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Empirical Investigation of the Impact of Multilateral Trade on Income Convergence Across Countries

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This paper investigates empirically the effects of established country-to-country trade on income convergence across countries. Using the β-convergence criterion we demonstrate that poorer economies grow faster than richer economies with international trade. Consequently, we find empirical evidence of a convergence in per capita income among richer and poorer countries. Monte Carlo models are estimated to simulate the characterization of β-convergence in randomly created trading groups of 8 to 23 member countries' economies. Our results indicate that income convergence is less likely to occur in our randomly created trading partnerships than in those that are formed as part of existing trade relationships. This result reaffirms the argument that countries that have established trade relationships are more likely to experience income convergence than countries that lack such trade relationships. Additionally, our research provides new empirical evidence on the impact of international trade on economic growth in general. This information is particularly valuable for the current analyses of the costs and benefits of restricting international trade in the U.S. and elsewhere.

Keywords: Multilateral Trade, Income Convergence

JEL Classification: F63, 010

I. Introduction

Although globalization is clearly occurring throughout most economies, there has recently been a strong trade protectionist movement in numerous countries, including the U.S., that emphasizes the harmful impact of free trade on some sectors of their economies, while at the same time denying the macro benefits from international trade.[1] The movement's origins can be traced to the mercantilists' trade doctrine, which denies the benefits from international trade that occur to countries that participate in such trade. Consequently, there appears to be doubts about the benefits of unrestricted international trade in particular, and of globalization in general. In addition to the current anti-free trade climate concerning the impact of such trade on economic growth, there is

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[1] This movement resulted, among other outcomes, in the 2016 U.K. exit from the European Union and the U.S. November 2016 Presidential election of Donald Trump whose campaign relied heavily on anti-free trade policies.

also no consensus on the impact of globalization on income distribution in trading countries. Critics of globalization and multilateral trade claim that trade is an exploitive mechanism that concentrates wealth and income and leads to increasing disparities in the well-being of rich and poor countries. In a closed economy context, economists have argued that the stocks of physical capital, human capital, technology, and infrastructure represent the primary determinants of the level of per capita output and thus, per capita income. In an open economy context, once countries are allowed to trade, the pursuit of comparative advantage allows countries to move beyond the constraints imposed by the in-country resource endowment. Therefore, the countries that participate in international trade can increase their productive capacity and their per capita incomes.

International trade can also impact factor prices and incomes in trading countries (Samuelson, 1948; Jones, 1965). According to conventional trade theory, which is based on the Heckscher-Ohlin model (Ohlin, 1933) and the Stolper-Samuelson (1941) theorem, increasing trade has had some effect on wage rate inequality in countries that trade. Empirical investigations of this issue include contributions by Krugman (1995), Feenstra and Hanson (1999), Ghosh *et al*. (2000 and 2002), Edwards and Lawrence (2010), and Liu and Trefler (2008), among others. Recent theoretical investigations of this issue include the work of Oladi and Beladi (2008), who developed a general equilibrium model to investigate the impact of technological change on wages of skilled and unskilled workers. According to their model, unskilled workers' wages are negatively affected by technological advances while the skilled workers' wages can also be reduced in some instances. Additionally, in their 2009 article, the two authors find that the elasticity of import demand can explain a wage gap between skilled and unskilled workers.

Furthermore, as mentioned previously, the standard free trade view of the beneficial impact of international trade on countries that participate in such trade has been challenged recently in the U.S. and elsewhere. In particular, in the U.S. a significant part of President Trump's economic plan directly contradicts the free trade paradigm by reviving the mercantilists' protectionist arguments against free trade. The proposed plan calls for imposing tariffs on a number of imports into the U.S. while subsidizing U.S. exports. This "border adjustment tax" economic policy is aimed at promoting economic growth in the U.S. Therefore, the current protectionist climate makes it imperative to provide further empirical evidence on the impact of international trade on economic growth. One way to accomplish this objective is to analyze the effects of free trade on the per capita income growth in countries that engage in such trade. Our paper makes such a contribution by analyzing the impact of trade on income convergence across 23 trading countries.

