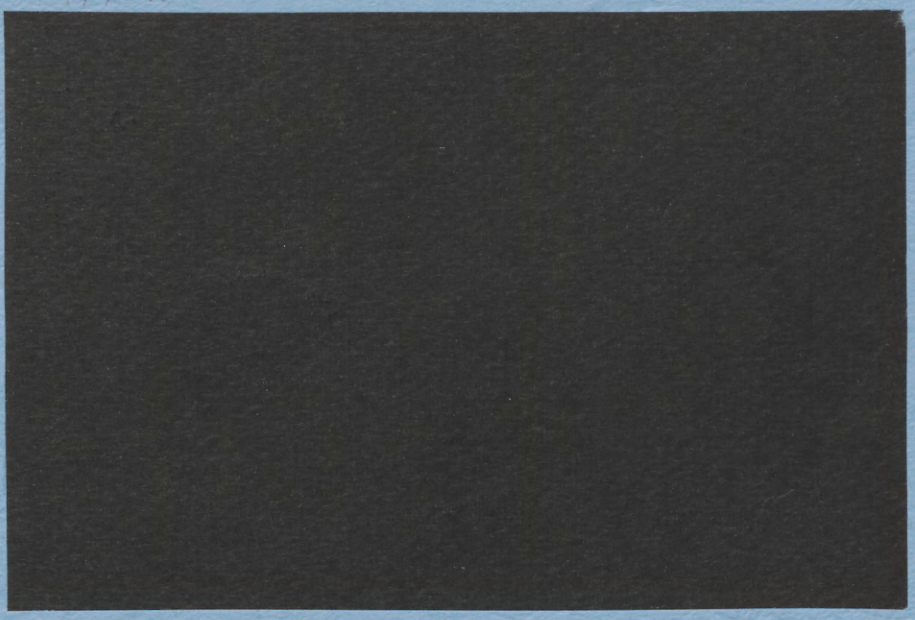
The Foerder Institute for Economic Research



Tel Aviv University

The Eitan Berglas School of Economics

מכון למחקר כלכלי ע"ש ד"ר ישעיהו פורדר

הפקולטה למדעי החברה — אוניברסיטת תל-אביב

TRADE AND CONVERGENCE AMONG COUNTRIES

by

Dan Ben-David

Working Paper No.35-95

November, 1995

[1] The Eitan Berglas School of Economics, Tel-Aviv University, Ramat Aviv Tel-Aviv 69978 and CEPR. (Tel.972-3-640-9912; Fax: 972-3-640-9908; E-mail: BenDavid@Econ.Tau.ac.il.)

I would like to thank John Antel, Richard Baldwin, Robert Baldwin, Jonathan Eaton, Robert Feenstra, Jim Harrigan, Jon Haveman, Sam Kortum, Dan Levin, Mike Loewy, David Papell, Kei-Mu Yi, and the participants of the NBER-CEPR conference on Growth and International Trade for their comments and suggestions. This paper was supported by a grant from the Advanced Researdh Program of the State of Texas.

THE FOERDER INSTITUTE FOR ECONOMIC RESEARCH
Faculty of Social Sciences
Tel-Aviv University, Ramat Aviv, Israel.

ABSTRACT

This paper examines the relationship between international trade and income convergence among countries by focusing on groups of countries comprising major trade partners. The majority of these trade-based groups exhibited significant convergence. Furthermore, a comparison of the trade-based groups with different country groupings (randomly selected, or according to other criteria) shows that the former were more likely to exhibit convergence than the latter.

I. INTRODUCTION

Much has been written about the extent of income convergence, or lack of it, among countries. This paper differs from much of the mainstream convergence literature in two related ways. While the primary focus here will be on trade's relationship to the convergence process, the methodology utilized to determine the existence and magnitude of convergence will not be through the common cross-country growth regressions used by Baumol (1986), Dowrick and Nguyen (1989), Barro (1991), Levine and Renelt (1992) and many others. Instead, convergence is characterized here by the reduction in income differentials within specific groups of countries over time.

Though there is evidence of a higher incidence of income convergence among some of the wealthier countries (see for example: Baumol, 1986 and 1989; and Ben-David, 1994b), it is not obvious why some subsets of these countries exhibit greater convergence than others, while still other subsets of countries display no convergence tendencies whatsoever. This paper analyzes this issue from the perspective of trade's contribution to the process.

When the analysis is broadened to include a wider spectrum of countries, the convergence evidence seems to dissipate entirely. Much of the impetus for the emergence of the endogenous growth literature over the past decade is due to this apparent lack of income convergence among countries. As Romer (1986), Lucas (1988), and others have observed, this raises some questions as to the empirical validity of some of the major conclusions of the standard neoclassical growth model. But as Barro (1991), Mankiw, Romer and Weil (1992), Levine and Renelt (1992) and others point out, once human capital, government policies, and other variables are accounted for, there appears to be strong evidence of *conditional* convergence.

The primary methodology used to test for the existence of convergence in the above studies was to regress growth rates on initial levels of income plus the additional factors that one wished to control for. A negative relationship between the rates of growth and the initial incomes was interpreted to imply convergence.

A different approach for analyzing the convergence process, and trade's contribution to that process, may be found in Ben-David (1993 and 1994a). Using annual dispersion measures rather than cross-country regressions, those papers focus specifically on groups of countries that formally liberalized trade and show how the timing of the convergence process is related to the timing of the liberalization process.

The neoclassical growth model (Solow, 1956) predicts income convergence among similar countries, even in the absence of trade. However, the free flow of goods may enhance this process. Heckscher (1919) and Ohlin (1933) hypothesized that free trade will draw factor prices towards equality. This was later formalized by Samuelson (1948 and 1949) as the factor price equalization proposition (see also Helpman and Krugman, 1985) which provides theoretical support for the idea that, under certain conditions, enhanced trade should lead to the equalization of commodity prices and the ensuing equalization of factor prices. While factor prices are not the same as total income, Ruffin (1987) shows that an equalization of the former can usually be considered as a catalyst for the equalization of the latter. Other research points to the diffusion of technology (Jovanovich and Lach, 1990) or knowledge (Grossman and Helpman, 1991) and the contribution of increased trade in spurring diffusion, and eventually, as Dollar, Wolff, and Baumol (1988) point out, income convergence.

One point should be clarified. The results from this paper alone are insufficient to discern between the hypothesis that countries that trade a great deal with one another tend to

converge, and the alternative hypothesis (usually associated with Linder, 1961) that similar countries tend to trade more.

However, an analysis of the relationship between trade *liberalization* and income convergence (in Ben-David, 1993 and 1994a), suggests that it is the former that produces the latter, rather than the other way around. The trade reform programs examined in those papers were performed according to specific timetables that varied from group to group. Although no intra-group income convergence was evident prior to the inception of the individual trade reforms, significant convergence, together with significant increases in the volume of trade, began to occur simultaneously with the removal of the trade barriers. These findings – that similar countries displayed no convergence tendencies prior to the implementation of trade liberalization and displayed significant convergence following the implementation of trade liberalization – provide evidence that it is the removal of obstacles to trade, rather than just the similarity suggested by the Linder hypothesis, which acts as a catalyst for income convergence.

While traditional trade theory tends to emphasize that it is increased openness, and not necessarily the actual volume of trade, that should lead to an equalization of incomes, the evidence from that earlier work points to a very strong relationship between the two. Hence, the premise here is that high levels of trade between countries are a good proxy for the degree of openness between them.

The primary difference between this paper and the earlier liberalization-convergence papers is in scope. Rather than being limited only to countries that created formal trade groups with specific timetables for the elimination of trade barriers, the emphasis here will be on providing a more general examination of the link between the magnitude of trade and the extent of income convergence or divergence.

