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## **TRADE AND THE RATE OF INCOME CONVERGENCE\***

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### **ABSTRACT**

To the extent that trade policy affects trade flows between countries, the ramifications can be far-reaching from an economic growth perspective. This paper examines one aspect of these ramifications, namely the impact of changes in the extent of trade between countries on changes in the rate of reduction in the size of the income gap that exists between them. Export and import data are used as the criteria for determining bilateral trade between major trade partners, resulting in the creation of 127 pairs of countries on the basis of export data and 134 pairs on the basis of import data. An increase in trade between major trade partners – and in particular, increased exports by poorer countries to their wealthier partners – is shown to be related to an increase in the rate of convergence between the countries.

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## I. INTRODUCTION

In a world that exhibits non-decreasing income gaps (and in many cases, increasing gaps) between most of the countries, there is nonetheless a small minority of countries exhibiting income convergence. Not all of these instances of convergence are among the wealthy countries, nor is it the case that all of the wealthy countries exhibit convergence.

In contrast to the conventional wisdom, convergence among relatively developed countries is far from a robust phenomenon (Ben-David, 1995). Some countries converge with others, but not with the remainder. Other countries converge with yet different countries, but also not with most. In short, a random grouping of the more developed countries will not yield income convergence in more instances than it will yield non-convergence.

Thus, if one focuses on the non-poor countries, can a thread be found that ties together the groups of converging countries in a manner that distinguishes them from the larger array of non-convergence groups? This paper explores the contribution of international trade to the convergence process.

Why should greater openness between countries be related to income convergence between them? The traditional trade and traditional growth theories do not provide much guidance in this regard. From the perspective of traditional trade theory, the factor price equalization proposition shows how – when certain restrictions are met – free trade can lead to the equalization of factor prices. But this does not necessarily imply the equalization of incomes. From the perspective of traditional growth theory, the Solow model can yield income convergence, but this occurs within a closed economy framework without the need for trade. Endogenous growth models dealing with trade tend to concentrate primarily on explaining steady state growth rates and there is little emphasis on explaining convergence in levels.

So what might be the intuition underlying the possible link between trade and income convergence? It is probably not unreasonable to assume that greater openness is related to increased competition, both at home and abroad, for domestic firms. The resultant sink or swim

environment makes it crucial for affected firms to absorb foreign knowledge and ideas. Hence, greater openness is presumably tied to increased knowledge spillovers between countries. To the extent that knowledge levels among countries converge to a common level, then intuition suggests that this might lead to a convergence in the developmental levels of countries as well. Grossman and Helpman (1991) and others have used the size of trade volumes as a proxy for the extent of knowledge spillovers between countries. Ben-David and Loewy (1998) incorporate this intuition into a model that details both the transitional, as well as the steady state, impact of trade policy on convergence and growth in per capita output. The model shows how movement towards free trade leads to higher trade volumes between the liberalizing countries, a reduction in income differentials among the liberalizers, and to faster growth.

This paper focuses on the empirical facets of this issue by examining 127 country pairs created on the basis of exports, and 134 country pairs created on the basis of imports. In each case there will be a source country that is paired with one of its major trade partners. The goal will be to examine how *changes* in trade relationships over time can lead to *changes* in the degree of income disparity among countries.

The following section provides some background and discusses related studies. Section three details the relationship between changes in trade and changes in the rate of convergence within trade-based groups of countries. Section four focuses on the trade-convergence relationship within a bilateral setting. Section five concludes.

## **II. BACKGROUND AND MOTIVATION**

The upsurge in growth-related research since the mid-1980s has included a number of important contributions that have focused on the relationship between international trade and output growth and convergence. Work that is directly related to the analysis below includes Coe and Helpman (1995), for example, who focus on the impact of R&D spillovers on productivity

growth. They find that a country's productivity levels are affected not only by its own investments in R&D, but also on the investments made by its trade partners. Keller (1998) disputes the importance of the bilateral trade relationships in the Coe and Helpman study, though his other work (Keller, 2000) also concludes that there does appear to be a general spillover effect emanating from foreign R&D. Dollar (1992), Edwards (1993), Harrison (1996), Sachs and Warner (1995), and Henrekson, Torstensson and Torstensson (1996) focus directly on the impact of trade openness on economic growth and find a positive relationship between the two.

