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A New Approach to Measuring Trade Openness

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Abstract

Trade openness, popularly measured as $(X + M)/GDP$ in the hundreds of studies published to date, consistently considers the world's biggest trading countries such as the USA and Japan to be closed economies, irrespective of the data set used. This paper suggests a composite trade intensity measure that more accurately reflects reality by combining two important dimensions of trade openness: trade intensity and the relative importance of a country's trade level to total world trade. Robustness tests show that the new measure of trade openness performs better when testing the trade openness-income growth hypothesis than the traditional trade intensity measure.

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INTRODUCTION

A vast literature investigating aspects of the relationship between trade openness and income growth exists. There is strong theoretical support grounded in classical, neoclassical and endogenous growth theory that increased trade leads to higher incomes. This theoretical literature has spawned an extensive empirical literature aimed at testing for evidence in support of the theory. One strand involves testing the export-led growth (ELG) hypothesis using mostly standard econometric time-series procedures. The results from these many studies are mixed, although most find evidence of some support for the contention that exports contribute to economic growth.¹ In the ELG literature, a very narrow definition of trade openness is used: exports' share, or manufactured exports' share of income and their relationship with economic growth.

A second strand uses various production function frameworks. Important examples include Edwards (1992, 1998) and Frankel and Romer (1999). In these studies, trade openness measures are included as additional explanatory variables in the regression models. The trade openness measures tend to be narrow and those typically used are either X/GDP , M/GDP , or $(X+M)/GDP$, usually described as trade intensity (TI). Again the results from this literature are mixed. Generally, cross-section studies tend to offer greater support for the proposition that trade openness matters compared to time-series studies.

The inconsistent results emerging from these studies have prompted Frankel and Romer (1999) to note that “despite the great effort that has been devoted to studying the issue, there is little persuasive evidence concerning the effect of trade on income” (p. 379). It is our contention that part of the explanation for this lack of conclusive evidence is due to the inappropriate way in which trade, defined in terms of trade openness, is measured in the empirical literature.

In what follows, we suggest an alternative approach that reflects more accurately the income generating benefits derived from trade openness. To this end, the paper is organized as follows. Section 2 describes the popular measures of trade openness used extensively in the literature.

Section 3 introduces an alternative measure of trade openness. Section 4 provides some robustness tests of the new trade openness measure. Section 5 concludes.

I. MEASURING TRADE OPENNESS

Trade openness has been measured in various ways in the hundreds of studies investigating the issue, but most measures share a common feature; they express trade in terms of its share of income for a given country. Table 1 provides a summary list of several of the more common measures of trade openness that have been used. The table lists the three most popular and traditional measures: M/GDP ; X/GDP ; and $(X + M)/GDP$; plus several alternatives that have been suggested to deal with outliers. In addition Alcalá and Ciccone (2004) have argued recently that the standard measure of trade openness, TI, can yield an estimate on income that is biased downwards because of the impact of non-tradeables on productivity. Hence, they suggest that nominal trade be divided by purchasing-power adjusted income, or real GDP.

Table 1 here

Irrespective of the trade openness measure used, in each case, the various measures provide a method for determining how open an economy is to world trade and the income growth benefits that flow from trade. Put simply, the higher is, for example, TI for a particular country, the more open its economy to trade benefits. Table 2 provides TI measures and resulting rankings for 136 countries using trade and income data for the year 2000, obtained from the Penn World Tables (PWT) (Heston et al; 2002). The 136 countries that comprise this data set are listed alphabetically. The top five countries according to the TI measure are Singapore, Hong Kong, Luxembourg, Malaysia, and Estonia. That is, these are the five economies most open to trade. Hence these countries ought to, theoretically, derive considerable benefit from trade in generating income.

Table 2 here

One advantage of using TI-based measures of openness is that they are not contrived.² Using TI measures, which are based on trade and income level outcomes achieved by various countries, it is usual practice to represent countries as being on an open to closed continuum. At the very open end are economies such as Singapore and Hong Kong. As we move along the continuum, we move from very open, to open, to less open, to less closed then closed economies. By symmetry, those countries at the bottom end are deemed to be very closed and unable to take advantage of the income growth benefits of trade. According to Table 2, the bottom five and most closed economies are: Japan, Argentina, Brazil, the USA and India. That is, using this standard TI measure, the world's biggest trading country, the USA, is a very closed economy! It is closed in the sense that its trade share of total economic activity is very low by world standards and it is therefore closed to trade benefits. But how sensible is it to classify the USA, the world's dominant trading country, as a closed economy? Moreover how sensible is it to use other related measures listed in Table 1 as the indicators of trade openness?

II. AN ALTERNATIVE APPROACH TO MEASURING TRADE OPENNESS

The obvious weakness in using TI, or its related alternatives listed in Table 1, is that they are one-dimensional measures of trade openness. They look only at the relative position of a country's trade performance compared to its domestic economy. That is, they focus on the question of how large is the proportion of a country's income associated with international trade. The weakness of these measures lies in their inability to consider another important dimension of trade openness, that being how important is the particular country's trade level to world trade. Put another way, they fail to take into account a country's openness to total world trade.

Consider a set of countries, $j = \{1, 2, \dots, n\}$, where country $i \in j$, then country i 's relative world trade intensity ($RWTI_i$) can be expressed as:

$$RWTI_i = \frac{(X + M)_i}{\sum_{j=1}^n (X + M)_j} \quad (1)$$

representing country i 's total trade relative to total world trade. Table 2 provides measures and resulting ranks for each country in terms of a country's relative share of international trade. The five biggest trading countries in this sample of 136 countries are: the USA, China, Germany, Russia and the UK. That is, these are obviously open economies in terms of the extent to which each one trades with the rest of the world. By comparison their respective TI ranks are as follows: USA, 133rd, China 113th, Germany 86th, Russia 77th, and the UK 97th. Thus we have a very different group of countries ranked as the most open using this second-dimensional measure of trade openness, RWTI, compared to TI, but each one of these five countries is ranked very lowly in terms of its TI.

From a theoretical point of view, the income benefits of trade are generated irrespective of whether a country enjoys a relatively large or small TI, so long as it trades with the rest of the world. Therefore when trade openness is measured only using the TI or related measures, it overlooks this second important dimension of trade openness which captures the income generating benefits associated with trading relatively heavily with the rest of the world. In what follows we suggest an alternative way of measuring trade openness combining both dimensions: TI and RWTI.

Trade openness is a two-dimensional concept. Both dimensions capture, in a different way, the extent to which a country's economy is linked to international economic activity. The first dimension involves measuring the proportion of a given country's total income that is linked to international trade and may be represented by TI and its related measures listed in Table 1. Country i 's trade intensity may theoretically be measured in the range:

$$0 \leq (X + M)_i / GDP_i \leq \infty$$

Measures greater than unity indicate that the country's level of international trade exceeds its income. Such countries often perform minimal value adding on imports which are then re-exported. Alternatively, some countries may heavily specialize in products in which they possess a comparative advantage, while extensively sourcing many other goods and services from the rest of the world. In either case, these countries are described as very open. By contrast, in cases where $(X + M)_i / GDP_i$

approaches zero, then trade represents a small proportion of a country's income and such countries are typically described as very closed.

The second dimension of trade openness involves the relative contribution that a country makes to total world trade and is measured by $RWTI_i$. The larger is $RWTI_i$, the bigger is the country in world trade, that is the more open is the country's economy to world trade in relative terms to all other countries. The closer is this measure to zero then the less the country trades with the rest of the world and the more closed off from world trade the country is. Importantly, if one country is able to increase its relative world trade intensity, then there must be a fall in the rest of the world's combined share of world trade.