More specifically, the objective of this paper will be to focus on groups of countries comprising major trade partners, compare them with different country groupings that are selected randomly or otherwise, and determine the extent that the former exhibit more income convergence than do the latter.

If trade plays a role in the convergence process, it should probably be evident among countries that are the principal trade partners of one another. Thus, the first step will be to determine each country's primary trade partners, and in this manner, to create what will be referred to as trade groups. This is done in section two. After the convergence model is detailed in section three, the next step will be to examine the behavior of income differentials within these groups (section four). Sections five through eight examine the robustness and sensitivity of these results from a number of different perspectives. Section nine concludes.

II. CREATION OF THE TRADE GROUPS

Trade groups were created for individual source countries that were selected as follows. Real per capita incomes in 1960, the initial year of this study, were used to rank all countries from richest (the U.S.) to poorest (Tanzania).[1] Countries that are primarily oil producers and formerly Communist countries were omitted from the sample. Also omitted were the poorest countries. These were defined as those countries that had 1960 per capita incomes that were below an ad hoc cutoff point of 25% of the U.S. per capita income level that year. This left 25 countries above the 25% cutoff point. For each of one of these source countries, a group of major trade partners was created.

---

[1] *Data Source:* Summers and Heston (1988)

How does one define who is a major trade partner of whom and how should the trade groups be formed? The usual practice in analyzing trade's impact on the growth process is to combine imports and exports and examine their joint effect. This is done here as well, with major export and import partners forming each source country's trade groups. However, to the extent that the major export and import partners are not the same, it is also interesting to see if any differences exist between groups formed solely on the basis of exports and groups formed solely on the basis of imports.

To keep the examination within manageable proportions, the goal is to implement some general criteria that limits the size of the trade groups to under 10 countries. The composition of the export-based trade groups is determined according to the following criteria. Suppose that country *i* is one of the 25 source countries. If *i* exported more than 4% of its total exports in 1985 (the final year of the sample) to any country *j*, then country *j* will be part of *i*'s trade group ("poor" countries with incomes below the 25% income threshold are allowed to be group members).[2] Why use 4% rather than, say, 5% or 10%? When the criteria is 10% for example, then in the majority of cases, there are either no trade partners that satisfy that criterion, or at best there is only one country. Reducing the cutoff to 5% led to only marginal improvements in group size. The groups resulting from the 4% threshold ranged in size from a minimum of three countries per group to a maximum of nine. These are roughly similar to the size of the trade liberalization groups that were analyzed in Ben-David (1993 and 1994a), but without the binding restrictions that these groups formally declare and adhere to trade agreements.

---

[2] From Ben-David (1994b), it is clear that the inclusion of poorer countries reduces the likelihood of finding convergence within the group.

Trade groups were also formed on the basis of imports, with any country j that is the source of over 4% of source country i's imports being included in i's import-based trade group. For the most part, the export-based groups tended to be quite similar to the import-based groups. For completeness, the union of the two groups was also examined. Table A1 in the Appendix lists the countries comprising each of the trade groups. Table A2 provides a legend of the name abbreviations.

III. The Convergence Model

It is now possible to examine the behavior of each group's income differentials over time and ascertain whether there is any noticeable evidence of convergence within them. The conventional, cross-country regression method for determining convergence has recently come under some criticism by Quah (1993a and 1993b) and Friedman (1992) for regression to the mean problems that bias the results. Quah shows that this bias is similar to Galton's fallacy. Friedman advocates Hotelling's (1933) view that convergence is indicated by a diminution of the income variance among countries over time. Several of the more recent studies on convergence have in fact avoided cross-country regressions altogether and relied instead on time series information for determining the existence, or lack thereof, of convergence (see for example: Bernard and Durlauf, 1993; Ben-David, 1993 and 1994b). Baumol and Wolff (1988) and Barro and Sala-i-Martin (1991) supplemented their cross-country convergence results with some time series evidence as well.

A further problem that renders the cross-country approach inapplicable for this study is that it requires many more countries than exist in the three to nine member trade groups that are the primary focus of the convergence analysis here. The number of observations in the common

cross-country convergence regressions equals the number of countries in the group being analyzed, so groups whose members number in the single digits would not produce very powerful results.

The convergence measure adopted here is based on the following relationship

$$(y_{i,t} - \bar{y}_t) = \phi(y_{i,t-1} - \bar{y}_{t-1}) + \epsilon_{i,t} \quad (1)$$

where $y_{i,t}$ is the log of country i's real per capita income at time t and $\bar{y}_t$ is the average of the group's log per capita incomes at time t.

A $\phi < 1$ indicates the existence of income convergence within the group, while a $\phi > 1$ indicates divergence. Once calculated, the estimated ϕ provides an indication of the rate of convergence within the given group. The half-life of the convergence process, or the number of years that it takes for the income gap to be cut in half is given by $\text{Ln}(.5)/\text{Ln}(\phi)$.[3]

The countries within each group are pooled together for the estimation of equation 1 and the convergence coefficient ($\hat{\phi}$) is calculated for each group. Pooling alleviates the need for the inclusion of a constant in the expression since, by construction, such a constant would equal zero.[4]

---

[3] This is derived in Ben-David (1993).

[4] The reason that the constant is zero is due to the following. Let $z_{i,t} = y_{i,t} - \bar{y}_t$ and $x_{i,t} = y_{i,t-1} - \bar{y}_{t-1}$. If $z_{i,t} = \alpha + \phi x_{i,t} + \epsilon_{i,t}$, then $\hat{\alpha} = \bar{z} + \hat{\phi}\bar{x}$. But

$$\begin{aligned}
\bar{z} &= \frac{1}{KT}\sum_{t=1}^{T}\sum_{i=1}^{K}(y_{i,t} - \bar{y}_t) \\
&= \frac{1}{KT}\sum_{t=1}^{T}\sum_{i=1}^{K} y_{i,t} - \frac{1}{T}\sum_{t=1}^{T}\bar{y}_t \\
&= \frac{1}{KT}\sum_{t=1}^{T}\sum_{i=1}^{K} y_{i,t} - \frac{1}{KT}\sum_{t=1}^{T}\sum_{i=1}^{K} y_{i,t} \\
&= 0
\end{aligned}$$

and the analysis is similar for $\bar{x}$, hence $\hat{\alpha} = 0$.

The augmented-Dickey-Fuller (ADF) form of equation 1 is

$$z_{i,t} = \phi z_{i,t-1} + \sum_{j=1}^{k} c_j \Delta z_{i,t-j} + \varepsilon_{i,t} \quad (2)$$

where $z_{i,t} = y_{i,t} - \bar{y}_t$ and $\Delta z_{i,t} = z_{i,t} - z_{i,t-1}$. In lieu of an intercept and trend, the applicable critical t-values for the estimations of this equation are the standard t-values (see Fuller, 1976, page 373). As Quah (1994) has shown, it is possible to use the standard t-statistic for testing the unit root null since, in the presence of pooling, the t-statistic will have an asymptotically normal distribution. This is corroborated in Levin and Lin (1992) who calculate critical t-values for small samples and find that in the case of pooled data without an intercept or trend, the critical values are nearly identical to the standard t-values.

The number of lags, k, is determined by choosing an upper bound of k_{max} and estimating the equation. If the last lag is not found to be significant at the 10% level, then k is reduced by one and the procedure is repeated. Given the tradeoff between the desirability of choosing a high k_{max} versus the constraint of only 26 years of data, an ad hoc initial upper bound value of $k_{max} = 4$ is chosen.