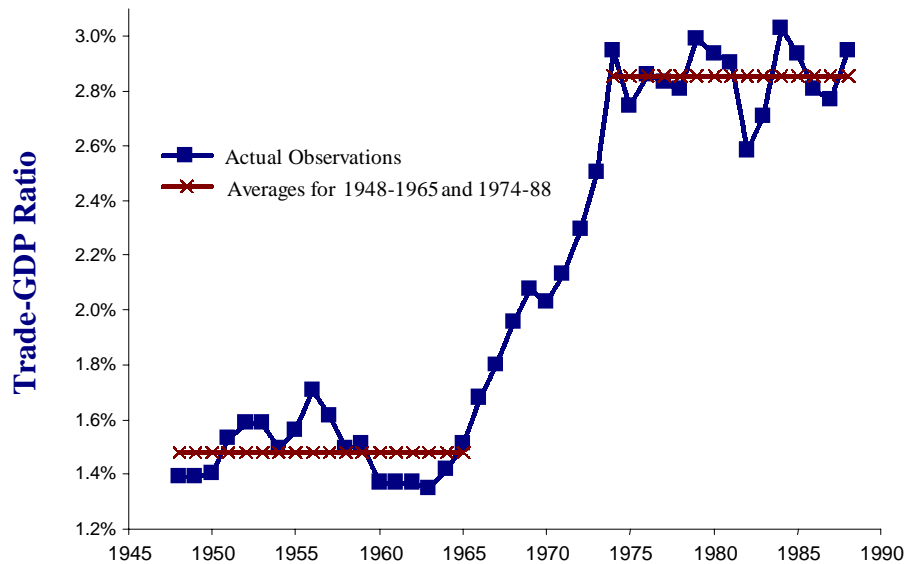
This study extends past research by Ben-David on the relationship between international trade and income convergence. The issue of causality (*i.e.* is it the increased trade that causes income convergence, or is it increasing income similarity between countries that causes increased trade?) was explored during the initial phase of the research by establishing evidence on the existence of a link between trade agreements and convergence. By choosing a small number of countries that decided to formally liberalize trade, Ben-David (1993) was able to examine the degree of disparity prior to, during, and following the implementation of the trade reforms. In each of these instances, no income convergence was apparent during the decades prior to the reduction of trade barriers. As the countries began their liberalization, income gaps began to fall, and they continued to remain below the pre-liberalization levels in the years following the end of the reform process.

To the extent that these agreements to liberalize trade are viewed as exogenous events, this result is important, for it provides support for the hypothesis that it is the movement towards freer trade that led to the convergence and not the other way around. Different groups that embarked on liberalization at different times began to converge during their respective time frames and not earlier or later.

This research on the impact of trade liberalization on incomes also showed a strong positive relationship between the degree of openness and the volume of trade. For example, the United States and Canada instituted a series of major trade reform measures between 1965 and 1973. These began with the implementation of the auto agreement between the two countries in

Figure 1

## Ratio of U.S.-Canada Trade to GDP



1965 and continued with much broader reforms during the years 1968 through 1973 as the Kennedy Round agreements were implemented (Preeg, 1970).

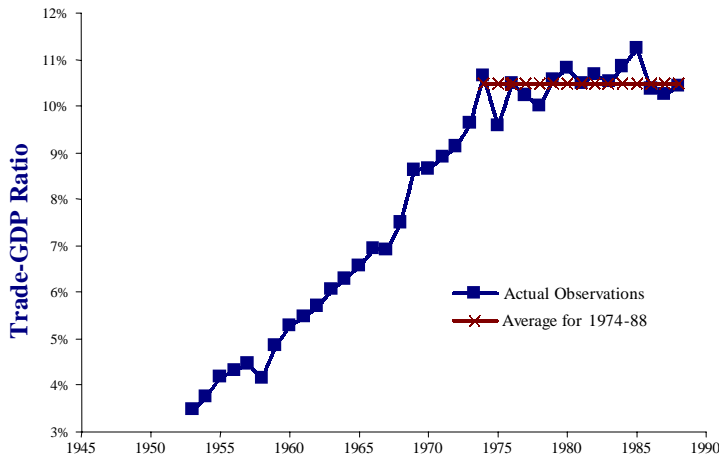
As is indicated in Figure 1, the liberalization of trade between the two countries had a marked effect on trade between the two. The figure plots the ratio of bilateral trade to total GDP of the two countries between 1948 and 1988 as well as the average trade-output ratio for the pre-reform period (1948-1965) and the average trade-output ratio for the post-reform period, (1974-1988). Trade grew at roughly the same rate as output prior to the reductions in trade barriers in 1965. The liberalization was accompanied by a substantial increase in trade. Upon completion of the Kennedy Round reforms, the trade ratio stabilized once again – at a level nearly twice the pre-reform level.

The formation of the European Economic Community (EEC) in the late 1950's and its expansion in the early 1970's provides another example of the impact that trade reforms may have on the volume of trade. The six founding countries of the EEC began to liberalize trade with one another over a decade before the Community was actually formalized.<sup>1</sup> Marshall Plan aid in the late 1940's was tied to the implementation of trade reforms. The reforms continued

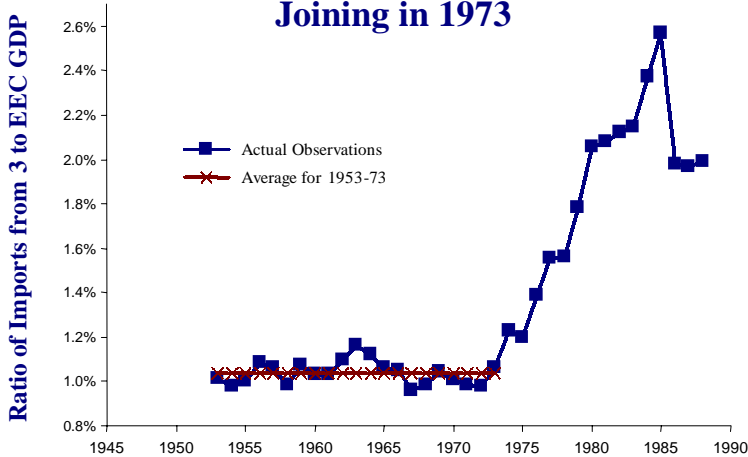
<sup>1</sup> The first EEC members were France, Germany, Belgium, Luxembourg, the Netherlands and Italy.