Proposition 1 *For any given country i with an open economy that trades with at least one country from the rest of the world, the relative world trade intensity measure operates in the range $0 \leq RWTI_i \leq 0.5$.*

Proof Assume the world is divided into two groups represented by country i and the rest of the world $n - i$. Let Country i 's trade be $(X + M)_i$ and the rest of the world's trade be $\sum_{j=1}^{n-i} (X + M)_j$. Therefore, total world trade can be written as:

$$\begin{aligned} \sum_{j=1}^n (X + M)_j &= (X + M)_i + \sum_{j=1}^{n-i} (X + M)_j \\ &= X_i + M_i + \sum_{j=1}^{n-i} X_j + \sum_{j=1}^{n-i} M_j \end{aligned} \quad (2)$$

where $\sum_{j=1}^{n-i} X_j$ is the rest of the world's exports and $\sum_{j=1}^{n-i} M_j$ is the rest of the world's imports. Since country i 's exports must equal the rest of the world's imports and country i 's imports must equal the rest of the world's exports, then total world trade can be written as:

$$\sum_{j=1}^n (X + M)_j = 2(X + M)_i \quad (3)$$

which implies that:

$$\frac{(X + M)_i}{\sum_{j=1}^n (X + M)_j} = \frac{1}{2} \quad (4)$$

Therefore, the relative world trade intensity measure cannot exceed 0.5 since no one country can import and export more than the rest of the world combined.³ Alternatively, it is evident that:

$$\sum_{i=1}^n \left[\frac{(X + M)_i}{\sum_{j=1}^n (X + M)_j} \right] = 1 \quad (5)$$

Therefore the mean of equation (5) is equal to $1/n$ and can never take a value larger than $1/2$ since there must be at least two countries for trade to occur.

Proposition 2 *The relationship between TI and RWTI is inverse and can be expressed with a downward sloping and convex to the origin Openness Frontier (OF).*

Proof The negative slope is an evident implication of the convexity of the OF which implies the existence of a diminishing marginal rate of substitution between TI and RWTI. This implies that any changes in the TI require larger and larger changes in the RWTI. Assume the world is divided into two groups represented by country i and the rest of the world $n - i$. Let country i 's trade be $(X + M)_i$ and the rest of the world's trade be $\sum_{j=1}^{n-i} (X + M)_j$. Country i 's $RWTI_i$ is expressed as:

$$\begin{aligned} RWTI_i &= \frac{(X + M)_i}{\sum_{j=1}^{n-i} (X + M)_j} \\ &= \frac{(X + M)_i}{(X + M)_i + \sum_{j=1}^{n-i} (X + M)_j} \end{aligned} \quad (6)$$

Holding GDP_i constant, an increase in TI_i requires $(X + M)_i$ to rise. Since the world's exports must always be equal to the world's imports, then $\sum_{j=1}^{n-i} (X + M)_j$ must increase proportionately with $(X + M)_i$, thus decreasing $RWTI_i$ at a much higher rate than TI_i .

Figure 1 provides a graphical representation of the Openness Frontier on which TI and RWTI interact with one another to create a more complete measure of trade openness. On the vertical axis is the traditional TI measure which may be as little as zero (a completely closed economy), but has no upper limit. On the horizontal axis is the second dimension of openness, the RWTI measure. The origin represents closedness according to either measure. Movement away from the origin indicates increasing openness. Countries close to the origin are closed because they are closed

on both measures. OF is asymptotic to infinity along the vertical axis since there is no theoretical limit to the upper value of TI. ⁴ The maximum value for RWTI, measured on the horizontal axis, is theoretically set at the value of 0.5 since beyond such a point it is not possible to increase the relative world trade share of any country without reducing the combined shares of all other countries to be less than this country's share.

The greater the number of countries enjoying relatively large shares of world trade, the closer to zero on the horizontal axis will be the majority of all other countries. That is, the further to the right and the greater the number of relatively large trading countries, the further to the left and closer to zero must be all other trading countries. Therefore, we would expect most countries to lie along or inside this frontier and their exact place along the horizontal axis depends upon the relative size of the dominant few countries. The most closed economies, with the greatest scope for realizing benefits from trade, will lie inside the frontier and closer to the origin. Movements away from the origin, but under the frontier, therefore, indicate increases in trade openness, resulting from either, or both, increasing TI or increasing RWTI.

Consider the hypothetical possibility that all countries enjoy identical shares of international trade. In such circumstance the size of this share would be represented by:

$$\bar{x} = \frac{\sum_{j=1}^n [(X+M)_i]}{\sum_{j=1}^n [(X+M)_j]} = \frac{1}{n} \quad (7)$$

which is exactly equal to the mean of the RWTI ratios. This is represented by the distance measure from the origin \bar{x} . ⁵ In such a case the TI share would also be fixed for each other country at some point along the vertical line at \bar{x} . It would not be possible to increase a country's TI without decreasing some other country's TI when RWTI is fixed at \bar{x} . Similarly there is very limited scope for a country to increase its TI when its RWTI measure exceeds \bar{x} . If we relax this assumption and allow RWTI to vary for each country, then positive distance from \bar{x} (the average of RWTI) will indicate the extent to which an individual country derives income benefits due to its larger than average share of world trade. Negative distance from \bar{x} will indicate the potential for deriving

income gains that a country may obtain from increasing its relative world trade share.

Alternatively, consider the hypothetical case that all countries enjoy identical TI measures, fixed at \bar{y} . In this case the only way a country can increase trade openness is to move out along the horizontal line from \bar{y} , increasing its relative world trade share at the expense of other countries. However there is a constraint on such opportunity since such an increase in RWTI for one country can only be achieved at the expense of diminishing RWTI for some or all other countries, but certainly for all other countries combined. For the ratio $(X + M)/GDP$ to remain constant at \bar{y} , GDP will have to fall for these affected countries triggering a further fall in $(X+M)$ and further falls in GDP. Such a scenario is inconsistent with a world of increasing incomes and expanding $\sum_{j=1}^n (X + M)_j$ whereby it is not possible for a country to expand its relative trade intensity measure beyond some very limited range while holding $(X + M)/GDP$ constant. This means that it is very unlikely that a country can enjoy a high TI ratio, above \bar{y} unless it also has a relatively small share of world trade. However, where countries have small shares of world trade and small TI measures, placing them close to the origin, then there is scope to expand both.

Figure 2a provides an actual scatter plot of TI against RWTI for the 136 countries in the PWT data set. The pattern of the scatter in this figure is consistent with the predictions of Figure 1. Those few countries with very high TI enjoy small but important shares of world trade. The small number of very large trading countries experience relatively low TI measures. Figure 2a provides an insight into the two-dimensional nature of trade openness. Economies can increase their openness in either of two ways given certain constraints. Benefits to trade can be realized if a country is able to increase either TI or RWTI, assuming it is within the Openness Frontier. Beyond that its scope is limited.⁶ The standard TI measure contains information only concerning the first dimension of trade openness and neglects the income growth potential associated with RWTI.

Proposition 3 *Trade openness is a two-dimensional measure determined by both TI and RWTI.*

Hence, it can be represented by the composite trade intensity (CTI) measure:

$$CTI_i = (1 + D_r)TI_i \quad (8)$$

where D_r represents a distance ratio measuring RWTI's deviation from \bar{x} , the mean of all countries' RWTI ratios, and represented by:

$$D_r = \frac{RWTI_i}{\bar{x}} - 1 \quad (9)$$

where $D_r > 0$ when $RWTI_i > \bar{x}$ and $D_r < 0$ when $RWTI_i < \bar{x}$.

Proof When countries are relatively small in terms of their share of total world trade, with a share smaller than \bar{x} , then their CTI_i will be lower than the standard TI_i measure. As the distance from \bar{x} increases toward the origin then CTI_i approaches zero. Alternatively, in the case of countries whose relative share of world trade is larger than \bar{x} , as distance from \bar{x} increases, CTI_i will be greater than TI_i .