While there are clearly more sophisticated methods available for estimating convergence (see for example Quah, 1993a, 1993b, and Bernard and Durlauf, 1993) the primary attractiveness of this measure lies in its simplicity, its applicability to relatively small groups of countries, and its usefulness for conducting relatively quick and simple convergence comparisons across a multitude of groups that include different country compositions.

IV. RESULTS

Results of the equation 2 estimation for each of the trade groups are reported in Table 1. The export-based groups appear on the left-hand side of the table, the import-based group are in the middle, and the union of the two groups is on the right side of the table. In each of the three cases, the source country of each group is listed first, followed by the number of countries in each trade group and the group's estimated convergence coefficient, $\hat{\phi}$.

The results in Table 1 indicate that most of the individual trade groups exhibited income convergence. In the case of the export-based trade groups, 24 of the 25 groups had a sub-unity $\hat{\phi}$, with 16 of these outcomes significant at the 10% level at least.[5] All but 3 of the 25 import-based groups had a sub-unity $\hat{\phi}$ and 17 of these outcomes were significant at the 10% level. The union of the export-based groups with the import-based groups produced similar results indicating convergence in a majority of the groups. The average convergence coefficient for each of the three types of trade groups was also significantly less than unity (at the 1% level).

V. COMPARISON WITH ALTERNATIVE COUNTRY GROUPINGS

One question that might be asked is whether these results are indicative of trade-related convergence, or whether any random grouping of these same countries might produce similar results. To test this conjecture, it is possible to group the 25 source countries into their many different possible subgroupings, estimate their convergence coefficients, and see how likely it is to find results of the type found in Table 1. Since the import and export-based groups ranged

[5] South Africa's results should be treated with caution since the makeup of its trade groups is quite heavily influenced by the fact that the country was subject to considerable economic sanctions that included trade embargoes from other industrialized countries.

Table 1: **Trade Group's Convergence Coefficients**

(sorted by t-statistics)

	Export-Based Groups‡						Import-Based Groups						Union of Im- and Ex-Based Groups‡					
	Source Country	#	$\hat{\phi}$	t-stat	k	Half Life	Dbl Life	Source Country	#	$\hat{\phi}$	t-stat	k	Half Life	Dbl Life	Source Country	#	$\hat{\phi}$	t-stat	k	Half Life	Dbl Life
1	CAN	3	0.935	-4.571 ***	4	10	0	CAN	3	0.935	-4.571 ***	4	10	0	CAN	3	0.935	-4.571 ***	4	10	0
2	AUSTR	6	0.974	-3.760 ***	0	26	0	NOR	9	0.959	-4.452 ***	1	17	0	NOR	10	0.960	-4.447 ***	1	17	0
3	GER	9	0.976	-3.713 ***	1	29	0	SWED	9	0.959	-4.452 ***	1	17	0	SWED	10	0.960	-4.447 ***	1	17	0
4	ICE	5	0.957	-3.565 ***	2	16	0	FIN	6	0.955	-4.380 ***	1	15	0	FIN	8	0.959	-4.318 ***	1	16	0
5	JAPAN	3	0.984	-3.470 ***	1	43	0	ICE	9	0.958	-4.024 ***	2	16	0	JAPAN	4	0.982	-4.190 ***	1	37	0
6	FRA	8	0.978	-3.236 ***	1	31	0	GER	8	0.973	-3.526 ***	2	25	0	ICE	9	0.958	-4.024 ***	2	16	0
7	NZ	5	0.966	-3.057 ***	1	20	0	JAPAN	3	0.959	-3.496 ***	1	16	0	GER	10	0.972	-3.934 ***	3	24	0
8	ITAL	6	0.979	-2.883 ***	1	32	0	DEN	9	0.969	-3.249 ***	3	22	0	AUSTR	6	0.974	-3.760 ***	0	26	0
9	SWIS	6	0.979	-2.883 ***	1	32	0	SWIS	8	0.978	-3.236 ***	1	31	0	DEN	9	0.969	-3.249 ***	3	22	0
10	BELLU	7	0.981	-2.643 ***	0	36	0	AUSTR	4	0.975	-3.233 ***	1	28	0	FRA	8	0.978	-3.236 ***	1	31	0
11	NETH	7	0.981	-2.643 ***	0	36	0	AUSTL	6	0.966	-3.209 ***	1	20	0	SWIS	8	0.978	-3.236 ***	1	31	0
12	SPA	7	0.983	-2.413 **	4	39	0	NZ	6	0.966	-3.209 ***	1	20	0	NZ	6	0.966	-3.209 ***	1	20	0
13	AUSTL	4	0.973	-2.309 **	2	25	0	FRA	7	0.981	-2.643 ***	0	36	0	AUSTL	6	0.966	-3.209 ***	1	20	0
14	SWED	9	0.979	-1.990 **	1	33	0	UK	9	0.979	-2.613 ***	3	33	0	ITAL	7	0.979	-3.010 ***	1	32	0
15	UK	8	0.992	-1.796 *	0	85	0	ITAL	6	0.983	-2.300 **	1	41	0	BELLU	7	0.981	-2.643 ***	0	36	0
16	FIN	7	0.980	-1.745 *	0	35	0	BELLU	6	0.979	-2.078 **	0	33	0	NETH	7	0.981	-2.643 ***	0	36	0
17	IRE	7	0.994	-1.359	0	109	0	NETH	6	0.979	-2.078 **	0	33	0	UK	10	0.992	-1.525	3	89	0
18	DEN	7	0.985	-1.237	1	47	0	SPA	7	0.993	-1.339	3	100	0	IRE	7	0.994	-1.359	0	109	0
19	CHIL	8	0.993	-1.117	3	102	0	IRE	5	0.994	-1.295	0	110	0	SPA	8	0.993	-1.341	3	105	0
20	NOR	7	0.988	-1.037	3	58	0	US	6	0.996	-0.731	1	186	0	US	6	0.996	-0.731	1	186	0
21	ARGN	5	0.996	-0.909	3	154	0	URUG	5	0.998	-0.445	1	300	0	URUG	6	0.998	-0.404	1	350	0
22	US	6	0.996	-0.731	1	186	0	MEX	3	0.999	-0.208	1	554	0	MEX	4	0.998	-0.327	2	318	0
23	URUG	6	0.998	-0.404	1	350	0	SAFR	6	1.003	0.553	3	0	204	ARGN	9	1.003	0.880	3	0	274
24	MEX	4	0.998	-0.327	2	318	0	ARGN	8	1.003	0.883	3	0	255	CHIL	9	1.006	1.127	1	0	115
25	SAFR	7	1.005	1.782 *	3	0	130	CHIL	6	1.006	0.903	1	0	116	SAFR	9	1.005	2.211 **	3	0	135
	Mean:		0.982	-6.143 ***				Mean:		0.978	-6.079 ***				Mean:		0.979	-5.817 ***			

‡ The list of countries in each group may be found in Appendix Table A1. A legend of the abbreviations is in Table A2.

*** Significantly different from one at the 1% level.
** Significant different from one at the 5% level.
* Significant different from one at the 10% level.

Export groups include all countries that receive over 4% of the source countries total exports.
Import groups include all countries that are the origin of over 4% of source countries total imports.
The column heading, #, represents the number of countries in each group.

in size from three countries to nine countries, the various random subgroupings will also range in size from three to nine countries.

In the case of subgroups with 3 countries, it is possible to create 2300 different subgroups from the 25 original source countries (*i.e.* 25!/(3!22!) subgroups). As the number of countries within each subgroup increases to nine, so does the number of different possible ways to group the countries. There are 12,650 possible subgroups of four, 53,130 possibilities of five, and up to 2,042,975 different possible subgroups consisting of nine countries.