**Figure 2: Behavior of Trade-Output Ratios for 6 Original EEC Members**

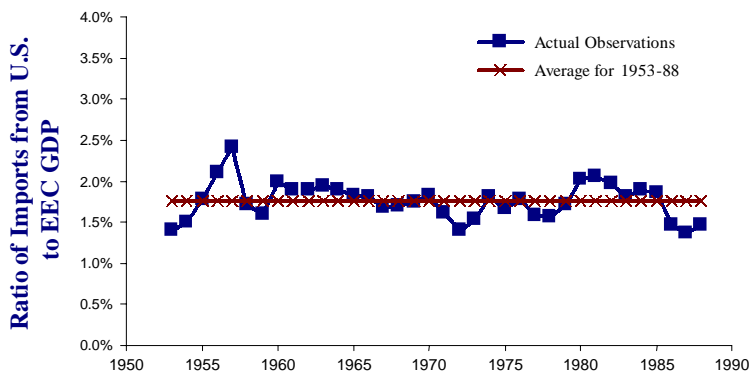
**Ratio of Intra-EEC Trade to EEC GDP**



**EEC Imports from 3 New Members Joining in 1973**



**EEC Imports from the United States**



throughout the 1950s with the signing of the additional agreements between the six original EEC countries and culminated in the formation of the Economic Community which implemented a series of further tariff and quota reductions. By the early 1970s, most trade barriers between the countries were gone, and as the top panel in Figure 2 shows, the trade-output ratio – which rose substantially until then – leveled off.

In 1973, the Community expanded with the inclusion of three new members.<sup>2</sup> EEC imports from the three countries prior to their inclusion into the Community (shown in the middle panel of Figure 2) was relatively constant. The import-output ratio rose steadily following membership in 1973.

And finally, for comparison purposes, imports from the United States, which was not a partner to the Community's liberalization measures, did not display the kind of changes that the

<sup>2</sup> Denmark, Ireland and the United Kingdom.

liberalizations rendered the partner countries. The bottom panel in Figure 2 shows that EEC imports from the U.S. remained fairly stable throughout the postwar period.

While there are clearly many other factors that effect the extent of trade between countries, trade liberalization appears to be a primary contributor in this regard. As the above examples indicate, prior to, following, and in lieu of trade reforms, there is very little evidence of substantial change in the extent of trade between countries. On the other hand, as countries become more open, the extent of openness is reflected in the extent of trade between them. This relationship will be utilized within the context of the following question: what kind of an effect can the extent of openness, which will be proxied for here by the extent of trade, have on the degree of income disparity between countries?

Ben-David (1996) examined the liberalization-convergence link by focusing on non-poor countries (which were defined as countries with per capita incomes of at least 25% of the United States, the lead country in 1960). For each of the resultant 25 *source countries* – as they will be referred to here – an export-based group was created that included all countries importing at least 4% of the source country's exports. Similarly, a 4% cutoff point was used to determine each source country's import-based group.<sup>3</sup>

By grouping together countries that are major trade partners of one another, the study showed a very high incidence of income convergence within the trade-based groups. As a reference point for determining the uniqueness of the trade-based convergence results, the same countries comprising the trade-based groups were grouped and regrouped repeatedly on a random basis and did not exhibit a prevalence of convergence outcomes – supporting the earlier results that, while convergence may be found among the more developed countries, it is more of an infrequent finding than a frequent one.

These earlier studies by Ben-David established that grouping countries according to cross-sectional trade criteria produces convergence results considerably more often than do

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<sup>3</sup> The source countries and their main trade partners are listed in the appendix table. Discussion of the selection criteria may be found in Ben-David (1996).

random grouping of countries. What is still not clear, however, is why some trade groups converged faster than others. That issue is the focus of this paper. It delves deeper into the trade-convergence relationship by asking whether *changes* in the extent of trade over time between any set of countries are related to *changes* in the extent of income convergence over time between these countries. In other words, did trade-based groups of countries that substantially increased their trade over a 26 year period also experience faster rates of convergence than those trade-based groups that only marginally increased their trade?

### III. INTRA-GROUP CONVERGENCE

One possible way to examine this question is to calculate the ratio of each group's total internal trade to the group's total GDP and determine whether this ratio is related to the group's convergence coefficient (which Ben-David, 1996, denotes as  $\phi$ ). A negative relationship might be interpreted as an indication that heightened trade coincides with income convergence.

The main problem with a test of this kind is that small countries tend to trade a much larger fraction of their incomes than do large countries. Therefore, any cross-sectional relationship between a group's trade ratio and its convergence coefficient might reflect the preponderance of small countries within groups rather than a trade-convergence relationship.