International trade promotes economic growth in numerous ways. According to Grossman and Helpman (1991), trade can affect long-run growth through several different channels. First, commodity exchange facilitates the transmission of new technology and technical information. Second, international competition provides incentives for firms in each country to adopt new ideas and innovations. Third, the size of the market that each country faces is enlarged by global integration. Van Den Berg (2001) also demonstrates that the introduction of learning-by-doing, human capital accumulation, and research and development (R&D) in an open country trade model may induce permanent economic growth.

However, because of power asymmetries that govern most trade relationships, the gains from trade may be allocated across the trading group in such a way that some of its members may be relatively disadvantaged in comparison to the relative advantage captured by others within it. It is in this context that our research proposes to add to the existing and expanding body of the literature on this issue. Our present paper analyzes the impact of multilateral trade on income distribution

among trading countries. In particular, our study provides empirical evidence on whether countries that trade within an established trade framework experience increased capacity for income convergence, or if this multilateral trade leads to an increasing gap between rich and poor countries. In other words, can the existing differences in technology, knowledge, and infrastructure for countries within a trading network be reduced through trade? Furthermore, does international trade result in a convergence of per capita income among the countries that engage in such trade?

The main objective of our research is to provide answers to the above mentioned issues. Since the convergence of per capita income among rich and poor countries is more likely to occur under the conditions of rapid economic growth, such as was the case in the late 1990s and early 2000s, we focus our empirical investigation on this period of time. Additionally, the results of our present research provide timely empirical evidence on the broader benefits of free trade.

II. Methodological Framework

Barro and Sala-i-Martin (1992 and 2003) and Sala-i-Martin (1996) introduce the two types of convergence that reflect the standard used in empirical studies of cross-country income convergence. These two different measures of convergence are termed β-convergence and σ-convergence. β-convergence refers to the situation where poorer economies experience a faster growth rate in per capita income than rich economies and σ-convergence refers to the situation where the dispersion of per capita income across a selected group of economies decreases over time.

We focus on β-convergence as the chosen method for exploring income convergence in this paper because β-convergence remains the primary focus for exploring income convergence in the literature of growth empirics and because it is a necessary condition for σ-convergence. In this study, we propose a comparison approach in which identical regression equations are estimated for both established trading groups and randomly selected countries assigned to a hypothetical trading group that has the same network size as the established trading group. The results for the actual trading groups are then compared to the properties of randomly assigned trading groups so that the effect of the trade group is identifiable. The method we employ is similar to that used by Ben-David (1996) to study the convergence among trading partners. We depart from Ben-David (1996) in two ways. First, while Ben-David took the σ-convergence approach, our study uses the β-convergence approach. Second, the present research includes larger trading groups than those used by Ben-David (1996). For example, our trading group size ranges from 8 to 23, whereas Ben-David's (1996) trading group sizes were 3 to 9.

III. The Empirical Model

Neoclassical growth models generate convergence with a set of exogenous and constant economic parameters, such as the constant saving rate. However, the assumption of an exogenous saving rate could introduce problems like dynamic inefficiency or excessive saving. This type of problem was resolved by the Ramsey (1928) model, and refined by Cass (1965) and Koopmans (1965). This approach relaxes the exogenous assumption of the saving rate by allowing consumers to make savings decisions based on the optimal intertemporal allocation of resources. In the Ramsey model, consumers behave optimally, and the saving rate rises or falls as the economy develops. The Ramsey model generates a pair of differential equations by using a log-linear approximation of the growth rate of capital per labor and the law of motion of consumption per

labor around the steady state. The solution gives the time path of the log of per capita income. Barro and Sala-i-Martin (2003) introduce the following parameterization of the Ramsey model:

$$(1/T)\cdot\log\left(y_{i,t_0+T}/y_{i,t_0}\right)=[(1-e^{-\beta T})/T]\cdot\log\left(\hat{y}^*\right)-[(1-e^{-\beta T})/T]\cdot\log(y_{i,t_0})+\varepsilon_{i,t_0,t_0+T}, \quad (1)$$

where $y_{i,t}$ is the real per capita GDP of the i^{th} economy at time t; T is the number of years of the time span; β is the parameter to be estimated; and $\varepsilon_{i,t_0,t_0+T}$ is the effect of the error terms between time t_0 and t_{0+T}. Again, Barro and Sala-i-Martin (2003) identify the coefficient β as a measure of the speed of convergence. If β is positive, $(1-e^{-\beta T})/T$ will be positive, hence the coefficient for the initial level of the log of real per capita GDP $\log(y_{i,t_0})$ will be negative. The negative relationship between the growth rate and the initial level of income is referred to as the β-convergence criterion.