For the smallest group size of 3, each of the possible subgroups was estimated, while for the larger groups, 5000 random draws of each group size were estimated. The cumulative distributions of the $\hat{\phi}$'s are graphed in Figure 1. Below the figure, in Table 2, are some of the critical values obtained from these distributions. The larger the group size, the smaller the variability of the $\hat{\phi}$'s. For example, the range of convergence coefficients for groups of nine ranged from 0.925 to 1.035, compared to a range between 0.672 and 1.103 for groups consisting of only three countries. As is evident from Figure 1, a random grouping (of any group size) is more likely to produce a $\hat{\phi} > 1$, *i.e.* a divergence outcome.

The results in Table 2 make it easier to determine how commonplace the convergence results really are. For example, New Zealand's import-based trade group consists of 6 countries and it had an estimated $\hat{\phi}$ of 0.966. From Table 2, it can be seen that the likelihood of drawing a randomly constructed group of six countries out of the original 25 and getting a $\hat{\phi}$ of 0.966 is less than 5%. In a similar fashion it is possible to compare the results of the other trade groups to those of the complete distributions and determine the uniqueness of each.

One additional point should be addressed here. While the trade groups tended to comprise primarily the countries that were among the 25 source countries, there were additional

Distribution of Convergence Coefficients (ϕ's)

The 25 Source Countries in Groups Consisting 3 to 9 Countries Per Group

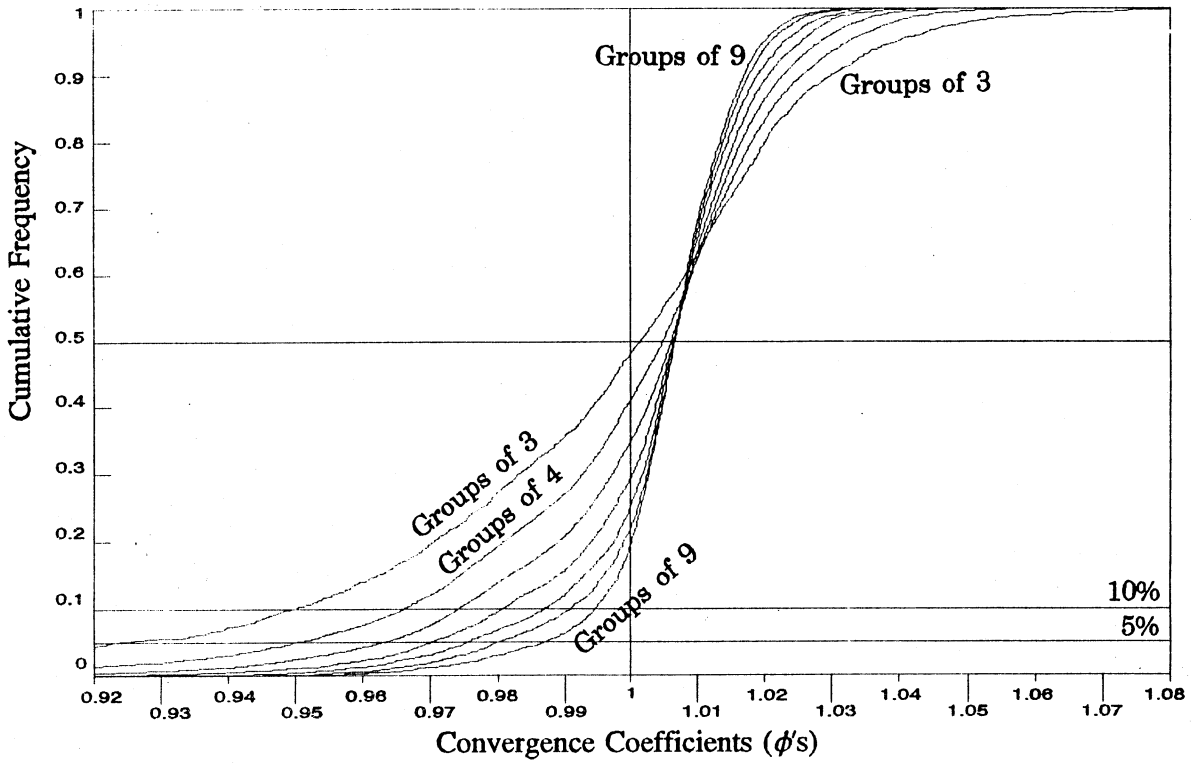


Figure 1

Table 2: **Critical Values of ϕ's**

Groupings of the 25 Source Countries
(3 to 9 Countries Per Group)

	Group Size						
	3[a]	4[b]	5[b]	6[b]	7[b]	8[b]	9[b]
1%	0.875	0.913	0.929	0.947	0.956	0.963	0.968
5%	0.922	0.950	0.961	0.970	0.975	0.980	0.987
10%	0.949	0.966	0.974	0.981	0.987	0.991	0.995
20%	0.970	0.982	0.989	0.994	0.997	0.999	1.000
30%	0.983	0.993	0.997	1.000	1.002	1.003	1.003
40%	0.994	0.999	1.003	1.004	1.004	1.005	1.005
50%	1.002	1.005	1.006	1.006	1.007	1.007	1.007
NOBS	2300	5000	5000	5000	5000	5000	5000

[a] All the possible groupings.
[b] 5,000 random groupings.

countries that were also found to be major trade partners in some of the instances. These included 7 additional countries with lower per capita incomes than those of the 25 source countries. Hence distributions from the larger pool of 32 countries were also calculated and these appear in Table 3.

Table 4 provides a summary of the probabilities of finding each of the trade group outcomes in a random draw of countries. Two probabilities are provided for each trade group. The first outcome is from the pool of 25 source countries while the second probability is from the larger pool of all 32 countries that appear in one or more of the trade groups.

Over half of the trade groups have $\hat{\phi}$'s that are below 10% of the possible outcomes, given the size of the respective trade group. These results are even stronger when they are compared to the drawings from the pool of 32 countries, where 18 (17) of the 25 export (import) based trade groups have $\hat{\phi}$'s below 10% of the possible outcomes. All but one of the export-based trade groups (and just one of the import-based groups) has a $\hat{\phi}$ that is less than 50% of the possible outcomes.

VI. Exclusion of Partners

While it would appear that grouping countries according to their trade affiliations produces significant convergence that is rarely replicated by random draws, could it be that all of this convergence within groups might be towards one country that is common to all, or nearly all, of the groups? The United States, which is a major trade partner of each of the other 24 countries is a prime candidate for this type of a bias. Its removal from each of the groups would then reduce the convergence bias, if one exists.

Table 3: Critical Values of ϕ's

Groupings of the 32 Major Trade Partners
(3 to 9 Countries Per Group)

	Group Size						
	3[a]	4[b]	5[b]	6[b]	7[b]	8[b]	9[b]
1%	0.895	0.931	0.953	0.973	0.976	0.979	0.982
5%	0.950	0.970	0.976	0.984	0.986	0.988	0.990
10%	0.970	0.979	0.984	0.990	0.992	0.994	0.995
20%	0.983	0.991	0.994	0.996	0.998	0.999	0.999
30%	0.993	0.998	0.999	1.000	1.001	1.001	1.001
40%	1.000	1.001	1.001	1.002	1.002	1.003	1.002
50%	1.004	1.004	1.004	1.005	1.004	1.004	1.004
NOBS	4960	5000	5000	5000	5000	5000	5000

[a] All the possible groupings.
[b] 5,000 random groupings.

Table 4: Convergence Coefficients and Probabilities from ϕ Distributions

(countries sorted by probabilities)

The probabilities of getting each group's $\hat{\phi}$ from random grouping of countries are based on the critical values in Tables 2 and 3.