An alternative way to examine the magnitude of trade's impact on convergence would be to look at each group individually and examine the behavior of its intra-group trade as well as the behavior of its intra-group income differentials *over time*, and then to determine the extent of the relationship between the two.

The total volume of intra-group trade was calculated for each of the 25 export-based and 25 import-based trade groups, for each of the years between 1960 and 1985.<sup>4</sup> To get a measure

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<sup>4</sup> *Data source:* IMF Direction of Trade Statistics



of how intra-group trade grew (if at all) relative to the group's total output, the total intra-group trade was divided by the group's aggregate GDPs.<sup>5</sup> This ratio, represented by the variable  $R_{i,t}^k$  (where  $i$  is the group's source country and  $k$  identifies the group as being import-based or export-based) was calculated for each of the 50 groups for each of the 26 years.

In Equation (1), each group  $i$ 's trade ratio at time  $t$  is regressed on trend ( $T_t$ ).

$$R_{i,t}^k = \alpha_{1,i}^k + \alpha_{2,i}^k T_t + \varepsilon_{i,t}^k \quad (1)$$

As is evident from the results in Table 1, these ratios were found to have increased significantly over time for every one of the groups. The question is, were these increases larger in the groups that converged the fastest?

Groups exhibiting convergence would be expected to have declining standard deviations ( $\sigma_{i,t}^k$ ) while diverging groups should have increasing standard deviations.<sup>6</sup> These are in fact the results from an estimation of Equation (2),

$$\sigma_{i,t}^k = \beta_{1,i}^k + \beta_{2,i}^k T_t + u_{i,t}^k \quad (2)$$

where each of those groups found to be converging in Ben-David (1996) display significantly negative trend coefficients in Table 2.

The trend coefficients on the trade ratios ( $\alpha_{2,i}^k$ ) and the trend coefficients on the income differentials ( $\beta_{2,i}^k$ ) provide an indication of the magnitude of the change in each variable during the specified time period. A relationship between the two trend coefficients, in the form of

$$\beta_{2,i}^k = \lambda_1^k + \lambda_2^k \alpha_{2,i}^k \quad , \quad (3)$$

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<sup>5</sup> Data source: IMF International Financial Statistics

<sup>6</sup> Data source: Summers and Heston (1995).

**Table 1: Regression of Group Trade-Output Ratios on Trend**

		$R_{it}^k = \alpha_{1,i}^k + \alpha_{2,i}^k T_t + \varepsilon_{it}^k$					
Source Country		Export-Based Groups			Import-Based Groups		
		$\hat{\alpha}_{1,i}^k$	$\hat{\alpha}_{2,i}^k$	$R^2$	$\hat{\alpha}_{1,i}^k$	$\hat{\alpha}_{2,i}^k$	$R^2$
1	ARGN	0.25588 ( 3.50)	0.05434 (16.94)	0.923	0.98474 ( 7.21)	0.09704 (16.18)	0.916
2	AUSTL	0.07710 ( 1.30)	0.05879 (22.53)	0.955	0.89195 ( 9.48)	0.07764 (18.80)	0.936
3	AUSTR	0.78729 ( 5.13)	0.08283 (12.28)	0.863	2.13506 (19.11)	0.09690 (19.75)	0.942
4	BELLU	1.08013 ( 3.17)	0.18259 (12.19)	0.861	0.94581 ( 3.17)	0.15488 (11.83)	0.854
5	CAN	0.67153 ( 6.67)	0.09245 (20.91)	0.948	0.77295 ( 6.37)	0.10172 (19.08)	0.938
6	CHIL	0.88157 ( 7.53)	0.09141 (17.78)	0.929	0.49118 ( 6.61)	0.05810 (17.80)	0.930
7	DEN	0.95842 ( 6.25)	0.09288 (13.79)	0.888	1.42079 ( 7.58)	0.14249 (17.31)	0.926
8	FIN	0.95221 ( 7.74)	0.06451 (11.93)	0.856	0.73706 ( 7.78)	0.08368 (20.11)	0.944
9	FRA	1.31155 ( 3.53)	0.19417 (11.91)	0.855	1.12411 ( 3.24)	0.18396 (12.07)	0.859
10	GER	1.40269 ( 3.61)	0.20238 (11.85)	0.854	1.37010 ( 5.00)	0.18241 (15.16)	0.905
11	ICE	0.31349 ( 3.98)	0.07442 (21.51)	0.951	1.28581 ( 8.40)	0.11535 (17.15)	0.925
12	IRE	0.89571 ( 2.93)	0.16340 (12.16)	0.860	0.50461 ( 4.02)	0.08553 (15.51)	0.909
13	ITAL	0.79765 ( 4.04)	0.11719 (13.50)	0.884	0.79612 ( 3.27)	0.14689 (13.75)	0.887
14	JAPAN	-0.29410 (-4.95)	0.07175 (27.49)	0.969	0.05770 ( 0.92)	0.06216 (22.67)	0.955
15	MEX	-0.07610 (-0.93)	0.06667 (18.54)	0.935	-0.08707 (-1.06)	0.06847 (18.95)	0.937
16	NETH	1.08013 ( 3.17)	0.18259 (12.19)	0.861	0.94581 ( 3.17)	0.15488 (11.83)	0.854
17	NOR	0.89630 ( 4.20)	0.12922 (13.78)	0.888	1.25147 ( 8.88)	0.11809 (19.08)	0.938
18	NZ	0.64190 ( 8.75)	0.05514 (17.12)	0.924	0.89195 ( 9.48)	0.07764 (18.80)	0.936
19	SAFR	0.37810 ( 4.45)	0.05948 (15.95)	0.914	0.79945 ( 6.99)	0.10314 (20.52)	0.946
20	SPA	0.79284 ( 3.37)	0.15130 (14.63)	0.899	0.67256 ( 3.84)	0.12856 (16.73)	0.921
21	SWED	1.23611 ( 5.12)	0.13657 (12.89)	0.874	1.25147 ( 8.88)	0.11809 (19.08)	0.938
22	SWIS	0.79765 ( 4.04)	0.11719 (13.50)	0.884	1.32633 ( 3.62)	0.19679 (12.25)	0.862
23	UK	1.09522 ( 3.12)	0.18999 (12.33)	0.864	1.42940 ( 5.14)	0.18817 (15.42)	0.908
24	URUG	0.59227 ( 6.91)	0.03950 (10.50)	0.821	0.54184 (10.49)	0.01630 ( 7.19)	0.683
25	US	1.16762 (10.07)	0.11101 (21.81)	0.952	1.32338 (10.90)	0.12015 (22.54)	0.955