Substituting (9) into (8) yields:

$$\begin{aligned} CTI_i &= \frac{1}{\bar{x}}(RWTI_i \times TI_i) \\ &= n(RWTI_i \times TI_i) \\ &= \frac{n(X + M)_i^2}{GDP_i \sum_{j=1}^n (X + M)_j} \end{aligned} \quad (10)$$

By using CTI we are able to adjust TI to take account of the relative importance, or openness, of a country to world trade. By using CTI, large trading countries like the USA and Germany will see their trade openness measures raised substantially compared to the standard TI measure. CTI will, therefore, more accurately capture the income generating benefits that come from trade openness, whether trade openness is sourced from TI or RWTI. Table 2 includes CTI measures for the sample of 136 countries. The top five countries ranked by CTI are Hong Kong, China, Singapore, Malaysia and Germany. The USA is ranked 9th. These are far more meaningful measures of trade openness. Large trading countries such as the USA, China, Germany and Japan are now deemed as open

according to CTI. Similarly, countries with high TI ratios such as Hong Kong and Singapore are also ranked highly by CTI. This new modified trade openness measure, CTI, is therefore able to capture both dimensions of international trade openness and combine them to give a more meaningful measure of trade openness. This is clearly illustrated as follows using the PWT data for 136 countries: Hong Kong is ranked 2nd on TI, 14th on RWTI and 1st on CTI. For China the ranks are respectively: 113th, 2nd, and 4th. For Singapore: 1st, 20th, 2nd. For Malaysia: 4th, 17th and 3rd. For Germany: 86th, 3rd and 5th. For the USA: 133rd, 1st, and 9th. These examples illustrate the separate influences of each openness dimension on trade openness. Countries with very high TI measures and important, though not large shares of world, trade such as Hong Kong and Singapore, achieve high CTI scores and low rank numbers. By contrast big countries that dominate world trade such as the USA and Germany, but have relatively small TI measures also achieve high CTI scores and low rank numbers. CTI is able to capture these two dimensions of trade openness. Importantly, using CTI, the world's largest trading countries are determined to be open rather than closed economies, in contrast to their determination as closed economies using the standard TI and related measures.

III. ROBUSTNESS OF THE CTI

To assess the robustness of CTI, we perform three sets of tests. Using several additional data sets, we verify the robustness of the world rankings by comparing the performance of the TI, RWTI, and CTI measures and by performing regression estimations of the well known Frankel and Romer (1999) model using the authors' data sets. There is no single, consistent data set providing trade and income data for all countries of the world. Instead, there are several different data sets in existence that include different country samples for different time periods. The first data set, used in the previous sections, is the PWT data, which includes trade (X+M) and GDP data for 136 countries for the year 2000. The second data set used is the World Economic Forum Database (Lopez-Claros et al., 2005), which comprises data on exports, imports, and GDP for 117 countries

for the year 2004. The third data set used is the World Bank's World Development Indicators (WDI) for 2000, which includes data on exports, imports, and GDP for 171 countries. The fourth data set used for the regression test comes from the Penn World Table of 1985 and includes two samples; a 150-country sample and a 98-country sample comprising data on per capita income, trade intensity, population, and area. ⁷

The first test involves comparing the pattern of scatter plots of TI against RWTI using each data set. Figure 2b is a scatter plot generated using the WEF data set, whereas Figure 2c is generated using the WDI data set. Figures 2b and 2c are very similar to Figure 2a.

In summary, the scatter plots represented by Figures 2a, 2b, and 2c exhibit the properties of a convex distribution which is consistent with the theoretical stipulations described in Figure 1. It is also important to note that most countries are close to the origin with respect to the RWTI. Furthermore, no countries are observed farther outward from the origin as the properties of the TI and RWTI measures do not permit that.

Table 3 here

A comparison of country rankings using the TI, RWTI, and CTI measures across the two additional data sets reveals results which are consistent with those reported for the PWT data set. For instance, as reported in Tables 3 and 4 and consistent with the PWT data set, Hong Kong ranks 2nd on TI, 10th on RWTI, and 1st on CTI using the WEF data set, and respectively 1st, 10th, and 1st using the WDI data set. Similarly for other countries, the USA respectively ranks 115th, 1st, and 7th using the WEF data set, and 169th, 1st, and 3rd using the WDI data set. Japan ranks 116th, 4th, and 18th using the WEF data set, and 171st, 3rd, and 17th using the WDI data set.

Table 4 here

The second robustness test involves substituting the alternative measures of trade openness listed in Table 1 for TI in Equation 10 and checking the resulting cross-correlations. As summarized

in Tables 5 and 6, we find that most of the openness measures discussed in Table 1 are highly positively correlated, although the real TI measure exhibits relatively lower correlation values, ranging between 0.68 and 0.82, due to substantially higher real GDP values for most countries after adjusting for purchasing power parity.⁸ This suggests that the ranking of countries using any of the alternative measures listed in Table 1 will yield results that are similar and consistent with the TI measure.

Table 5 here

Table 6 here

The third robustness test involves a test of the trade openness-income growth hypothesis. This is done by replicating a well known regression model suggested by Frankel and Romer (1999) and replacing the standard TI measure with the alternative CTI.⁹ Frankel and Romer (1999) estimate the following equation:

$$\ln Y_i = \alpha_0 + \alpha_1 TI_i + \gamma_1 \ln N_i + \gamma_2 \ln A_i + u_i \quad (11)$$

where Y_i is country i 's per capita income, TI_i represents the standard TI measure, N_i is population, and A_i is area. This equation was estimated by Frankel and Romer (1999) using two samples from 1985 Penn World Table data: a 150-country sample and a 98-country sample. The latter is suggested by Mankiw et al. (1992) as a more reliable sample since it excludes smaller countries that may exhibit abnormal peculiarities. We limit our robustness analysis to ordinary least squares estimations.¹⁰

We estimate the following equation:

$$\ln Y_i = \tau_0 + \tau_1 \ln CTI_i + \eta_1 \ln N_i + \eta_2 \ln A_i + u_i \quad (12)$$

where CTI_i represents the Composite Trade Intensity measure. Contrary to the TI measure, the CTI is not expressed in percentage and thus can be converted into logarithm. The coefficient estimate for CTI can therefore be interpreted as an elasticity coefficient.

Table 7 here

As summarized in Table 7, it is not possible to perfectly replicate the results produced by Frankel and Romer (1999). Nevertheless, all reported coefficient estimates and measures of explanatory power are very close to those reported by the authors. Using the 150-country and 98-country samples, we find that when we use the CTI measure in lieu of TI, a substantial increase in explanatory power is observed. In fact, for the 150-country sample, the reported adjusted- R^2 value increases from 0.10 to 0.44, the Schwartz criterion statistic decreases from 2.92 to 2.44, and the standard error of the regression drops from 0.98 to 0.78. According to FR(150), Frankel and Romer's estimations using the 150-country sample, a one percentage point increase in trade intensity results in a 0.88 percent increase in per capita income. Our estimations, denoted by SW(150) which use CTI in lieu of TI, yield an income increase of only 0.27 percent for a one percent increase in composite trade intensity.¹¹

Similarly for the 98-country sample, when CTI is used as a measure of openness in lieu of TI, the reported adjusted- R^2 value increases from 0.10 to 0.61, the Schwartz criterion statistic decreases from 3.56 to 2.72, and the standard error of the regression drops from 1.33 to 0.88. According to FR(98), Frankel and Romer's estimations using the 98-country sample, a one percentage point increase in trade share leads to a 0.78 percent increase in per capita income. Our estimations, denoted by SW(98), yield an income increase of 0.45 percent for a one percent increase in composite trade intensity. Taken together, these are compelling regression results in favor of CTI over TI.

It is interesting to note that the exclusion of smaller economies from the 150-country sample results in a slightly smaller trade share elasticity when using TI as a measure of openness (0.88 to 0.78) versus a substantially larger trade share elasticity when using CTI (0.27 to 0.45). The difference in magnitude between the TI and CTI elasticity coefficients may suggest that the true impact of trade on income may be biased upwards when using TI.

IV. CONCLUDING REMARKS

Theoretically, trade openness matters. However, the empirical literature testing the trade openness-income hypothesis has been less conclusive. It is our contention that part of the reason for the sometimes contradictory empirical results is the inappropriate method used to measure trade openness, usually measured as TI or its closely related alternatives listed in Table 1. However, all these measures suffer from the same problem; they capture only one dimension of trade openness, the dimension linking trade to domestic income.

The income growth advantages of trade are also derived by economies that may have low TI measures but trade heavily with the rest of the world. Indeed, as this paper shows, it is impossible for large trading countries such as the USA to enjoy a high TI measure. The paper, therefore, argues that to obtain a more accurate measure of trade openness, the relative contribution that a country makes to world trade also needs to be included.

Currently, it is common to describe countries like the USA and Germany, very large trading countries, as closed economies which makes very little sense. On the evidence of three different data sets used in this study, the USA share of world trade is somewhere between 10% and 17%. Therefore, the USA derives considerable income benefits from trade. The USA is obviously an open economy and yet according to traditional TI measures, it is described as closed.