	Export-Based Groups					Import-Based Groups				
				Probabilities					Probabilities	
	Source Country	Group Size	$\hat{\phi}$	All 25 Source	All 32 Traders	Source Country	Group Size	$\hat{\phi}$	All 25 Source	All 32 Traders
1	GER	9	0.976	5%	1%	ICE	9	0.958	1%	1%
2	FRA	8	0.978	5%	1%	NOR	9	0.959	1%	1%
3	SWED	9	0.979	5%	1%	SWED	9	0.959	1%	1%
4	ICE	5	0.957	5%	5%	FIN	6	0.955	5%	1%
5	NZ	5	0.966	10%	5%	AUSTL	6	0.966	5%	1%
6	CAN	3	0.935	10%	5%	NZ	6	0.966	5%	1%
7	AUSTR	6	0.974	10%	5%	DEN	9	0.969	5%	1%
8	ITAL	6	0.979	10%	5%	GER	8	0.973	5%	1%
9	SWIS	6	0.979	10%	5%	SWIS	8	0.978	5%	1%
10	FIN	7	0.980	10%	5%	UK	9	0.979	5%	1%
11	NETH	7	0.981	10%	5%	CAN	3	0.935	10%	5%
12	BELLU	7	0.981	10%	5%	NETH	6	0.979	10%	5%
13	SPA	7	0.983	10%	5%	BELLU	6	0.979	10%	5%
14	DEN	7	0.985	10%	5%	FRA	7	0.981	10%	5%
15	AUSTL	4	0.973	20%	10%	ITAL	6	0.983	20%	5%
16	NOR	7	0.988	20%	10%	JAPAN	3	0.959	20%	10%
17	UK	8	0.992	20%	10%	AUSTR	4	0.975	20%	10%
18	CHIL	8	0.993	20%	10%	SPA	7	0.993	20%	20%
19	IRE	7	0.994	20%	20%	US	6	0.996	30%	20%
20	US	6	0.996	30%	20%	IRE	5	0.994	30%	30%
21	ARGN	5	0.996	30%	30%	ARGN	8	1.003	30%	40%
22	URUG	6	0.998	30%	30%	URUG	5	0.998	40%	30%
23	JAPAN	3	0.984	40%	30%	SAFR	6	1.003	40%	50%
24	MEX	4	0.998	40%	30%	MEX	3	0.999	50%	40%
25	SAFR	7	1.005	50%		CHIL	6	1.006	50%	

The estimated convergence coefficients for the export-based trade groups, minus the U.S., appear on the left-hand side of Table 5a, while the results for the import-based groups appear on the left-hand side of Table 5b. 21 (20) of the 24 export (24 import) groups still have $\hat{\phi}$'s below unity.

Like before, the overall $\hat{\phi}$ distributions were calculated for the all combinations of the source countries, minus the United States, as well as all 31 (again minus the U.S.) of the major traders. The critical values from these distributions appear in Appendix Table A3. While the exclusion of the United States weakens the results, the majority of the trade group outcomes fall below 20% of the random outcomes and all but two of the export groups (three of the import groups) have convergence coefficients that are smaller than the majority of the possible convergence coefficients.

In addition to the U.S., which appeared in every group, there were three other countries, the U.K., Germany, and Japan that also appeared as major trade partners in a number of the groups. The results from the exclusion of these countries are also reported in Tables 5a and 5b while the relevant critical values may be found in Appendix Table A3. As in the U.S. case, the exclusion of these countries does not appreciably alter the relatively high incidence of convergence within the trade groups.

VII. Changing the Base Years of the Trade Groups

The idea for creating trade groups based on end-of-period (*i.e.* 1985) trade data stemmed from a desire to create groups of countries that had evolved over time into major trade partners, hence increasing the likelihood of finding convergence. Had the grouping criteria been based

Table 5a: **Convergence Coefficients of *Export* Groups Excluding U.S., U.K., Germany and Japan**

(countries sorted by probabilities from ϕ distributions)

The probabilities of getting each group's $\hat{\phi}$ from random grouping of countries are based on the critical values in Table A3.

	Excluding the United States					Excluding the U.K.					Excluding Germany					Excluding Japan				
				Probabilities					Probabilities					Probabilities					Probabilities	
	Source Country	Size	$\hat{\phi}$	All 25 Source	All 32 Traders	Source Country	Size	$\hat{\phi}$	All 25 Source	All 32 Traders	Source Country	Size	$\hat{\phi}$	All 25 Source	All 32 Traders	Source Country	Size	$\hat{\phi}$	All 25 Source	All 32 Traders
1	NZ	4	0.900	1%	1%	DEN	6	0.970	5%	1%	FRA	7	0.977	5%	5%	AUSTR	6	0.974	5%	1%
2	ICE	4	0.919	5%	1%	FIN	6	0.971	5%	1%	SWED	8	0.980	5%	5%	GER	9	0.976	5%	1%
3	GER	8	0.974	5%	1%	SWED	8	0.973	5%	1%	CAN	3	0.935	10%	5%	FRA	8	0.978	5%	1%
4	AUSTL	3	0.915	5%	5%	GER	8	0.975	5%	1%	ICE	4	0.963	10%	5%	SWED	9	0.979	5%	1%
5	FRA	7	0.976	5%	5%	FRA	7	0.977	5%	5%	NZ	5	0.966	10%	5%	FIN	7	0.980	5%	5%
6	SWED	8	0.981	5%	5%	ICE	4	0.951	5%	5%	AUSTR	5	0.973	10%	5%	BELLU	7	0.981	5%	5%
7	AUSTR	5	0.972	10%	5%	CAN	3	0.935	10%	5%	SPA	6	0.980	10%	5%	NETH	7	0.981	5%	5%
8	SWIS	5	0.977	20%	5%	SPA	6	0.978	10%	5%	NETH	6	0.980	10%	5%	SWIS	6	0.979	10%	5%
9	ITAL	5	0.977	20%	5%	NOR	6	0.979	10%	5%	BELLU	6	0.980	10%	5%	ITAL	6	0.979	10%	5%
10	SPA	6	0.986	20%	10%	BELLU	6	0.982	10%	5%	FIN	6	0.981	10%	5%	SPA	7	0.983	10%	5%
11	BELLU	6	0.986	20%	10%	NETH	6	0.982	10%	5%	ITAL	5	0.978	20%	5%	DEN	7	0.985	10%	5%
12	NETH	6	0.986	20%	10%	AUSTR	5	0.976	20%	5%	SWIS	5	0.978	20%	5%	NOR	7	0.988	10%	10%
13	FIN	6	0.988	20%	10%	ITAL	5	0.978	20%	5%	AUSTL	4	0.973	20%	10%	UK	8	0.992	10%	10%
14	CAN	2	0.936	20%	20%	SWIS	5	0.978	20%	5%	DEN	6	0.987	20%	10%	CAN	2	0.925	20%	10%
15	CHIL	7	0.994	20%	20%	NZ	4	0.973	20%	10%	UK	7	0.991	20%	10%	ICE	4	0.984	20%	20%
16	DEN	6	0.995	20%	20%	AUSTL	4	0.973	20%	10%	CHIL	7	0.993	20%	10%	CHIL	7	0.994	20%	20%
17	UK	7	0.997	20%	20%	IRE	6	0.994	20%	20%	NOR	6	0.990	20%	20%	IRE	7	0.994	20%	20%
18	ARGN	4	0.995	30%	30%	CHIL	7	0.994	20%	20%	IRE	6	0.993	20%	20%	US	5	0.996	30%	30%
19	URUG	5	0.997	30%	30%	JAPAN	3	0.984	30%	20%	JAPAN	3	0.984	30%	20%	URUG	6	0.998	30%	30%
20	IRE	6	0.998	30%	30%	ARGN	5	0.996	30%	30%	ARGN	5	0.996	30%	30%	ARGN	4	0.995	30%	30%
21	NOR	6	1.000	30%	30%	US	5	0.997	30%	30%	URUG	5	0.996	30%	30%	MEX	3	0.991	40%	30%
22	JAPAN	2	0.989	50%	40%	URUG	5	0.998	30%	30%	US	5	0.997	30%	30%	NZ	4	0.998	40%	30%
23	SAFR	6	1.006	50%		MEX	4	0.998	40%	30%	MEX	4	0.998	40%	30%	SAFR	6	1.005	40%	50%
24	MEX	3	1.037			SAFR	6	1.005	50%		SAFR	7	1.005	50%		AUSTL	3	1.004		50%