*t*-statistics in parentheses. The number of observations is 26 in each of the estimations.

**Table 2: Regression of Group Income Differentials on Trend**

$$\sigma_{it}^k = \beta_{1,i}^k + \beta_{2,i}^k T_t + u_{it}^k$$

Source Country		Export-Based Groups			Import-Based Groups		
		$\hat{\beta}_{1,i}^k$	$\hat{\beta}_{2,i}^k$	$R^2$	$\hat{\beta}_{1,i}^k$	$\hat{\beta}_{2,i}^k$	$R^2$
1	ARGN	0.68967 (40.55)	-0.00573 (-5.21)	0.530	0.69992 (38.97)	0.00142 ( 1.22)	0.058
2	AUSTL	0.43507 (22.53)	-0.01215 (-9.72)	0.797	0.33706 (22.52)	-0.00888 (-9.16)	0.777
3	AUSTR	0.32441 (71.06)	-0.00638 (-21.60)	0.951	0.33979 (63.18)	-0.00765 (-21.96)	0.953
4	BELLU	0.23872 (66.01)	-0.00359 (-15.35)	0.908	0.18865 (38.46)	-0.00324 (-10.20)	0.813
5	CAN	0.57913 (33.21)	-0.01867 (-16.53)	0.919	0.57913 (33.21)	-0.01867 (-16.53)	0.919
6	CHIL	0.55286 (43.32)	-0.00420 (-5.08)	0.518	0.70877 (41.57)	0.00352 ( 3.19)	0.297
7	DEN	0.15151 (34.22)	-0.00158 (-5.51)	0.559	0.27602 (23.51)	-0.00763 (-10.04)	0.808
8	FIN	0.17900 (33.73)	-0.00212 (-6.17)	0.614	0.35673 (30.57)	-0.01055 (-13.97)	0.890
9	FRA	0.26134 (72.59)	-0.00494 (-21.20)	0.949	0.23873 (66.01)	-0.00359 (-15.35)	0.908
10	GER	0.26049 (74.75)	-0.00515 (-22.83)	0.956	0.31277 (36.30)	-0.00769 (-13.78)	0.888
11	ICE	0.38488 (28.57)	-0.01140 (-13.07)	0.877	0.27599 (23.56)	-0.00747 (-9.85)	0.802
12	IRE	0.31771 (104.31)	-0.00193 (-9.77)	0.799	0.38916 (101.87)	-0.00252 (-10.18)	0.812
13	ITAL	0.30152 (76.25)	-0.00551 (-21.53)	0.951	0.26007 (66.54)	-0.00388 (-15.32)	0.907
14	JAPAN	1.28558 (74.50)	-0.02201 (-19.70)	0.942	0.53878 (26.74)	-0.01665 (-12.77)	0.872
15	MEX	0.55361 (47.09)	-0.00516 (-6.78)	0.657	0.66384 (47.38)	-0.00625 (-6.89)	0.664
16	NETH	0.23872 (66.01)	-0.00359 (-15.35)	0.908	0.18865 (38.46)	-0.00324 (-10.20)	0.813
17	NOR	0.15680 (28.05)	-0.00162 (-4.47)	0.455	0.28487 (26.33)	-0.00774 (-11.05)	0.836
18	NZ	0.43923 (27.21)	-0.01291 (-12.35)	0.864	0.38197 (26.23)	-0.01106 (-11.73)	0.851
19	SAFR	1.18147 (160.30)	0.01486 ( 31.14)	0.976	0.38504 (28.02)	-0.00178 (-2.00)	0.142
20	SPA	0.32188 (49.15)	-0.00478 (-11.26)	0.841	0.42304 (58.39)	-0.00328 (-7.00)	0.671
21	SWED	0.16482 (30.16)	-0.00218 (-6.16)	0.612	0.28487 (26.33)	-0.00774 (-11.05)	0.836
22	SWIS	0.30152 (76.25)	-0.00551 (-21.53)	0.951	0.26135 (72.59)	-0.00494 (-21.20)	0.949
23	UK	0.31690 (100.23)	-0.00231 (-11.27)	0.841	0.29054 (30.03)	-0.00647 (-10.33)	0.817
24	URUG	0.64209 (38.26)	-0.00391 (-3.60)	0.351	0.69824 (39.22)	-0.00454 (-3.94)	0.392
25	US	0.49012 (49.02)	-0.00503 (-7.77)	0.716	0.49013 (49.02)	-0.00503 (-7.77)	0.716