The first term of the right-hand side is an expression of the steady-state income value $\hat{y}^*$. By assuming that all economies have the same value for the steady-state income, the following regression equation can be estimated by using an ordinary least squares (OLS) method.

$$(1/T)\cdot\log\left(y_{i,t_0+T}/y_{i,t_0}\right)=\beta_0+\beta_1\cdot\log(y_{i,t_0})+\varepsilon_{i,t_0,t_0+T}, \quad (2)$$

where β_0 and β_1 are parameters to be estimated. The dependent variable of the model is the average growth rate of the real per capita GDP of one economy during a certain period of time. The explanatory variable is the initial level of the log of real per capital GDP of the economy. If β-convergence exists in this group of economies, the coefficient for $\log(y_{i,t_0})$ should be negative, which means that the growth rate of real per capita GDP is inversely related to the initial level of the log of real per capita GDP. If the coefficient is positive, divergence occurs and poorer economies will never catch up with richer economies. In the next section, β in Equation (1) and β_0 and β_1 in Equation (2) are estimated.

IV. Data and Estimation Methodology

As explained previously, the focus of our paper is on the late 1990s and the early 2000s. Therefore, the data used in this study are obtained from the Penn World Table Version 6.0 (Heston *et al*., 2001), World Trade Organization (1998), and International Monetary Fund (1998). The Penn World data provide y_{i,t_0}, per capita income of the i^{th} economy in 1960, and y_{i,t_0+T}, per capita income of the i^{th} economy in 1997.

Membership in the trading network group is determined by using the following methodology. First, leader economies are selected from the top 25 exporters and the top 25 importers in world trade of merchandise and commercial services in 1997 (World Trade Organization, 1998). As a considerable overlap exists in the leading exporters and importers for both merchandise trade and commercial services, only 30 leader economies are selected from the leading traders.[2] Among the 30 economies selected, Germany and the Russian Federation are excluded because the per capita incomes in 1960 are not available; Taiwan is also excluded because of the lack of data on bilateral trade with other economies.

In the next step, member economies of trading groups are defined for each of the 27 leader economies. For each of the 27 leader economies, membership in the trade network group is

[2] Trading network groups are identified by the leader economy; e.g., Group France refers to the trading network group based on the pattern of trade relative to exports to and imports from France.

established as follows. Consider the leader country *A* and another country *B*. If country *B* received more than 1% of country *A*'s total exports in 1997, or if more than 1% of economy *A*'s total imports in 1997 were from country *B*, country *B* is included in country *A*'s trading group (data are from the International Monetary Fund, 1998). Within a trading network group, Middle East countries and formerly communist countries are excluded.[3] There are other economies that are excluded due to lack of data on income growth, e.g., Libya (should be assigned to Group Italy). There is not an *a priori* reason that 1% is used as the cutoff point; however it generates a group size between 8 to 23 economies, and this gives us a broad range of group sizes to explore the nature of the convergence criteria. If the group size of the trading network is too small, the regression results might not be robust and if the sample size is too large, economies in one group might be so heterogeneous that they will not converge to a same steady-state level of per capita income. Based on this grouping, there are 27 trading groups and 45 countries/economies involved in this study. The names of the countries/economies included in the study are listed in Appendix A.

In addition to the 27 groups, we also study another three additional "special case" trading groups. We call these three additional "special case" groups the Industrial Countries Group, Group India (1960-97), and Group China (1980-97). The Industrial Countries Group is formed in the same way as the other trading groups, but is limited to inclusion of countries on the list of industrial countries provided by the International Monetary Fund (1998). Our inclusion of India is due to India's growing importance to global trade flows even though India was not identified as a leading exporter or importer in 1997. Economic reform started in China in 1979 when the process of economic liberalization began. The inclusion of China in our analyses can provide information on the impact of trade liberalization on China's income convergence.