Table 5b: **Convergence Coefficients of *Import* Groups Excluding U.S., U.K. and Germany**

(countries sorted by probabilities from ϕ distributions)

The probabilities of getting each group's $\hat{\phi}$ from random grouping of countries are based on the critical values in Table A3.

	Excluding the United States					Excluding the U.K.					Excluding Germany					Excluding Japan				
				Probabilities					Probabilities					Probabilities					Probabilities	
	Source Country	Size	$\hat{\phi}$	All 25 Source	All 32 Traders	Source Country	Size	$\hat{\phi}$	All 25 Source	All 32 Traders	Source Country	Size	$\hat{\phi}$	All 25 Source	All 32 Traders	Source Country	Size	$\hat{\phi}$	All 25 Source	All 32 Traders
1	FIN	5	0.921	1%	1%	ICE	8	0.952	1%	1%	NOR	8	0.960	1%	1%	SWIS	8	0.978	5%	1%
2	ICE	8	0.944	1%	1%	SWED	8	0.953	1%	1%	SWED	8	0.960	1%	1%	SWED	8	0.978	5%	1%
3	SWED	8	0.950	1%	1%	NOR	8	0.953	1%	1%	ICE	8	0.962	1%	1%	NOR	8	0.978	5%	1%
4	NOR	8	0.950	1%	1%	DEN	8	0.960	1%	1%	FIN	5	0.955	5%	1%	FRA	7	0.981	5%	5%
5	AUSTL	5	0.945	5%	1%	FIN	5	0.949	5%	1%	DEN	8	0.971	5%	1%	GER	7	0.981	5%	5%
6	NZ	5	0.945	5%	1%	GER	7	0.968	5%	1%	SWIS	7	0.977	5%	5%	ICE	8	0.986	5%	5%
7	DEN	8	0.962	5%	1%	SWIS	7	0.977	5%	5%	UK	8	0.981	5%	5%	DEN	8	0.986	5%	5%
8	GER	7	0.968	5%	1%	CAN	3	0.935	10%	5%	CAN	3	0.935	10%	5%	FIN	5	0.975	10%	5%
9	UK	8	0.980	5%	1%	AUSTL	5	0.967	10%	5%	AUSTL	5	0.966	10%	5%	NETH	6	0.979	10%	5%
10	SWIS	7	0.976	5%	5%	NZ	5	0.967	10%	5%	NZ	5	0.966	10%	5%	BELLU	6	0.979	10%	5%
11	AUSTR	4	0.975	20%	10%	BELLU	5	0.968	10%	5%	FRA	6	0.980	10%	5%	ITAL	6	0.983	10%	5%
12	NETH	5	0.980	20%	10%	NETH	5	0.968	10%	5%	NETH	5	0.979	20%	5%	UK	8	0.988	10%	5%
13	BELLU	5	0.980	20%	10%	FRA	6	0.982	10%	5%	BELLU	5	0.979	20%	5%	CAN	2	0.925	20%	10%
14	ITAL	5	0.986	20%	10%	JAPAN	3	0.959	20%	10%	JAPAN	3	0.959	20%	10%	AUSTR	4	0.975	20%	10%
15	FRA	6	0.986	20%	10%	AUSTR	4	0.975	20%	10%	ITAL	5	0.981	20%	10%	SPA	7	0.993	20%	20%
16	JAPAN	2	0.934	20%	20%	ITAL	5	0.983	20%	10%	SPA	6	0.992	20%	20%	IRE	5	0.994	30%	20%
17	CAN	2	0.936	20%	20%	SPA	6	0.994	20%	20%	AUSTR	3	0.972	30%	20%	US	5	0.996	30%	30%
18	URUG	4	0.995	30%	30%	IRE	4	0.994	30%	30%	IRE	4	0.993	30%	30%	URUG	5	0.998	30%	30%
19	SPA	6	0.999	30%	30%	US	5	0.997	30%	30%	US	5	0.997	30%	30%	ARGN	7	1.003	30%	50%
20	IRE	4	0.999	40%	30%	URUG	5	0.998	30%	30%	URUG	4	0.994	40%	30%	NZ	5	1.000	40%	40%
21	ARGN	7	1.004	40%	50%	ARGN	8	1.003	30%	50%	ARGN	7	1.003	40%	50%	AUSTL	5	1.000	40%	40%
22	SAFR	5	1.008			SAFR	5	1.003	40%	50%	SAFR	5	1.003	40%	50%	MEX	2	0.983	50%	40%
23	CHIL	5	1.014			MEX	3	0.999	50%	40%	MEX	3	0.999	50%	40%	CHIL	5	1.005	50%	
24	MEX	2	1.019			CHIL	6	1.006	50%		CHIL	5	1.008			SAFR	5	1.010		

on beginning-of-period (that is, 1960) data, then it might have included countries that were no longer major trade partners by the period's end.

In the event that there were no changes in the trade relationships (as far as major partners are concerned), then the whole issue of which period should form the base year for determination of the trade groups becomes inconsequential. On the other hand, if the 1960-based group memberships differ from those of the 1985-based groups, then presumably, there should also be less evidence of convergence.

Table 6 provides a comparison of the two bases. On the left-hand side of the table are the export group $\hat{\phi}$'s for the 1985-based groups as well as the 1960-based groups. The import group comparison is on the right-hand side of the table. For both the 1960 and 1985-based groups, the $\hat{\phi}$'s are ranked from the smallest to the largest.

While creation of the 1960-based groups does not overturn the high incidence of convergence, the frequency of non-convergence is nonetheless higher in the 1960-based groups, with the number of $\hat{\phi}$'s exceeding unity increasing from 1 to 4 in the export case, and from 3 to 6 in the import case. In addition, the maximum $\hat{\phi}$ for the 1960-based groups is higher than the maximum $\hat{\phi}$ for the 1985-based groups (for both import and export groups). Likewise, the minimum 1960 $\hat{\phi}$ also exceeds the minimum 1985 $\hat{\phi}$ for the import groups, though this is not the case for the export groups. However, the latter finding is an exception for the export groups, as 19 of the 25 export group 1960-based $\hat{\phi}$'s are larger than their matching 1985-based $\hat{\phi}$'s. In the case of the import groups, every one of the 1960-based $\hat{\phi}$'s are larger than their matching 1985-based $\hat{\phi}$'s.