*t*-statistics in parentheses. The number of observations is 26 in each of the estimations.

should provide some evidence of whether groups that had the largest increases in trade (that is, the largest  $\alpha_{2,i}^k$ ) were also those that converged the fastest (*i.e.* had the most negative  $\beta_{2,i}^k$ ).

Isolating  $\alpha_{2,i}^k$  in Equation (1) and  $\beta_{2,i}^k$  in Equation (2) and then substituting these values into Equation (3) yields

$$\sigma_{i,t}^k = \mu^k + \lambda_1^k T_t + \lambda_2^k R_{i,t}^k + \xi_{i,t}^k \quad (4)$$

where  $\mu^k = \beta_1^k - \alpha_1^k \lambda_2^k$ . To eliminate the need to explicitly account for fixed effects, Equation (4) is differenced, yielding

$$D\sigma_{i,t}^k = \lambda_1^k + \lambda_2^k DR_{i,t-2}^k + v_{i,t}^k \quad (5)$$

where  $Dx_{i,t}^k$  is the difference between  $x_{i,t}^k$  and  $x_{i,t-1}^k$  for  $x = \{\sigma, R\}$ . The sign of  $\lambda_1^k$ , which was the trend coefficient in Equation (4), indicates income convergence (if negative) or divergence (if positive) within the groups. Since aggregate output appears in the numerator used in calculating  $\sigma_{i,t}^k$  and in the denominator of the trade ratios,  $R_{i,t}^k$ , the differenced lagged variable,  $DR_{i,t-2}^k$  is used instead to avoid an overlap of the periods.<sup>7</sup>

The data for the 25 trade-based groups is pooled (once for the exports and once for the imports) and Equation (5) is estimated. The results appear in Table 3. The significantly negative intercept, for both the export and the import estimations, indicates that the trade groups exhibit income convergence – which is consistent with the convergence results from Ben-David (1996). The addition here is  $\lambda_2$ , the estimated coefficient for the variable  $DR$ , which

**Table 3**  
**Relationship Between Changes in Trade and Changes in Income Disparity**

$D\sigma_{i,t}^k = \lambda_1^k + \lambda_2^k DR_{i,t-2}^k + v_{i,t}^k$				
	$\lambda_1^k$	$\lambda_2^k$	$N$	$R^2$
Exports	-0.022 (-11.39)	-0.058 (-2.23)	575	0.009
Imports	-0.024 (-12.41)	-0.079 (-2.86)	575	0.014

*t*-statistics in parentheses. *N* is the number of observations.

<sup>7</sup> Specifically, since  $D\sigma_{it}$  includes  $\sigma_{it-1}$  and  $DR_{it-1}$  includes  $R_{it-1}$ , then an overlap would exist for period  $t-1$ . Hence  $DR_{it-2}$  is used in Equation (5).

measures the contribution of changes in intra-group trade towards changes in intra-group disparity. These estimated coefficients for the trade ratios are significantly negative for both exports and imports. The implication of a negative  $\lambda_2$  is that increases in the extent of trade lead to further reductions in the income differentials among the trade group members.

#### IV. BILATERAL CONVERGENCE

Rather than focus on the trade groups in their entirety, it is possible to add a measure of precision to the analysis by focusing on the *bilateral* relationships between each of the source countries with each of their primary trade partners. The volume of bilateral trade between each source country  $i$  and each of its primary trade partners ( $j$ ) is divided by the source country's total GDP. The log of this ratio,  $R_{ij,t}^k$  is calculated for each of the 127 export-based pairs of countries and each of the 134 import-based pairs for each of the 25 years. The income gaps,  $G_{ij,t}^k$  (which now replace  $\sigma_{i,t}^k$  in the analysis), measure the annual differences of the logs of real GDP per worker between each source country and each of their main partners. In the event that the source country is wealthier, then  $G_{ij,t}^k$  is positive. Otherwise, it is negative. Pairs exhibiting convergence would be expected to have declining income gaps (in absolute terms) while diverging groups should have increasing gaps.<sup>8</sup>