V. Empirical Results

The 27 trading groups and regression results for Equations (1) and (2) are given in Table 1. $\hat{\beta}$ is the estimator of convergence speed in Equation (1), which is estimated by the Gauss-Newton nonlinear least squares method. An estimate of the coefficient on the log of initial income per capita in Equation (2), $\hat{\beta}_1$, is estimated using a linear least squares method. Calculated *t*-values for each estimator are listed in parentheses.

With few exceptions, the estimates of β in Equation (1) and β_1 in Equation (2) reflect interpretive consistency in the sense that they reinforce each other with appropriate signs and magnitudes. The estimated coefficient $\hat{\beta}_1$ indicates that among these 27 trading groups, 24 of them have statistically significant coefficients, and all of the significant coefficients have the expected negative sign. This means the growth rate of per capita income is negatively related to the starting value of per capita income, i.e., poorer economies grow faster than richer ones. Twenty-four trading groups show strong evidence that trading partners converge in per capita income. Ben-David (1996) measures the standard deviation of log real per capita GDP and gets 17 converging groups out of 25 using the Summers-Heston data (Heston *et al*., 2001) from 1960 to 1985. In Ben-David's study, the groups whose leader economies are the United Kingdom (U.K.), Ireland, Spain, United States (U.S.), Uruguay, Mexico, Argentina, and Chile show significant divergence.

[3] China is an exception to the communist country exclusion and enters into our analysis as one of the special case leader countries.

Table 1: Twenty-Seven Trading Groups and Coefficients Estimates

	Leader Economy	Trade Partners	$\hat{\beta}$ (Eq. 1)	$\hat{\beta}_1$ (Eq. 2)
1	U.S. (21)	Bel-Lux, Switzerland, Singapore, H.K., Japan, Canada, France, Netherlands, Australia, U.K., Italy, Korea, Malaysia, Mexico, Thailand, Brazil, Venezuela, Philippines, Taiwan, Indonesia	0.0169* (2.600)	-0.0126* (-3.439)
2	Japan (17)	U.S., Singapore, H.K., Canada, France, Netherlands, Australia, U.K., Korea, Malaysia, Thailand, Brazil, Panama, Philippines, Taiwan, Indonesia	0.0161* (2.240)	-0.0121* (-2.874)
3	Canada (10)	U.S., Norway, Japan, France, U.K., Italy, Korea, Mexico, Taiwan	0.0344* (2.758)	-0.0194* (-4.979)
4	France (15)	U.S., Bel-Lux, Switzerland, Norway, H.K., Austria, Japan, Netherlands, U.K., Sweden, Italy, Ireland, Spain, Portugal	0.0279* (3.085)	-0.0174* (-5.033)
5	U.K. (21)	U.S., Bel-Lux, Switzerland, Norway, Singapore, Denmark, Japan, Canada, France, Netherlands, Australia, Finland, Sweden, Italy, Ireland, Spain, Korea, Malaysia, Turkey, Taiwan	0.0283* (4.035)	-0.0175* (-6.796)
6	Italy (19)	U.S., Bel-Lux, Switzerland, H.K., Austria, Japan, France, Netherlands, U.K., Sweden, Ireland, Spain, Greece, Portugal, South Africa, Turkey, Brazil, Algeria	0.0089 (1.536)	-0.0076 (-1.721)
7	Netherlands (16)	U.S., Bel-Lux, Switzerland, Norway, Denmark, Austria, Japan, France, U.K., Sweden, Italy, Ireland, Spain, Malaysia, Taiwan	0.0241* (4.150)	-0.0160* (-6.270)
8	H.K. (16)	U.S., Singapore, Japan, Canada, France, Netherlands, Australia, U.K., Italy, Korea, Malaysia, Thailand, Philippines, Taiwan, India	0.0148 (2.010)	-0.0114* (-2.502)
9	Bel-Lux (13)	U.S., Switzerland, Austria, Japan, France, Netherlands, U.K., Sweden, Italy, Ireland, Spain, India	0.0049 (1.378)	-0.0045 (-1.389)
10	Korea (21)	U.S., Switzerland, Singapore, H.K., Japan, Canada, France, Netherlands, Australia, U.K., Italy, Malaysia, Mexico, South Africa, Thailand, Brazil, Panama, Philippines, Taiwan, Indonesia	0.0182* (2.574)	-0.0133* (-3.496)