Table 6: **Comparison of Trade Group Convergence Coefficients**
1985-Based Groups versus 1960-Based Groups

	Export Group $\hat{\phi}$'s (ranked from smallest to largest)			Import Group $\hat{\phi}$'s (ranked from smallest to largest)		
	1985 Base Year (A)	1960 Base Year (B)	Difference (B-A)	1985 Base Year (D)	1960 Base Year (E)	Difference (E-D)
1	0.9351	0.9328	-0.0023	0.9351	0.9684	0.0333
2	0.9567	0.9717	0.0150	0.9548	0.9684	0.0136
3	0.9656	0.9741	0.0085	0.9576	0.9732	0.0156
4	0.9728	0.9745	0.0017	0.9588	0.9741	0.0153
5	0.9741	0.9759	0.0017	0.9589	0.9741	0.0152
6	0.9761	0.9764	0.0004	0.9589	0.9760	0.0171
7	0.9777	0.9769	-0.0008	0.9661	0.9777	0.0115
8	0.9788	0.9775	-0.0014	0.9661	0.9804	0.0143
9	0.9788	0.9788	0.0000	0.9687	0.9810	0.0124
10	0.9792	0.9789	-0.0004	0.9730	0.9818	0.0088
11	0.9802	0.9793	-0.0009	0.9751	0.9824	0.0073
12	0.9811	0.9796	-0.0016	0.9777	0.9838	0.0061
13	0.9811	0.9813	0.0002	0.9793	0.9847	0.0054
14	0.9826	0.9851	0.0026	0.9793	0.9869	0.0076
15	0.9841	0.9881	0.0040	0.9793	0.9923	0.0129
16	0.9854	0.9913	0.0059	0.9811	0.9928	0.0116
17	0.9882	0.9934	0.0052	0.9834	0.9932	0.0099
18	0.9919	0.9954	0.0035	0.9931	0.9958	0.0027
19	0.9932	0.9963	0.0031	0.9937	0.9968	0.0030
20	0.9937	0.9968	0.0031	0.9963	1.0036	0.0073
21	0.9955	0.9988	0.0032	0.9977	1.0039	0.0062
22	0.9963	1.0040	0.0077	0.9988	1.0047	0.0059
23	0.9978	1.0084	0.0106	1.0027	1.0058	0.0030
24	0.9980	1.0087	0.0107	1.0034	1.0092	0.0058
25	1.0050	1.0144	0.0094	1.0060	1.0164	0.0104

VIII. Comparison with Groups Based on Proximity and Language

As the country groupings in Table A1 suggest, many of the countries that comprise the trade groups share other characteristics as well. For example, 7 of the 25 source countries share English as their primary language while 5 other countries are primarily Spanish-speaking. In addition, quite a few of the countries are also in close geographical proximity with one another. Since common language and proximity facilitate information flows, and to the extent that these flows are a source of income convergence, then it is possible that the income convergence exhibited by the trade groups is due less to trade flows than to proximity and/or common language. Of course, since a number of the major trade partners share a common language and, in a number of instances, a common border, it is not possible to make a complete distinction between the impact of trade and the impact of common language and proximity.

It is however possible to regroup the countries in such a way so as to reflect common languages or, alternatively, geographical closeness. The degree of convergence within each of these groups could then be compared to the results of the trade-based groups. While both types of groups could be expected to exhibit income convergence, the purpose of this section is to discern whether the trade-based groups exhibit more evidence of convergence.

Geographical proximity is defined here to be a neighboring country with a common border, or, when the border is water, the nearest neighbor across the water. Such regional groupings were constructed for each of the source countries. As in the trade group case, these groups do not include countries that are primarily oil producers or formerly Communist

countries. In addition, countries were also grouped according to a common primary language.[6] In keeping with the trade group's minimum size of three, only proximity and language-based groups with at least three countries were examined.

Under these criteria, there are two language groups (English and Spanish) and 22 regional groupings. The composition of these groups may be found in Appendix Table A4. As the results in Table 7 indicate, there is no evidence of convergence (nor of divergence) within either the group of English-speaking countries, or the group of Spanish-speaking countries.

The regional groupings are sorted by the *t*-statistics of the convergence coefficients. Just 7 of the 22 groups (or roughly one-third of the groups) exhibit income convergence at a 10% or higher level. This compares with approximately two-thirds of the trade-based groups (either export or import) that exhibited significant convergence.

Thus, the tendency towards convergence appears to be considerably stronger when the basis for constructing groups is trade rather than proximity or common language. This evidence is supported by a separate study aimed at gauging the extent of growth spillovers among countries. In that study, Weinhold (1995) examines the role of trade that cannot be explained by geography, size or cultural links and concludes that trade's contribution to spillovers is substantially stronger than that of the other factors.

---

[6] Countries with more than one official language are omitted from the sample to eliminate as much noise as possible. However, several of the regional groupings tend to reflect language ties with multiple language countries, so that common languages ties are also observed in this indirect manner. For example, Switzerland's three official languages are French, Italian, and German. Switzerland's regional group is France, Italy, Germany, and Austria.

Table 7:

Convergence Coefficients of Groups Based on Common Language and Geographical Proximity

(sorted by t-statistics)

	Source	Size	$\hat{\phi}$	t-stat	k
Groups Based on a Common Language					
1	Spanish	5	1.006	0.221	0
2	English	7	1.002	0.507	0
Groups Based on Geographical Proximity					
1	URUG	3	0.949	-3.577 ***	1
2	SWIS	5	0.974	-3.511 ***	2
3	AUSTR	4	0.975	-3.233 ***	1
4	ITAL	4	0.976	-3.221 ***	1
5	GERM	6	0.965	-3.150 ***	4
6	FRA	7	0.980	-2.570 ***	4
7	SPA	3	0.988	-1.722 *	2
8	ARGN	6	0.988	-1.430	3
9	SWED	4	0.972	-1.428	1
10	US	3	0.994	-1.349	4
11	BELLU	5	0.980	-0.911	4
12	CHIL	4	0.994	-0.578	0
13	UK	5	0.997	-0.550	3
14	NZ	3	0.997	-0.349	0
15	SA	5	0.999	-0.105	0
16	NOR	3	1.000	-0.013	1
17	DEN	4	1.003	0.083	2
18	NETH	4	1.008	0.339	0
19	ICE	4	1.003	0.386	4
20	MEX	3	1.004	1.190	1
21	JAP	5	1.007	1.346	1
22	AUSTL	3	1.009	2.320 **	4

*** Significantly different from one at the 1% level.
** Significant different from one at the 5% level.

IX. CONCLUSIONS

This paper provides evidence that income convergence among countries, while far from being a world-wide phenomenon, seems to be a prevailing feature among countries that trade extensively with one another.

Grouping countries according to their primary trade affiliations tends to produce significant income convergence within the groups. Convergence of this magnitude is not a common outcome among these countries when they are grouped randomly instead of by their trade patterns. Furthermore, this convergence is not due to the inclusion of any one particular country, but is instead an outcome that tends to be relatively robust to the exclusion of trade partners that are members in most of the groups.

Creating trade groups according to initial-period trade rather than terminal-period trade does not affect the results in any major way. If anything, there is more convergence evidence in the groups that are based on trade in the last year of the sample. This would appear to be consistent with the earlier results since groups of countries that have become (or remained) major partners over the duration of the period converge a bit more than groups that include countries that have since ceased being major partners.

These findings would appear to corroborate Heckscher (1919) and Ohlin's (1933) intuition that trade does indeed play an equalizing role and that, as Ohlin pointed out:

> ... the mobility of goods to some extent compensates for the lack of interregional mobility of factors; or (which is really the same thing), trade mitigates the disadvantages of the unsuitable geographical distribution of the productive facilities [Ohlin (1933, p. 29)].

In a world that exhibits increasingly larger income gaps between the majority of countries, evidence that heightened trade may be associated with a reduction in these gaps should provide some measure of reassurance to the advocates of free trade.

REFERENCES

Barro, Robert J. (1991), "Economic Growth in a Cross-Section of Countries," *Quarterly Journal of Economics*, *106*, 407-443.