The version of Equation (5) estimated in the bilateral case is

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<sup>8</sup> Note that, while country  $j$  might be one of country  $i$ 's primary import partners, it is also possible that country  $i$  is a primary import partner of country  $j$  (with a similar type of overlap possible for export pairs as well). There are 25 such instances of overlap in the import case and 27 in the export case. In these instances of overlap, the numerator of  $R_{ij,t}^k$  will be the same as the numerator of  $R_{ji,t}^k$ . Not so the denominator, which reflects the source country's aggregate output level. Hence,  $R_{ij,t}^k \neq R_{ji,t}^k$  and in the analysis that follows, all of the import and export-based pairs are used. However, to the extent that the inclusion of all pairs leads to any bias in the outcomes, each of the following tests was rerun twice more: once with just one-half of the overlapping pairs, and then again with the other half of the overlapping pairs. None of the results reported below are sensitive to these omissions, hence only the overall results are reported.

$$DG_{ij,t}^k = \lambda_1^k + \eta_1^k DUM_{ij}^k + \lambda_2^k DR_{ij,t-2}^k + \eta_2^k DUM_{ij}^k DR_{ij,t-2}^k + v_{ij,t}^k \quad (6)$$

where the variable  $DUM_{ij}^k$  equals unity if the initial level of income of the source country is greater than that of its partner country, *i.e.* the income gap is positive.  $DUM_{ij}^k$  equals zero when the initial income gap is negative.

The baseline case in Equation (6) is one where the source country is initially poorer than its partner country, *i.e.*  $DUM_{ij}^k = 0$ . When the income gaps are negative, convergence is indicated when the gap become less negative over time. That is,  $\lambda_1$  should be positive in the event of convergence. To the extent that increased trade intensifies the convergence process, then the expected signs would be  $\lambda_2 < 0$  and  $(\lambda_2 + \eta_2) > 0$ .

The opposite is true for instances when the source country is wealthier ( $DUM_{ij}^k = 1$ ). In this case, convergence is indicated when the gap falls over time and the sum  $(\lambda_1 + \eta_1)$  is negative. If increased trade leads to faster convergence, then the expected signs would be  $\lambda_2 > 0$  and  $(\lambda_2 + \eta_2) < 0$ .

Equation (6) is estimated for all of the 127 country pairs based on exports and all of the 134 pairs based on imports. The results are reported in lines 1 and 4 of Table 4. Since there are a sizable number of country pairs characterized by income gaps that are always positive – or always negative – throughout the entire sample period, it is possible to re-estimate Equation (6) separately for the positive-gaps-only cases and the negative-gaps-only cases. In these cases, given the uniformity of the sign of the dependent variable, the equation can be estimated without the need for dummies. The results of these estimations in the export case are reported in lines 2 and 3, while the import results appear in lines 5 and 6.

For both exports and imports, the intercepts ( $\lambda_1$ ) are significantly positive for negative income gaps and significantly negative ( $\lambda_1 + \eta_1$ ) for pairs of countries with positive income gaps – which implies that the bilateral income gaps between the trade partners are falling over time. These results are also evident in the negative-gaps-only cases as well as in the positive-gaps-only

**Table 4**  
**Relationship Between Changes in Bilateral Trade**  
**and Changes in Bilateral Income Gaps**

$D G_{ij,t}^k = \lambda_1^k + \eta_1^k DUM_{ij}^k + \lambda_2^k DR_{ij,t-2}^k + \eta_2^k DUM_{ij}^k DR_{ij,t-2}^k + v_{ij,t}^k$						
	$\lambda_1^k$	$\eta_1^k$	$\lambda_2^k$	$\eta_2^k$	$N$	$R^2$
<b>EXPORTS</b>						
1. All 127 Pairs	0.0050 (5.75)	-0.0175 (-12.85)	0.0256 (6.30)	-0.0182 (-2.99)	2852	0.070
2. Only Negative Gaps (57 Pairs)	0.0042 (3.96)		0.0243 (5.44)		1311	0.022
3. Only Positive Gaps (28 Pairs)	-0.0127 (-10.19)		0.0302 (3.70)		644	0.021
<b>IMPORTS</b>						
4. All 134 Pairs	0.0058 (6.39)	-0.0196 (-14.73)	-0.0002 (-0.04)	-0.0051 (-0.74)	2967	0.070
5. Only Negative Gaps (55 Pairs)	0.0045 (4.21)		0.0059 (0.99)		1265	0.001
6. Only Positive Gaps (34 Pairs)	-0.0145 (-11.74)		-0.0112 (-2.05)		782	0.005

*t*-statistics in parentheses. *N* is the number of observations.

cases, for both exports and imports. Thus, the results from these estimations support the earlier outcomes that countries that trade extensively with one another exhibit significant convergence.

Does an increase in these already large trade flows lead to an increase in the speed of income convergence? Recall that in the case of negative income gaps, a positive  $\lambda_2$  indicates that increases in the trade-output ratios lead to less negative income gaps – *i.e.* faster convergence. In line 2, when the source country remains poorer throughout the sample period, increased exports by the poorer source country to the wealthier partner country significantly speed up the convergence process. When the source country is the wealthier of the two, the results reported in line 6 indicate that increased imports by the wealthier source country lead to significantly faster convergence – a result that corroborates the findings in line 2 (which represent the flip side of the

same coin). In short, increasing the flow of trade from the poorer country to the wealthier country (be they the poorer source country's exports or the wealthier source country's imports) speeds up the convergence process.