Table 1: Twenty-Seven Trading Groups and Coefficients Estimates: Continues

	Leader Economy	Trade Partners	$\hat{\beta}$ (Eq. 1)	$\hat{\beta}_1$ (Eq. 2)
11	Singapore (17)	U.S., Switzerland, H.K., Japan, France, Netherlands, Australia, U.K., Italy, Ireland, Korea, Malaysia, Thailand, Philippines, Taiwan, India	0.0163* (2.202)	-0.0122* (-2.836)
12	Mexico (8)	U.S., Japan, Canada, France, Italy, Malaysia, Taiwan	0.0251 (2.154)	-0.0164* (-3.077)
13	Spain (18)	U.S., Bel-Lux, Switzerland, Austria, Japan, France, Netherlands, U.K., Sweden, Italy, Ireland, Portugal, Argentina, Turkey, Brazil, Algeria, Nigeria	-0.0011 (-0.0034)	0.0011 (0.2821)
14	Sweden (18)	U.S., Bel-Lux, Norway, Denmark, H.K., Austria, Switzerland, Japan, Canada, France, Netherlands, Australia, Finland, U.K., Italy, Ireland, Spain	0.0329* (3.108)	-0.0190* (-5.724)
15	Malaysia (18)	U.S., Bel-Lux, Singapore, H.K., Switzerland, Japan, France, Netherlands, Australia, U.K., Italy, Korea, Thailand, Philippines, Taiwan, Indonesia, India	0.0126* (2.312)	-0.0101* (-2.780)
16	Switzerland (16)	U.S., Bel-Lux, Singapore, H.K., Austria, Japan, France, Netherlands, U.K., Sweden, Italy, Ireland, Spain, Korea, Turkey	0.0312* (2.853)	-0.0185* (-5.025)
17	Australia (23)	U.S., Bel-Lux, Switzerland, Singapore, H.K., Japan, Canada, France, Netherlands, U.K., Sweden, Italy, New Zealand, Korea, Malaysia, South Africa, Thailand, Philippines, Taiwan, Indonesia, PNG, India	0.0131* (2.394)	-0.0104* (-2.943)
18	Austria (11)	U.S., Bel-Lux, Switzerland, Japan, France, Netherlands, U.K., Sweden, Italy, Spain	0.0185* (2.232)	-0.0134* (-2.898)
19	Thailand (18)	U.S., Bel-Lux, Switzerland, Singapore, H.K., Japan, Canada, France, Netherlands, Australia, U.K., Italy, Korea, Malaysia, Philippines, Taiwan, Indonesia	0.0173* (2.854)	-0.0128* (-3.768)
20	Brazil (22)	U.S., Bel-Lux, Switzerland, Japan, Canada, France, Netherlands, U.K., Sweden, Italy, Spain, Korea, Argentina, Chile, Uruguay, Mexico, Venezuela, Algeria, Paraguay, Taiwan, Bolivia	0.0117 (1.812)	-0.0095* (-2.161)
21	Indonesia (19)	U.S., Bel-Lux, Singapore, H.K., Japan, Canada, France, Netherlands, Australia, U.K., Italy, Spain, Korea, Malaysia, Thailand, Philippines, Taiwan, India	0.0115* (2.242)	-0.0093* (-2.642)
22	Ireland (17)	U.S., Bel-Lux, Switzerland, Norway, Singapore, Denmark, Japan, France, Netherlands, U.K., Sweden, Italy, Spain, Korea, Malaysia, Taiwan	0.0319* (4.027)	-0.0188* (-7.223)