The compelling contribution of this paper has been to suggest a new, more complete and more accurate composite measure of trade openness; a measure that more sensibly represents the degree of true trade openness. By combining both the trade intensity of a given country with its relative share of world trade, we have created a composite trade intensity measure that is better able to classify the degree of trade openness enjoyed by countries. Using this new composite measure, CTI, large trading countries such as the USA and Germany are now classified as open economies alongside those countries such as Singapore and Hong Kong which have traditionally been described as open. The use of CTI instead of TI in analyzing the trade openness-income growth relationship

for specific countries also makes more sense. For example, China has steadily been increasing its share of total world trade, thereby deriving considerable income growth advantages and making its economy more heavily linked to the world economy. However, its TI measure remains low, indicating that it is a closed economy, which makes very little sense. CTI is a far more meaningful measure for analyzing China's trade openness-income growth experience.

Two important questions begging further research are suggested by this paper. First, will the previously common inconclusive empirical findings generated from testing the trade openness-income growth hypothesis now be replaced with a more consistent set of outcomes predicted by theory? Second, does TI consistently overstate the income benefits of trade compared to CTI?

Notes

1. See Giles and Williams (2000a) and (2000b) for a review of the empirical literature.
2. This is in contrast to the trade policy openness measures used by other researchers such as the arbitrary binary (1,0) measure suggested by Sachs and Warner (1995).
3. It is important to note that this upper limit relative world trade intensity captures the rest of the world's trade at the aggregate level, as trade may occur between countries $n - i$.
4. In practice, diminishing returns to TI will set in at some relatively high TI ratio, but its exact value is unknown.
5. The greater the number of countries in the world, the closer to the origin \bar{x} is. This becomes relevant when we look at different data sets which include different numbers of countries. See section 4 below.
6. We ignore here the issue of benefits to world income derived from an increase of world trade. We are dealing only with the relative position of individual countries and what they may be able to do to realize income gains from trade openness themselves.
7. We would like to express our sincere gratitude to David Romer for generously providing the data used in Frankel and Romer (1999).
8. Correlation tests are not completed using PWT data set because of export and import data constraints. Similarly, the real TI measure is excluded for the WDI data set.
9. According to Google Scholar, there are now more than 1,000 citations to Frankel and Romer (1999).
10. Frankel and Romer (1999) find no evidence of overstated effects of trade on income when using an ordinary least squares procedure.

11. This small but statistically significant elasticity may result from any of a range of different combinations of changes of RWTI and/or TI combining to increase CTI.

References

- [1] Alcalá, F. and Ciccone, A. (2004). Trade and Productivity. *Quarterly Journal of Economics*, 119, 613-46.
- [2] Edwards, S. (1992). Trade Orientation, Distortions, and Growth in Developing Countries. *Journal of Development Economics*, 39, 31-57.
- [3] Edwards, S. (1998). Openness, Productivity and Growth: What Do We Really Know? *The Economic Journal*, 108, 383-98.
- [4] Frankel, J.A. (2000). Assessing the Efficiency Gains from Further Liberalization. Harvard KSG Faculty Research Working Paper No. RWP01-030.
- [5] Frankel, J.A. and Romer, D. (1999). Does Trade Cause Growth? *American Economic Review*, 89, 379-99.
- [6] Giles, J.A. and Williams, C.L. (2000a). Export-Led Growth: A Survey of the Empirical Literature and Some Non-causality Results: Part I. *Journal of International Trade and Economic Development*, 9, 261-337.
- [7] Giles, J.A. and Williams, C.L. (2000b). Export-Led Growth: A Survey of the Empirical Literature and Some Non-causality Results: Part II. *Journal of International Trade and Economic Development*, 9, 445-70.
- [8] Heston, A., Summers, R. and Aten, B. (2002). Penn World Table Version 6.1. Technical Report. Center for International Comparisons at the University of Pennsylvania, Philadelphia.
- [9] Li, K., Morck, R., Yang, F. and Yeung, B. (2004). Firm-Specific Variation and Openness in Emerging Markets. *The Review of Economics and Statistics*, 86, 658-69.
- [10] Lopez-Claros, A., Porter, M.E. and Schwab, K. (2005). *The Global Competitiveness Report 2005-2006*. World Economic Forum.
- [11] Mankiw, N.G., Romer, D. and Weil, D.N. (1992). A Contribution to the Empirics of Economic Growth. *Quarterly Journal of Economics*, 107, 407-37.
- [12] Sachs, J. and Warner, A. (1995). Economic Reform and the Process of Global Integration. *Brookings Papers on Economic Activity*, 1, 1-118.

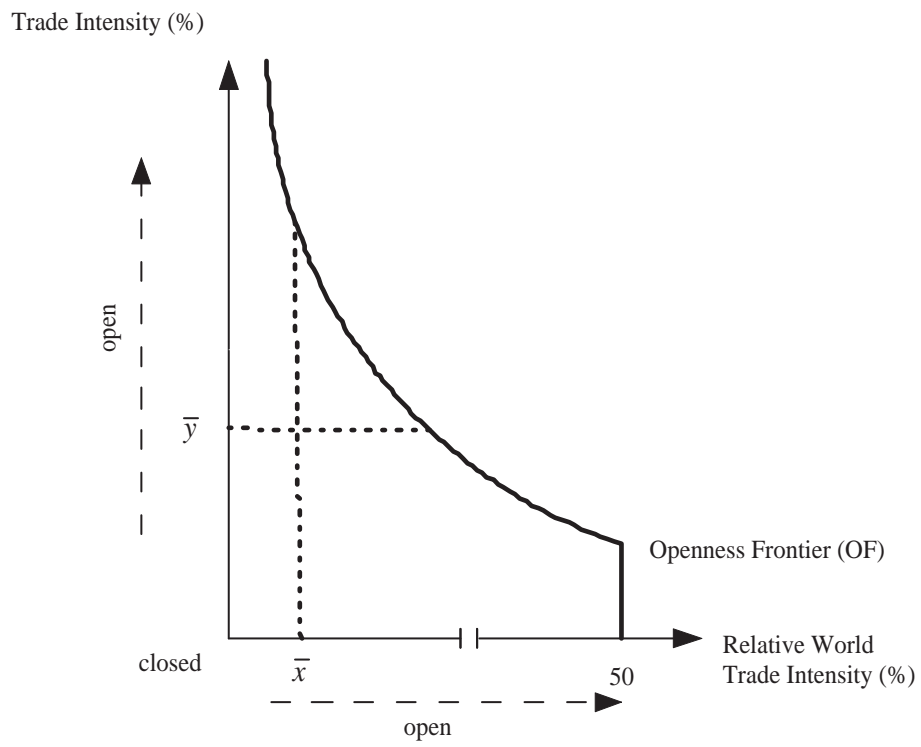
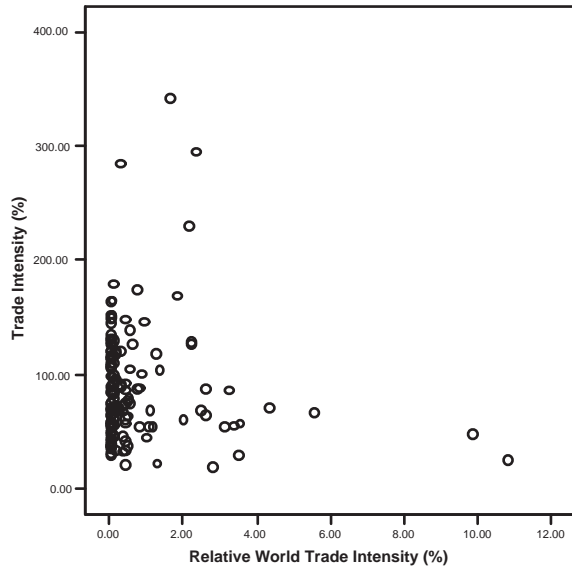
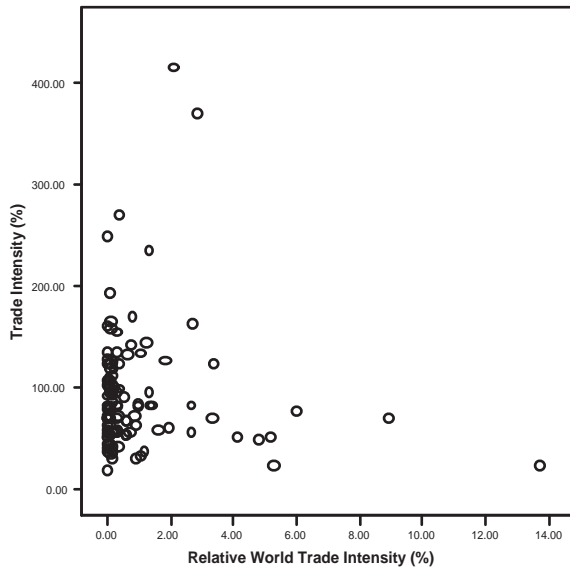