The results regarding trade flows in the other direction are not as conclusive. On the one hand, there are the results from line 3 indicating that increased exports by the wealthier source country in fact widen the income gap, or at least act to diminish the convergence that is reflected in the intercept. On the other hand, the results in line 5 provide weak evidence (they are not significant) that when the poorer source country increases its imports, the income gap falls further. These two outcomes are not consistent with one another. Furthermore, an examination of the mixed gap estimations in lines 1 and 4 also do not suggest a significant contribution of trade flowing from the wealthier country to the poorer country.<sup>9</sup>

## V. CONCLUSION

This paper focused on the relationship between trade and income convergence over time. Changes in the extent of trade (among heavy traders) appear to have an effect on the degree of income disparity among countries. Increases in intra-group trade intensified the speed of convergence among the group members.

Breaking up the groups into the individual pairings of source and partner countries serves to sharpen the findings. The bilateral pairs continue to exhibit significant convergence – be they export-based or import-based pairs. Increased trade by the countries appears to further strengthen the convergence when the flow being increased is from the poorer partner to the wealthier partner. This result holds irrespective of whether the source country is the wealthier or poorer trade partner. Increased trade flows in the other direction, however, do not appear to be conclusively related to changes in income convergence.

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<sup>9</sup> Recall that not all of the source countries are major trade partners and not all of the major trade partners are source countries. Hence there is room for discrepancies in comparisons of results for poorer source country exports vs. wealthier source country imports and for poorer source country imports vs. wealthier source country exports.



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**Appendix Table:**

**List of Countries in Trade Groups**

Source Country		Countries in Group							
<b>Export-Based Groups</b>									
1	CAN	JAPAN	US						
2	NZ	AUSTL	JAPAN	UK	US				
3	AUSTL	JAPAN	NZ	US					
4	ICE	GER	JAPAN	UK	US				
5	GER	AUSTR	BELLU	FRA	ITAL	NETH	SWIS	UK	US
6	SPA	FRA	GER	ITAL	NETH	UK	US		
7	JAPAN	SKOR	US						
8	FRA	BELLU	GER	ITAL	NETH	SWIS	UK	US	
9	AUSTR	GER	ITAL	SWIS	UK	US			
10	SWIS	FRA	GER	ITAL	UK	US			
11	ITAL	FRA	GER	SWIS	UK	US			
12	BELLU	FRA	GER	ITAL	NETH	UK	US		
13	NETH	BELLU	FRA	GER	ITAL	UK	US		
14	US	CAN	GER	JAP	MEX	UK			
15	CHIL	AUSTR	BRAZ	GER	ITAL	JAPAN	UK	US	
16	UK	BELLU	FRA	GER	IRE	ITAL	NETH	US	
17	SWED	DEN	FIN	FRA	GER	NETH	NOR	UK	US
18	ARGN	BRAZ	JAPAN	NETH	US				
19	FIN	DEN	GER	NOR	SWED	UK	US		
20	IRE	BELLU	FRA	GER	NETH	UK	US		
21	MEX	JAPAN	SPA	US					
22	DEN	FRA	GER	NOR	SWED	UK	US		
23	NOR	FRA	GER	NETH	SWED	UK	US		
24	URUG	ARGN	BRAZ	GER	UK	US			
25	SAFR	CONG	ETHI	GHAN	JAPAN	UK	US		
<b>Import-Based Groups</b>									
1	CAN	JAPAN	US						
2	DEN	FRA	GER	JAPAN	NETH	NOR	SWED	UK	US
3	JAP	AUSTL	US						
4	FIN	GER	JAPAN	SWED	UK	US			
5	GER	BELLU	FRA	ITAL	JAPAN	NETH	UK	US	
6	NOR	DEN	FIN	FRA	GER	JAPAN	SWED	UK	US
7	SWED	DEN	FIN	FRA	GER	JAPAN	NOR	UK	US
8	NZ	AUSTL	GER	JAPAN	UK	US			
9	AUSTL	GER	JAPAN	NZ	UK	US			
10	UK	BELLU	FRA	GER	ITAL	JAPAN	NETH	NOR	US
11	ICE	DEN	GER	JAPAN	NETH	NOR	SWE	UK	US
12	AUSTR	GER	ITAL	SWIS					
13	SWIS	BELLU	FRA	GER	ITAL	NETH	UK	US	
14	FRA	BELLU	GER	ITAL	NETH	UK	US		
15	ITAL	FRA	GER	NETH	UK	US			
16	NETH	BELLU	FRA	GER	UK	US			
17	BELLU	FRA	GER	NETH	UK	US			
18	US	CAN	GER	JAPAN	MEX	UK			
19	SPA	FRA	GER	ITAL	MEX	UK	US		
20	IRE	FRA	GER	UK	US				
21	MEX	JAPAN	US						
22	URUG	ARGN	BRAZ	GER	US				
23	SAFR	FRA	GER	JAPAN	UK	US			
24	CHIL	BRAZ	GER	GUYA	JAPAN	US			
25	ARGN	BOLI	BRAZ	FRA	GER	ITAL	JAP	US	