Table 1: Twenty-Seven Trading Groups and Coefficients Estimates: Continues

	Leader Economy	Trade Partners	$\hat{\beta}$ (Eq. 1)	$\hat{\beta}_1$ (Eq. 2)
23	Turkey (19)	U.S., Bel-Lux, Switzerland, Singapore, Austria, Japan, France, Netherlands, U.K., Sweden, Italy, Spain, Greece, Korea, Portugal, Romania, Algeria, Taiwan	0.0189* (2.699)	-0.0136* (-3.698)
24	Denmark (14)	U.S., Bel-Lux, Switzerland, Japan, France, Netherlands, Finland, U.K., Sweden, Italy, Spain, Portugal, Norway	0.0188* (2.992)	-0.0136* (-4.003)
25	Philippines (14)	U.S., Singapore, H.K., Japan, Canada, France, Netherlands, Australia, U.K., Korea, Malaysia, Thailand, Taiwan	0.0233* (2.293)	-0.0156* (-3.369)
26	Norway (17)	U.S., Bel-Lux, Switzerland, Denmark, Austria, Japan, Canada, France, Netherlands, Finland, U.K., Sweden, Italy, Ireland, Spain, Korea	0.0276* (4.339)	-0.0173* (-7.093)
27	China (17)	U.S., Singapore, H.K., Japan, Canada, France, Netherlands, Australia, U.K., Italy, Korea, Malaysia, Thailand, Brazil, Taiwan, Indonesia	0.0154* (2.907)	-0.0117* (-3.681)

Note: Leader economies are selected from the top 25 exporters and the top 25 importers in world trade of merchandise and commercial services in 1997, considering also the availability of income and trade data. For each leader economy A, if more than 1% of economy A's total exports in 1997 were to economy B, or if more than 1% of economy A's total imports in 1997 were from economy B, B is a trading partner of A. In the second column, the numbers in the parentheses are group sizes. The numbers in parentheses of the last two columns are *t*-values for the corresponding estimates.
* Indicates significantly different from zero at the 5% level.

In this study, Uruguay, Argentina, and Chile are not selected as leader economies, but the U.K., Ireland, U.S., and Mexico groups show significant convergence. Group Spain is still not significantly converging. In addition to Group Spain, Group Italy and Group Belgium-Luxemburg (Bel-Lux) also have insignificant $\hat{\beta}_1$, although they have the desired negative sign.

The nonlinear least squares estimation in Equation (1) indicates slightly different results. There are 21 significant estimates out of 27. The coefficients that are significant have the expected positive signs. Except for the three non-converging groups estimated by Equation (1), Group Hong Kong (H.K.), Group Mexico, and Group Brazil are also non-converging in Equation (1). The value of $\hat{\beta}$, i.e., the estimated convergence speed, ranges from 0.0115 (Group Indonesia) to 0.0344 (Group Canada), which indicates a half life from 20 to 60 years approximately. In other words, it will take 20 to 60 years for an economy to halve the distance from the current per capita income to the steady state. Although the convergence speed is somewhat slow, our results give support to the claim that for trading partners poorer economies grow faster than richer ones. Therefore, our present research indicates that convergence takes place among trading partners.

The estimation results for our "special case" trading groups are reported in Table 2. Not surprisingly, these results show that the Industrialized Countries Group and Group China (1980-97) are converging. The converging speed for Group China (1980-97) is greater than that for Group India (1960-97). However, for Group India during 1960-97, the estimated coefficient is not significant.

In contrast to the six non-converging trading groups in Table 1, including Group India in Table 2, most of these groups consist of either several developing economies or poor economies. It is important to differentiate between developed and developing economies. In particular, the assumption that all economies have the same characteristics is clearly incorrect. Furthermore, developing economies have to grow faster to catch up with more developed economies.

There are 45 economies in total analyzed in the present study. The number of economies in a trading group varies from 8 to 23. In most of the trading groups, poorer economies grow faster than richer ones. In order to highlight the role of trade, it is natural to investigate whether a similar result will happen in a group of economies that do not engage heavily in international trade.