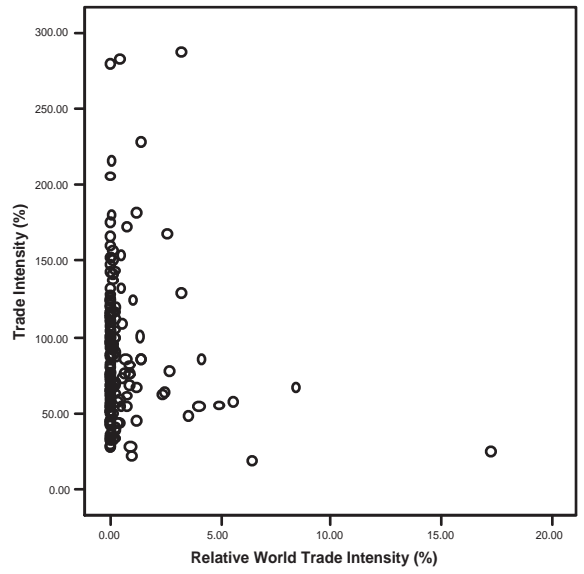
Figure 1: Openness Frontier



(a) PWT Data (n=136)



(b) WEF Data (n=117)



(c) WDI Data (n=171)

Figure 2: Trade Intensity and Relative World Trade Intensity

Table 1: Measures of Trade Openness

Measure	Definition
M_i/GDP_i	Import trade intensity; measured as imports (M) divided by country i's nominal income (GDP)
X_i/GDP_i	Export trade intensity; measured as exports (X) divided by country i's GDP
$(X + M)_i/GDP_i$	Trade intensity (TI); measured as exports and imports divided by country i's GDP
$1 - [(X + M)_i/2GDP_i] \times 100$	Adjusted trade intensity; and alternative method for handling outliers originally suggested by Frankel (2000)
$M/GDP_i - (1 - GDP_i/\sum_{i=1}^k GDP_i)$	Adjusted trade intensity; a modification to the Frankel (2000) approach, suggested by Li et al. (2004)
$(X + M)/rGDP_i$	Real trade intensity; where the denominator is purchasing power parity adjusted GDP (real GDP) following Alcalá and Ciccone (2004)

Table 2: PWT Trade Openness Measures and Ranks; $n = 136$, 2000

Countries	(X+M)/GDP	Rank	RWTI	Rank	CTI	Rank
Albania	59.42	96	0.031	106	251.98	109
Algeria	64.35	90	0.502	39	4397.08	43
Antigua	150.32	12	0.008	125	158.25	116
Argentina	22.22	135	0.406	48	1226.62	73
Armenia	74.93	70	0.037	102	374.72	101
Australia	45.60	117	0.999	27	6195.90	36
Austria	101.22	43	0.857	29	11803.85	24
Azerbaijan	79.08	66	0.095	73	1023.41	78
Bangladesh	33.22	129	0.325	54	1466.20	66
Barbados	106.68	40	0.021	114	304.61	104
Belarus	140.36	16	0.516	37	9851.67	29
Belgium	169.33	7	1.826	19	42056.33	6
Belize	110.66	37	0.008	122	120.52	119
Benin	44.45	118	0.014	120	86.81	124
Bolivia	42.64	119	0.044	99	254.11	108
Brazil	23.03	134	1.278	22	4003.69	46
Bulgaria	121.53	27	0.265	56	4385.04	44
Burkina Faso	40.33	121	0.019	115	103.38	121
Burundi	30.54	131	0.005	129	22.46	134
Cameroon	57.44	100	0.083	84	645.90	89
Canada	86.80	60	3.225	8	38072.67	10
Cape Verde	85.05	63	0.007	126	78.44	127
Chad	48.60	112	0.015	117	99.72	122
Chile	62.52	92	0.416	46	3533.10	47
China	48.36	113	9.841	2	64724.01	4
Colombia	42.33	120	0.436	42	2512.50	55
Comoros	57.52	99	0.002	135	19.24	135
Congo	132.5	18	0.043	100	767.59	86
Costa Rica	94.48	50	0.089	77	1142.73	74
Cote d'Ivoire	85.22	62	0.116	68	1348.69	69
Croatia	95.64	49	0.168	63	2187.81	58
Czech Republic	146.62	14	0.940	28	18749.05	20
Denmark	80.12	65	0.513	38	5593.44	38
Dominica	114.86	35	0.003	134	45.63	132
Dominican Republic	69.06	83	0.137	65	1291.38	72
Ecuador	73.36	73	0.145	64	1448.05	67
Egypt	38.81	123	0.460	41	2428.66	56
El Salvador	70.12	79	0.086	81	815.85	83
Equatorial Guinea	153.05	10	0.030	107	630.81	93

Table 2: PWT Trade Openness Measures and Ranks; $n = 136$, 2000 (Continued)

Countries	(X+M)/GDP	Rank	RWTI	Rank	CTI	Rank
Estonia	179.93	5	0.113	69	2756.36	54
Ethiopia	46.08	116	0.090	76	562.32	95
Finland	76.03	68	0.404	49	4178.57	45
France	55.9	103	3.355	7	25505.43	14
Gabon	71.79	76	0.029	109	282.08	105
Gambia	108.92	38	0.008	123	117.54	120
Georgia	84.05	64	0.094	74	1079.06	77
Germany	67.07	86	5.544	3	50565.79	5
Ghana	118.75	30	0.133	66	2142.40	60
Greece	57.91	98	0.400	50	3150.76	52
Grenada	136.17	17	0.004	131	66.62	128
Guatemala	47.76	114	0.099	71	643.87	92
Guinea	57.15	101	0.053	93	410.17	99
Guinea-Bissau	89.69	55	0.003	132	40.69	133
Honduras	98.76	46	0.058	90	774.85	85
Hong Kong	295.19	2	2.354	14	94491.06	1
Hungary	127.24	24	0.593	34	10269.28	25
Iceland	75.81	69	0.024	112	249.01	110
India	30.45	132	3.491	6	14458.98	23
Indonesia	69.21	82	2.472	13	23263.88	16
Iran	55.69	105	1.074	26	8133.67	33
Ireland	175.56	6	0.760	32	18156.82	21
Israel	86.87	59	0.436	43	5151.90	41
Italy	55.59	106	3.088	9	23342.66	15
Jamaica	99.33	45	0.038	101	514.76	96
Japan	20.1	136	2.781	10	7603.43	35
Jordan	110.96	36	0.098	72	1473.70	65
Kazakhstan	105.63	41	0.550	35	7905.90	34
Kenya	61.71	94	0.103	70	862.75	80
Korea, Republic of	87.18	58	2.589	11	30697.46	12
Kyrgyzstan	97.67	47	0.065	85	859.55	81
Latvia	100.08	44	0.083	83	1128.60	75
Lebanon	50.83	110	0.056	92	389.47	100
Lesotho	116.81	32	0.015	119	237.00	112
Lithuania	96.72	48	0.126	67	1660.10	64
Luxembourg	285.59	3	0.260	58	10083.46	27
Macao	151.21	11	0.064	86	1324.25	71
Macedonia	107.8	39	0.051	94	743.36	87
Madagascar	59.52	95	0.034	104	275.75	106

Table 2: PWT Trade Openness Measures and Ranks; $n = 136$, 2000 (Continued)

