysis of Bilateral Trade Patterns with Panel Data*", Review of International Economics, Vol. 8.

Johanson, J. and F. Wiedersheim-Paul (1975), "*The internationalization of the firm - Four Swedish cases*." *Journal of Management Studies*, 12 (3), p. 305-322

Johanson, J. Vahalne, J.E 1977 *" The internationalization process of the firm: a model of knowledge development and increasing foreign market commitment"s. Journal of International Business Studies, v. 8, n. 1, p. 23-32,*

Kluckhohn C. 1951, " *The Study of Culture*", in "*The Policy Sciences*", a cura di D.Lerner, H.D Lasswell, Stanford University Press, Stanford.

Linneman, Hans. 1966 "*An Economic Study of International Trade Flows".* Amsterdam: North- Holland.

Manning, W.G. and J. Mullahy 2001, "*Estimating Log Models: To Transform or Not to Transform?,*" Journal of Health Economics 20, pp.461-494.

National Scienze Foundation: Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania- for dataset-.

Pritchett L., 1996 "*Measuring Outward Orientation in LDCs: Can It Be Done? ,*in " Journal Development Economics", vol.49, pp. 307-335.

Porojan A. 2000 "*Trade Flows and Spatial Effects: The gravity model revisited"* University of Derby Working Paper.

Rocco R. Huang (2005), "*Distance and Trade: Disentangling Unfamiliarity Effects and Transport Cost Effects*" European Economic Review,pp.161-181.

Ronald B. Davies Delia Ionascu, Helga Kristjánsdóttir (2000), "*Estimating the Impact of Time-Invariant Variables on FDI with Fixed Effect*", Department of Economics,Copenhagen Business School;

Rodriguez F., Rodik D., 2001 "*Trade Policy and Economic Growth: a Skeptic's Guide to the Cross-National Evidence"*, Macroeconomics Annual 2000, eds. Ben Bernanke, Kenneth S. Rogoff, MIT Press for NBER, Cambridge.

Tinbergen, J. 1962, "*The World Economy. Suggestions for an International Economic Policy.*", New York, NY: Twentieth Century Fund.

Ziliak, J. P. 1997, "*Efficient Estimation with Panel Data When Instruments are Predetermined:An Empirical Comparison of Moment-Condition Estimators*." Journal of Business and Economic Statistics, 15, pp. 419-431.

World Bank 1998 "*East Asia-The Road to Recovery",* Washington

United Nation Statistics Division, United Nations Common Database, Country 1982-2006