Table 2: Four Trading Groups and Coefficients

Leader Economy	**Trade Partners**	$\hat{\beta}$ **(Eq. 1)**	$\hat{\beta}_1$ **(Eq. 2)**
Industrial Countries (1960-97)	U.S., Bel-Lux, Switzerland, Norway, Austria, Japan, Canada, France, Netherlands, Australia, U.K., Sweden, Italy, Ireland, Spain	0.0213* (2.816)	-0.0147* (-3.989)
China (1960-97)	U.S., Singapore, H.K., Japan, Canada, France, Netherlands, Australia, U.K., Italy, Korea, Malaysia, Thailand, Brazil, Taiwan, Indonesia	0.0154* (2.907)	-0.0117* (-3.681)
China (1980-97)	U.S., Singapore, H.K., Japan, Canada, France, Netherlands, Australia, U.K., Italy, Korea, Malaysia, Thailand, Brazil, Taiwan, Indonesia	0.0223* (2.395)	-0.0152* (-3.499)
India (1960-97)	U.S., Bel-Lux, Singapore, H.K., Switzerland, Japan, Canada, France, Netherlands, Australia, U.K., Italy, Spain, Korea, Malaysia, South Africa, Thailand, Taiwan, Morocco, Sri Lanka, Indonesia, Bangladesh, Nigeria	0.0060 (1.367)	-0.0053 (-1.465)

* Indicates significantly different from zero at the 5% level.

Our study addresses this possibility by randomly selecting 8 to 23 economies out of the 45 economies, and then estimating the regression coefficients for each group. For groups with 8 economies, there are $C_{45}^{8} = 215{,}553{,}195$ different combinations out of 45 economies; for groups with 23, there are $C_{45}^{23} = 4.117 \times 10^{12}$ different combinations. Since each of the different-sized groups consists of such a large number of possibilities, 10,000 combinations are randomly drawn from the pool of each group size.

Given the 10,000 regressions for each group, the mean is calculated from the set of only those groups with the statistically significant coefficients. Table 3 summarizes the results of these estimates. The means of $\hat{\beta}_1$'s are still negative but with a scale of 10^{-3} for all groups. Compared

to the values of the significant $\hat{\beta}_1$'s in Table 1, these means are very small numbers although they are significantly different from zero.

Table 3: Coefficients for Random Groups with Different Sizes

Group Size	Mean of $\hat{\beta}_1$	Standard Deviation of $\hat{\beta}_1$
8	-0.0070	0.0069
10	-0.0069	0.0058
11	-0.0069	0.0052
13	-0.0069	0.0046
14	-0.0068	0.0044
15	-0.0068	0.0040
16	-0.0069	0.0038
17	-0.0068	0.0036
18	-0.0068	0.0035
19	-0.0068	0.0033
20	-0.0068	0.0031
21	-0.0068	0.0030
22	-0.0068	0.0028
23	-0.0068	0.0027

Note: For each group size, 10,000 regressions are estimated among randomly selected economies. The means and the standard deviations are for the significant (at 5% level) estimates only.

The distribution of $\hat{\beta}_1$ for each sample size is normal. Therefore, we can use this distribution to generate the probability of observing the coefficient estimate for a trading group. For most of the groups, that is 20 out of 27, the probability of observing $\hat{\beta}_1$ is less than 5% or 10% (Table 4). Given these results, it is fair to conclude that these $\hat{\beta}_1$ distributions do not occur accidentally. Therefore, it appears that convergence is less likely to happen in the randomly selected groups than in the trading groups.

In this study, an indirect method is used to analyze the role of trade in convergence. The results indicate that trade contributes to convergence in per capita income among trading partners. However, this conclusion does not hold for all the trading groups studied, especially for the groups that include both developed economies and the poorest economies. However, in general, it is reasonable to conclude that globalization or integration of the countries of the world may raise the per capita income of all countries.