Countries	(X+M)/GDP	Rank	RWTI	Rank	CTI	Rank
Malawi	64.48	89	0.023	113	198.06	113
Malaysia	230.33	4	2.124	17	66527.34	3
Mali	65.34	87	0.030	108	263.52	107
Mauritius	130.55	20	0.094	75	1665.73	63
Mexico	64.69	88	2.569	12	22598.55	17
Moldova	126.86	25	0.051	95	871.98	79
Morocco	68.41	85	0.355	51	3303.47	50
Mozambique	54.63	109	0.045	98	336.24	102
Nepal	55.96	102	0.085	82	645.86	90
Netherlands	129.59	21	2.235	15	39390.81	8
New Zealand	71.82	75	0.232	59	2261.49	57
Nicaragua	121.32	28	0.050	96	831.29	82
Niger	38.53	124	0.016	116	82.99	126
Nigeria	93.12	51	0.411	47	5202.25	40
Norway	77.05	67	0.467	40	4888.75	42
Pakistan	34.57	127	0.433	44	2036.74	61
Panama	71.97	74	0.057	91	562.70	94
Paraguay	55.7	104	0.062	87	468.27	97
Peru	33.81	128	0.175	61	805.23	84
Philippines	104.11	42	1.345	21	19045.97	19
Poland	69.27	81	1.088	25	10247.45	26
Portugal	74.91	71	0.539	36	5487.75	39
Romania	74.03	72	0.351	52	3532.91	48
Russia	70.68	77	4.325	4	41574.34	7
Rwanda	32.33	130	0.011	121	49.65	131
Sao Tome & Principe	115.32	34	0.001	136	14.82	136
Senegal	70.08	80	0.047	97	450.01	98
Seychelles	164.76	9	0.007	127	146.86	117
Sierra Leone	50.52	111	0.008	124	53.87	130
Singapore	341.59	1	1.653	20	76812.24	2
Slovak Republic	149.56	13	0.429	45	8719.60	31
Slovenia	121.75	26	0.173	62	2862.60	53
South Africa	55.15	107	0.796	31	5969.26	37
Spain	62.22	93	1.989	18	16830.83	22
Sri Lanka	90.21	54	0.282	55	3460.93	49
St. Kitts & Nevis	131.49	19	0.003	133	59.30	129
St. Lucia	121.24	29	0.005	128	89.48	123
St. Vincent & Grenadines	128.76	22	0.005	130	85.57	125

Table 2: PWT Trade Openness Measures and Ranks; $n = 136$, 2000 (Continued)

Countries	(X+M)/GDP	Rank	RWTI	Rank	CTI	Rank
Swaziland	146.31	15	0.032	105	645.73	91
Sweden	89.02	56	0.818	30	9903.01	28
Switzerland	87.93	57	0.750	33	8963.29	30
Syria	68.59	84	0.203	60	1889.69	62
Tajikistan	165.37	8	0.059	88	1331.56	70
Tanzania	37.93	125	0.026	110	135.91	118
Thailand	127.61	23	2.189	16	37984.57	11
Togo	85.41	61	0.015	118	174.92	114
Trinidad & Tobago	116.23	33	0.087	79	1379.33	68
Tunisia	91.58	53	0.263	57	3271.14	51
Turkey	54.98	108	1.146	24	8567.41	32
Uganda	35.66	126	0.034	103	166.32	115
Ukraine	118.24	31	1.267	23	20374	18
United Kingdom	57.91	97	3.530	5	27798.85	13
United States	26.2	133	10.810	1	38517.96	9
Uruguay	39.98	122	0.058	89	313.77	103
Venezuela	46.3	115	0.340	53	2143.42	59
Yemen	91.95	52	0.088	78	1094.34	76
Zambia	70.45	78	0.025	111	240.86	111
Zimbabwe	62.61	91	0.087	80	738.10	88

Table 3: WEF Trade Openness Measures and Ranks; $n = 117$, 2004

Countries	(X+M)/GDP	Rank	RWTI	Rank	CTI	Rank
Albania	52.80	97	0.018	100	113.32	107
Algeria	71.20	73	0.268	50	2234.30	51
Argentina	43.42	104	0.305	44	1549.52	57
Armenia	71.40	70	0.012	109	97.80	108
Australia	39.37	108	1.124	23	5178.43	35
Austria	95.86	46	1.284	20	14404.16	20
Azerbaijan	119.10	28	0.047	80	655.39	73
Bahrain	158.50	11	0.079	69	1461.67	59
Bangladesh	36.40	111	0.095	65	402.54	84
Belgium	164.38	9	2.676	11	51459.66	5
Benin	45.90	102	0.009	113	46.56	115
Bolivia	52.20	100	0.023	95	138.00	103
Bosnia & Herzegovina	102.80	35	0.039	86	473.24	79
Botswana	74.90	64	0.032	90	276.96	90
Brazil	31.33	114	0.869	29	3185.13	44
Bulgaria	127.13	21	0.141	58	2090.76	52
Cambodia	124.80	24	0.026	93	373.13	86
Cameroon	55.60	93	0.037	87	241.36	93
Canada	72.06	69	3.318	9	27975.12	11
Chad	64.00	79	0.013	108	95.76	110
Chile	72.90	67	0.316	43	2692.56	46
China	78.50	63	5.987	3	54989.90	4
Colombia	42.79	105	0.188	55	942.99	65
Costa Rica	96.21	45	0.082	67	926.97	66
Croatia	103.15	34	0.158	57	1911.30	53
Cyprus	97.68	42	0.070	73	795.99	69
Czech Republic	143.00	14	0.708	32	11843.49	25
Denmark	81.91	59	0.918	27	8795.99	29
Dominican Republic	79.80	61	0.072	72	669.94	72
East Timor	19.71	117	0.000	117	0.69	117
Ecuador	54.74	94	0.076	71	484.48	78
Egypt	57.97	86	0.206	53	1400.45	60
El Salvador	71.39	71	0.052	78	435.72	82
Estonia	166.78	8	0.086	66	1684.83	56
Ethiopia	56.00	92	0.021	96	139.26	102
Finland	68.66	78	0.591	35	4748.15	36
France	51.34	101	4.791	6	28783.18	10
Gambia	135.80	16	0.003	116	40.51	116
Georgia	70.60	76	0.015	105	120.08	106

Table 3: WEF Trade Openness Measures and Ranks; $n = 117$, 2004 (Continued)

Countries	(X+M)/GDP	Rank	RWTI	Rank	CTI	Rank
Germany	71.06	74	8.893	2	73934.32	3
Ghana	109.40	31	0.045	84	571.96	75
Greece	54.40	95	0.517	38	3290.15	43
Guatemala	45.30	103	0.055	77	289.97	89
Guyana	249.90	4	0.009	112	260.84	92
Honduras	100.97	38	0.035	88	409.64	83
Hong Kong SAR	371.23	2	2.825	10	122689.17	1
Hungary	133.55	18	0.614	34	9586.43	27
Iceland	79.55	62	0.047	81	437.46	81
India	33.90	112	1.036	24	4110.10	41
Indonesia	57.80	87	0.689	33	4661.02	37
Ireland	144.91	13	1.216	22	20623.68	15
Israel	91.90	49	0.494	39	5316.48	34
Italy	52.54	99	4.083	7	25102.80	14
Jamaica	101.90	37	0.041	85	489.37	77
Japan	24.33	116	5.252	4	14948.70	18
Jordan	124.50	25	0.063	75	920.12	67
Kazakhstan	100.70	39	0.190	54	2235.89	50
Kenya	63.90	80	0.046	82	344.96	88
Korea	83.69	56	2.637	13	25823.45	13
Kuwait	97.10	43	0.233	52	2642.55	48
Kyrgyz Republic	83.80	55	0.008	114	82.33	112
Latvia	102.40	36	0.065	74	774.78	70
Lithuania	111.88	29	0.115	64	1501.37	58
Luxembourg	270.78	3	0.398	40	12608.18	24
Macedonia, FYR	103.70	33	0.023	94	275.14	91
Madagascar	73.80	65	0.015	104	128.45	105
Malawi	72.10	68	0.006	115	52.40	114
Malaysia	234.57	5	1.277	21	35059.68	8
Mali	60.30	83	0.014	106	96.95	109
Malta	195.30	6	0.049	79	1112.07	64
Mauritius	110.61	30	0.030	92	390.69	85
Mexico	62.01	82	1.940	15	14074.67	21
Moldova	128.91	19	0.015	103	232.14	94
Mongolia	160.80	10	0.010	111	180.46	98
Morocco	57.40	90	0.132	59	888.00	68
Mozambique	71.20	72	0.018	101	152.17	101
Namibia	93.30	47	0.020	97	220.46	95
Netherlands	125.49	22	3.354	8	49246.64	6