Table 4: Probability of Observing the Results of Trading Groups

Leader Economy	$\hat{\beta}_1$ (Eq. 2)	Prob(observing $\hat{\beta}_1$)
Canada (10)	-0.0194*	0.0154
Sweden (18)	-0.0190*	0.0002
Ireland (17)	-0.0188*	0.0004
Switzerland (16)	-0.0185*	0.0011
U.K. (22)	-0.0175*	<0.0001
France (15)	-0.0174*	0.0040
Norway (17)	-0.0173*	0.0018
Mexico (8)	-0.0164*	0.0869
Netherlands (16)	-0.0160*	0.0084
Philippines (14)	-0.0156*	0.0228
Turkey (19)	-0.0136*	0.0197
Denmark (14)	-0.0136*	0.0606
Austria (11)	-0.0134*	0.1056
Korea (21)	-0.0133*	0.0150
Thailand (18)	-0.0128*	0.0436
U.S. (21)	-0.0126*	0.0268
Singapore (17)	-0.0122*	0.0668
Japan (17)	-0.0121*	0.0708
China (17)	-0.0117*	0.0869
H.K. (16)	-0.0114*	0.1190
Australia (23)	-0.0104*	0.0918
Malaysia (18)	-0.0101*	0.1736
Brazil (22)	-0.0095*	0.1685
Indonesia (19)	-0.0093*	0.2236
Italy (20)	-0.0076	0.3974
Bel-Lux (13)	-0.0045	0.3015
Spain (18)	0.0011	0.0119

Note: Based on the distribution of $\hat{\beta}_1$ for randomly selected economies for each group size, this table shows the probability of observing the $\hat{\beta}_1$ for trading partners. Fourteen are less than 5% and 20 are less than 10%.
* Indicates significantly different from zero at the 5% level.

VI. Conclusion

This paper makes three contributions to the literature regarding per capita income convergence among countries/economies that are members of established trading groups. First, empirical evidence suggests that trade within a trade group increases per capita income of poorer countries in such a group at a faster rate than richer countries in that group. Second, when estimated income convergence parameters are compared between established trading groups and randomly assigned trading groups of identical size, there is no evidence of income convergence within the randomly assigned trading groupings. This result strengthens the case that international trade does exert influence in characterizing β-convergence among countries/economies within an established trading group. Third, our research provides new empirical evidence on the Ben-David (1996)

research. Ben-David compared change in the dispersion of incomes between trading partners and non-trading partners and found that it is more likely for trading partners to have σ-convergence. It is possible that dispersion in real per capita income is affected by random shocks that are not related to income. Consequently, even if an increasing dispersion in per capita income is observed among a group of economies, they still could have β-convergence. Restricting one's focus to σ-convergence limits the exploration of another important aspect of convergence. As a complement to Ben-David's work, our paper provides further, and more complete, empirical evidence of the effects of trade on income convergence within trading groups.

Our research indicates that if countries are able to enter into a pattern of trade within a trading group, then it is likely that trade liberalization will benefit these countries. Furthermore, the test results of the present study indicate that trade will eventually help developing countries catch up with the per capita income levels enjoyed by their developed countries trading partners. Additionally, the results of our study provide further empirical evidence in the current discussion of the costs and benefits of free trade in general. It is reasonable to conclude that trade increases the per capita income in all countries that engage in it. Therefore, restricting international trade may perhaps benefit some sectors of domestic economies, but it will harm their overall economic growth.

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Appendix A: List of Economies

27 Leader Economies	45 Economies Involved in This Study
Canada	Argentina
Sweden	Australia
Ireland	Austria
Switzerland	Belgium-Luxemburg
U.K.	Bolivia
France	Brazil
Norway	Canada
Mexico	Switzerland
Netherlands	Chile
Philippines	China
Turkey	Denmark
Denmark	Algeria
Austria	Spain
Korea	Finland
Thailand	France
U.S.	U.K.
Singapore	Greece
Japan	H.K.
China	Indonesia
H.K.	India
Australia	Ireland
Malaysia	Italy
Brazil	Japan
Indonesia	South Korea
Italy	Mexico
Belgium-Luxemburg	Malaysia
Spain	Nigeria
	Netherlands
	Norway
	New Zealand
	Panama
	Philippines
	Papua New Guinea
	Portugal
	Paraguay
	Romania
	Singapore
	Sweden
	Thailand
	Turkey
	Taiwan
	Uruguay
	U.S.
	Venezuela
	South Africa