Table 3: WEF Trade Openness Measures and Ranks; $n = 117$, 2004 (Continued)

Countries	(X+M)/GDP	Rank	RWTI	Rank	CTI	Rank
New Zealand	58.84	85	0.264	51	1816.41	55
Nicaragua	80.20	60	0.016	102	154.23	100
Nigeria	84.10	54	0.277	48	2729.36	45
Norway	73.25	66	0.848	30	7271.00	30
Pakistan	32.24	113	0.123	60	464.52	80
Panama	123.80	26	0.079	68	1143.81	63
Paraguay	97.70	41	0.032	91	361.24	87
Peru	39.07	109	0.123	61	560.46	76
Philippines	100.50	40	0.396	41	4652.10	38
Poland	85.00	51	0.950	26	9450.48	28
Portugal	69.34	77	0.536	36	4350.04	40
Qatar	87.50	50	0.115	63	1178.51	62
Romania	83.20	57	0.274	49	2671.14	47
Russian Federation	59.15	84	1.594	17	11029.84	26
Serbia & Montenegro	40.80	107	0.046	83	217.35	96
Singapore	416.70	1	2.058	14	100352.62	2
Slovak Republic	156.29	12	0.297	45	5430.59	33
Slovenia	120.49	27	0.183	56	2575.70	49
South Africa	53.64	96	0.528	37	3313.64	42
Spain	57.77	88	2.652	12	17927.15	16
Sri Lanka	82.20	58	0.077	70	735.99	71
Sweden	84.47	52	1.354	19	13376.34	23
Switzerland	84.19	53	1.394	18	13728.06	22
Taiwan	127.72	20	1.803	16	26935.99	12
Tajikistan	109.30	32	0.010	110	133.99	104
Tanzania	37.70	110	0.019	99	83.29	111
Thailand	134.94	17	1.020	25	16105.22	17
Trinidad & Tobago	96.50	44	0.056	76	631.89	74
Tunisia	92.51	48	0.122	62	1322.67	61
Turkey	63.56	81	0.882	28	6559.59	31
Uganda	41.70	106	0.013	107	64.36	113
Ukraine	125.30	23	0.377	42	5524.55	32
United Arab Emirates	169.80	7	0.752	31	14931.51	19
United Kingdom	52.74	98	5.183	5	31983.89	9
United States	25.20	115	13.672	1	40310.14	7
Uruguay	57.59	89	0.032	89	216.14	97
Venezuela	56.62	91	0.281	46	1864.50	54
Vietnam	137.20	15	0.278	47	4469.97	39
Zimbabwe	70.80	75	0.019	98	157.86	99

Table 4: WDI Trade Openness Measures and Ranks; $n = 171$, 2000

Countries	(X+M)/GDP	Rank	RWTI	Rank	CTI	Rank
Albania	60.25	121	0.015	119	152.95	124
Algeria	63.77	116	0.228	50	2484.40	53
Angolia	157.12	14	0.096	70	2573.77	51
Antigua & Barbuda	143.6	21	0.007	142	159.88	123
Armenia	73.92	97	0.009	132	119.17	133
Aruba	279.59	3	0.035	96	1660.32	67
Australia	45.75	145	1.188	19	9297.54	32
Austria	101.17	55	1.284	18	22207.18	16
Azerbaijan	77.42	88	0.027	100	360.70	103
Bahrain	151.57	18	0.081	72	2090.84	58
Bangladesh	33.21	162	0.101	66	573.04	89
Barbados	111.68	47	0.019	116	367.45	101
Belarus	141.61	22	0.108	64	2610.53	50
Belgium	168.05	11	2.559	12	73527.23	4
Belize	125.71	28	0.007	139	150.14	126
Benin	43.3	153	0.007	143	48.17	151
Bhutan	80.73	85	0.003	158	36.31	156
Bolivia	45.34	146	0.025	105	197.18	119
Bosnia & Herzegovina	87.78	77	0.027	102	400.34	99
Botswana	100.97	57	0.035	95	611.19	88
Brazil	22.84	170	0.918	23	3586.12	44
Bulgaria	116.76	38	0.098	68	1961.53	62
Burkina Faso	34.39	159	0.006	146	35.11	157
Burundi	33.07	163	0.001	165	8.47	167
Cambodia	113.86	45	0.027	99	531.46	94
Cameroon	57.57	125	0.034	97	336.07	105
Canada	86.4	78	4.120	6	60864.22	6
Cape Verde	88.92	74	0.003	154	47.94	152
Central African Republic	29.44	166	0.002	163	9.43	166
Chad	54.4	133	0.005	149	46.97	153
Chile	58.51	123	0.295	42	2951.50	47
China	49.07	142	3.539	8	29695.61	13
Colombia	40.9	154	0.229	49	1600.76	70
Comoros	44.49	149	0.001	169	4.61	171
Congo, Dem. Rep.	43.43	152	0.012	124	92.61	141
Congo, Rep.	123.92	32	0.027	103	564.64	92
Costa Rica	94.29	68	0.100	67	1614.22	69
Cote d'Ivoire	72.48	98	0.051	85	635.88	87
Croatia	99.39	60	0.122	59	2075.58	59

Table 4: WDI Trade Openness Measures and Ranks; $n = 171$, 2000 (Continued)

Countries	(X+M)/GDP	Rank	RWTI	Rank	CTI	Rank
Czech Republic	132	25	0.491	36	11082.54	26
Denmark	82.24	83	0.868	25	12202.80	25
Djibouti	107.38	51	0.004	151	72.81	146
Dominica	120.39	36	0.002	160	44.85	154
Dominican Republic	100.07	58	0.132	57	2252.73	55
Ecuador	68.07	108	0.072	74	841.28	79
Egypt	39.18	156	0.260	44	1742.41	66
El Salvador	69.83	102	0.061	79	729.44	83
Eritrea	96.89	64	0.004	150	67.96	147
Estonia	180.37	8	0.066	75	2028.41	61
Ethiopia	45.12	147	0.020	113	151.80	125
Fiji	125.11	30	0.014	120	294.92	110
Finland	76.73	90	0.615	33	8067.66	33
France	55.86	127	4.887	5	46677.71	9
French Polynesia	29.13	167	0.007	141	33.43	159
Gabon	71.84	99	0.024	107	290.54	111
Gambia	104.75	53	0.003	156	52.75	149
Georgia	62.95	117	0.013	122	137.56	129
Germany	67.23	110	8.395	2	96517.08	2
Ghana	116.57	40	0.039	93	772.75	82
Greece	59.73	122	0.447	39	4562.88	39
Grenada	132.52	24	0.004	153	82.22	144
Guatemala	49.15	141	0.063	76	532.40	93
Guinea	52.32	136	0.011	128	97.21	139
Guinea-Bissau	83.34	82	0.001	166	17.05	165
Guyana	206.71	6	0.010	131	347.40	104
Haiti	46.11	143	0.012	125	95.90	140
Honduras	97.76	62	0.039	92	650.43	85
Hong Kong, China	287.41	1	3.167	10	155641	1
Hungary	153.61	15	0.479	38	12583.23	24
Iceland	77.09	89	0.043	90	571.40	90
India	28.54	168	0.871	24	4250.70	42
Indonesia	76.4	91	0.842	28	10997.83	28
Iran	43.97	150	0.282	43	2123.85	57
Ireland	181.75	7	1.151	21	35759.67	12
Israel	85.83	80	0.659	32	9674.14	31
Italy	55.6	129	3.973	7	37771.98	10
Jamaica	97.48	63	0.048	87	804.05	81
Japan	20.17	171	6.398	3	22066.92	17

Table 4: WDI Trade Openness Measures and Ranks; $n = 171$, 2000 (Continued)

Countries	(X+M)/GDP	Rank	RWTI	Rank	CTI	Rank
Jordan	110.23	49	0.062	78	1172.44	73
Kazakhstan	105.36	52	0.129	58	2319.73	54
Kenya	62.18	120	0.044	89	463.58	98
Kiribati	94.13	69	0.000	171	4.90	170
Korea, Rep.	78.49	86	2.684	11	36019.27	11
Kuwait	88.24	76	0.218	51	3289.79	45
Kyrgyz Republic	89.43	72	0.008	134	125.11	130
Lao PDR	65.41	113	0.008	136	84.03	142
Latvia	99.89	59	0.052	84	880.76	78
Lebanon	50.75	139	0.056	81	488.22	97
Lesotho	122.21	33	0.007	138	146.50	127
Libya	51.02	138	0.118	63	1025.50	74
Lithuania	96.14	67	0.073	73	1203.23	72
Luxembourg	282.9	2	0.370	40	17912.59	22
Macao, China	152.68	17	0.063	77	1650.41	68
Macedonia, FYR	110.7	48	0.027	104	502.37	95
Madagascar	68.69	105	0.018	117	209.05	118
Malawi	64.67	114	0.008	135	83.09	143
Malaysia	228.87	4	1.380	17	54013.44	8
Maldives	161.09	13	0.007	140	184.90	121
Mali	66.16	112	0.011	130	120.96	132
Malta	216.21	5	0.055	82	2033.82	60
Mauritania	96.2	66	0.006	145	99.33	138
Mauritius	128.62	27	0.038	94	834.97	80
Mexico	63.94	115	2.481	13	27124.25	14
Moldova	125.36	29	0.011	129	231.49	117
Mongolia	147.37	19	0.009	133	234.85	116
Morocco	68.97	104	0.153	55	1808.84	64
Mozambique	51.77	137	0.013	123	112.62	134
Namibia	96.8	65	0.022	110	364.87	102
Nepal	55.71	128	0.020	111	194.56	120
Netherlands	129.72	26	3.214	9	71289.27	5
New Zealand	70.16	101	0.245	47	2934.17	48
Nicaragua	74.53	95	0.020	114	250.55	114
Niger	43.5	151	0.005	148	38.89	155
Nigeria	90.81	71	0.255	45	3964.47	43
Norway	76.05	93	0.848	27	11029.38	27
Oman	89.07	73	0.118	62	1802.82	65
Pakistan	34.3	160	0.168	54	984.75	76

Table 4: WDI Openness World Rankings (Continued)

Countries	(X+M)/GDP	Rank	RWTI	Rank	CTI	Rank
Palau	117.29	37	0.001	167	18.22	164
Panama	137.82	23	0.107	65	2516.04	52
Paraguay	54.98	131	0.028	98	266.47	112
Peru	34.13	161	0.121	60	706.32	84
Philippines	108.9	50	0.552	34	10278.60	29
Poland	62.22	119	0.694	31	7382.65	34
Portugal	74.31	96	0.526	35	6684.00	36
Puerto Rico	173.25	10	0.706	30	20908.01	19
Romania	71.37	100	0.177	53	2157.95	56
Russian Federation	68.09	107	1.182	20	13765	23
Rwanda	32.62	164	0.004	152	21.99	162
Samoa	114.16	44	0.002	164	34.37	158
Sao Tome & Principe	115.63	41	0.000	170	7.09	169
Saudi Arabia	68.55	106	0.861	26	10088.09	30
Senegal	69.69	103	0.020	112	242.35	115
Serbia & Montenegro	76.15	92	0.044	88	569.47	91
Seychelles	153.06	16	0.006	144	165.32	122
Sierra Leone	50.57	140	0.002	161	18.51	163
Slovak Republic	144.09	20	0.194	52	4789.11	38
Slovenia	116.65	39	0.149	56	2967.83	46
Solomon Islands	98.58	61	0.002	162	33.18	160
South Africa	54.72	132	0.486	37	4547.57	40
Spain	62.48	118	2.345	14	25052.71	15
Sri Lanka	88.64	75	0.096	69	1462.45	71
St. Kitts & Nevis	120.78	34	0.003	157	54.97	148
St. Lucia	115.57	42	0.005	147	104.17	135
St. Vincent & the Grenadines	114.35	43	0.003	159	50.17	150
Sudan	29.73	165	0.024	106	123.13	131
Suriname	52.6	134	0.003	155	28.18	161
Swaziland	176.43	9	0.016	118	494.07	96
Sweden	86.4	79	1.385	16	20458.56	21
Switzerland	85.52	81	1.405	15	20545.03	20
Syrian Arab Republic	67.81	109	0.082	71	945.14	77
Tajikistan	166.5	12	0.011	127	313.71	108
Tanzania	37.12	157	0.023	109	142.86	128
Thailand	124.91	31	1.026	22	21914.72	18
Togo	81.45	84	0.007	137	100.75	137
Tonga	66.59	111	0.001	168	7.74	168
Trinidad and Tobago	104.59	54	0.057	80	1018.06	75

Table 4: WDI Openness World Rankings (Continued)

Countries	(X+M)/GDP	Rank	RWTI	Rank	CTI	Rank
Tunisia	91.85	70	0.120	61	1878.57	63
Turkey	55.58	130	0.739	29	7019.82	35
Turkmenistan	101.1	56	0.019	115	332.64	107
Uganda	34.45	158	0.014	121	79.82	145
Ukraine	120.4	35	0.252	46	5181.23	37
United Kingdom	58.19	124	5.596	4	55679.53	7
United States	26.34	169	17.167	1	77324.60	3
Uruguay	40.28	155	0.054	83	372.40	100
Uzbekistan	46.11	144	0.042	91	335.04	106
Venezuela, RB	44.77	148	0.350	41	2677.91	49
Vietnam	112.53	46	0.234	48	4511.56	41
West Bank and Gaza	75.16	94	0.023	108	299.31	109
Yemen, Rep.	77.57	87	0.049	86	648.62	86
Zambia	52.49	135	0.011	126	101.93	136
Zimbabwe	56.55	126	0.027	101	262.92	113

Table 5: Correlation Matrix (WEF Data Set)

Variable	M/GDP	X/GDP	TI	Andersen	Li et al.	$(X + M)/rGDP$
M/GDP	1.00					
X/GDP	0.91	1.00				
TI	0.97	0.97	1.00			
Andersen	0.91	0.94	0.95	1.00		
Li et al.	0.99	0.90	0.97	0.89	1.00	
$(X + M)/rGDP$	0.68	0.82	0.77	0.73	0.68	1.00

Table 6: Correlation Matrix (WDI Data Set)

Variable	M/GDP	X/GDP	TI	Andersen	Li et al.
M/GDP	1.00				
X/GDP	0.77	1.00			
TI	0.93	0.94	1.00		
Andersen	0.86	0.95	0.96	1.00	
Li et al.	0.99	0.76	0.93	0.85	1.00

Table 7: Effect of Trade on Income

	FR(150)	SW(150)	FR(98)	SW(98)
Intercept	6.28*** (9.71)	8.02*** (21.33)	6.44*** (4.20)	8.37*** (11.26)
TI	0.88*** (3.85)	- -	0.78** (2.09)	- -
Ln CTI	- -	0.27*** (6.19)	- -	0.45*** (9.09)
Ln population	0.18*** (2.70)	-0.04 (-0.59)	0.39*** (3.37)	-0.04 (-0.39)
Ln area	-0.05 (-1.00)	-0.06 (-1.44)	-0.19* (-1.87)	-0.11* (-1.70)
Adjusted R^2	0.10	0.44	0.10	0.61
F-Statistic	6.57	40.11	4.82	52.28
Schwartz Criterion	2.92	2.44	3.56	2.72
Std. Error of regression	0.98	0.78	1.33	0.88

Notes: FR(150) and FR(98) denote estimation results for equation (11) as specified by Frankel and Romer for the 150-country and 98-country samples. SW(150) and SW(98) represent the estimation results of equation (12) which include the proposed CTI measure for the same samples. Coefficient estimates are reported with their corresponding t-statistic values between parentheses. Asterisks, *, **, and *** denote statistical significance respectively at the 0.10, 0.05, and 0.01 levels.