Barro, Robert J. and Xavier Sala-i-Martin (1991), "Convergence Across States and Regions," *Brookings Papers on Economic Activity*, 107-82.

Baumol, William J. (1986), "Productivity Growth, Convergence, and Welfare: What the Long-Run Data Show," *American Economic Review*, *76*, 1072-85.

Baumol, William J. and Edward N. Wolff (1988), "Productivity Growth, Convergence, and Welfare: Reply," *American Economic Review*, *78*, 1155-59.

Baumol, William J., Sue Ann B. Blackman and Edward N. Wolff (1989), *Productivity and American Leadership: The Long View*, Cambridge, MA: MIT Press.

Ben-David, Dan (1993), "Equalizing Exchange: Trade Liberalization and Income Convergence," *Quarterly Journal of Economics*, *108*, 653-79.

Ben-David, Dan (1994a), "Income Disparity Among Countries and the Effects of Freer Trade," *Economic Growth and the Structure of Long Run Development*, in Luigi L. Pasinetti and Robert M. Solow (eds), London: Macmillan, 45-64.

Ben-David, Dan (1994b), "Convergence Clubs and Diverging Economies," CEPR Working Paper No. 922.

Bernard, Andrew B. and Steven N. Durlauf (1993), "Convergence in International Output," unpublished working paper, MIT.

Dollar, David, Edward N. Wolff, and William J. Baumol (1988), "The Factor-Price Equalization Model and Industry Labor Productivity: An Empirical Test across Countries," in Robert C. Feenstra (ed.), *Empirical Methods for International Trade*, Cambridge: MIT Press, 23-47.

Dowrick, Steve and Duc-Tho Nguyen (1989), "OECD Comparative Economic Growth 1950-85: Catch-Up and Convergence," *American Economic Review*, *79*, 1010-30.

Fuller, Wayne (1976), *Introduction to Statistical Time Series*, Wiley: New York.

Friedman, Milton (1992), "Do Old Fallacies Ever Die?" *Journal of Economic Literature*, *30*, 2129-2132.

Grossman, Gene and Elhanan Helpman (1991), *Innovation and Growth in the Global Economy*, Cambridge: MIT Press.

Heckscher, E. (1919), "The Effect of Foreign Trade on the Distribution of Income," *Ekonomisk Tidskrift*, *21*, pp. 1-32. Reprinted in AEA *Readings in the Theory of International Trade*, Philadelphia: Blakiston Co., 1950.

Helpman, Elhanan and Paul R. Krugman (1985), *Market Structure and Foreign Trade*, Cambridge: MIT Press.

Hotelling, Harold (1933), "Review of *The Triumph of Mediocrity in Business*, by Horace Secrist," *Journal of the American Statistical Association*, *28*(184), 463-65.

International Monetary Fund, *Direction of Trade Statistics Yearbook*, Washington, D.C., various editions.

International Monetary Fund, *International Financial Statistics Yearbook*, Washington, D.C., various editions.

Jovanovic, Boyan, and Saul Lach (1990), "The Diffusion of Technology and Inequality Among Nations," Paper presented at the NBER Workshop on Economic Growth.

Levin, Andrew and Chien-Fu Lin (1992), "Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties," University of California - San Diego Discussion Paper 92-23.

Levine, Ross and David Renelt (1992), "A Sensitivity Analysis of Cross-Country Growth Regressions," *American Economic Review*, *82*, 942-63.

Linder, Staffan B. (1961), *An Essay on Trade and Transformation*, New York: Wiley.

Lucas, Robert E. Jr. (1988), "On the Mechanics of Economic Development," *Journal of Monetary Economics*, *22*, 3-42.

Mankiw, N. Gregory, David Romer and David N. Weil (1992), "A Contribution to the Empirics of Economic Growth," *Quarterly Journal of Economics*, *107*, 407-37.

Ohlin, Bertil (1933), *Interregional and International Trade*, Cambridge: Harvard University Press, chap. 2.

Quah, Danny (1994), "Exploiting Cross-Section Cross-section Variation for Unit Root Inference in Dynamic Data," *Economic Letters*, *44*, 9-19.

Quah, Danny (1993a), "Galton's Fallacy and Tests of the Convergence Hypothesis," *Scandinavian Journal of Economics*, *95*, 427-443.

Quah, Danny (1993b), "Empirical Cross-Section Dynamics in Economic Growth," *European Economic Review*, *37*, 426-434.

Romer, Paul M. (1986), "Increasing Returns and Long Run Growth," *Journal of Political Economy*, *94*, 1002-38.

Ruffin, Roy J. (1987), "The Missing Link: The Ricardian Approach to the Factor Endowments Theory of Trade," Unpublished Working Paper.

Samuelson, Paul A. (1948), "International Trade and the Equalisation of Factor Prices," *Economic Journal*, *58*, 163-84.

Samuelson, Paul A. (1949), "International Factor-Price Equalisation Once Again," *Economic Journal*, *59*, 181-97.

Solow, Robert M. (1956), "A Contribution to the Theory of Economic Growth," *Quarterly Journal of Economics, 70*, Reprinted in Joseph E. Stiglitz and Hirofumi Uzawa (eds), *Readings in the Modern Theory of Economic Growth*, Cambridge: MIT Press, 58-87.

Summers, Robert and Alan Heston (1988), "A New Set of International Comparisons of Real Product and Price Levels Estimates for 130 Countries, 1950-1985," *Review of Income and Wealth*, *34*, 1-25.

Weinhold, Diana (1995), "The Importance of Trade and Space For Economic Growth," Unpublished Working Paper.

Table A1: **List of Countries in Trade Groups**
(legend in Table A2)

	Source Country	Countries in Group							
Export-Based Groups									
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		
Import-Based Groups									
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	

TABLE A2: Legend of Countries

	Code	Country
1	ARGN	Argentina
2	AUSTL	Australia
3	AUSTR	Austria
4	BELLU	Belgium-Luxembourg
5	BOLI	Bolivia
6	BRAZ	Brazil
7	CAN	Canada
8	CHIL	Chile
9	CONG	Congo
10	DEN	Denmark
11	ETHI	Ethiopia
12	FIN	Finland
13	FRA	France
14	GER	Germany
15	GHAN	Ghana
16	GUYA	Guyana
17	ICE	Iceland
18	IRE	Ireland
19	ITAL	Italy
20	JAPAN	Japan
21	MEX	Mexico
22	NETH	Netherlands
23	NOR	Norway
24	NZ	New Zealand
25	SAFR	South Africa
26	SKOR	South Korea
27	SPA	Spain
28	SWED	Sweden
29	SWIS	Switzerland
30	UK	United Kingdom
31	URUG	Uruguay
32	US	United States

Table A3: **Critical Values of ϕ's**

(when specific countries are excluded)

	Group Size (out of the 25 source countries)							Group Size (out of the 32 major trade partners)						
	2[a]	3[a]	4[b]	5[b]	6[b]	7[b]	8[b]	2[a]	3[a]	4[b]	5[b]	6[b]	7[b]	8[b]
	Excluding the United States													
1%	0.647	0.872	0.906	0.927	0.942	0.952	0.961	0.765	0.893	0.937	0.953	0.972	0.975	0.980
5%	0.853	0.918	0.946	0.959	0.970	0.976	0.982	0.890	0.948	0.972	0.978	0.983	0.986	0.988
10%	0.899	0.947	0.965	0.974	0.983	0.989	0.992	0.922	0.970	0.981	0.986	0.989	0.992	0.994
20%	0.936	0.971	0.983	0.991	0.995	0.999	1.000	0.960	0.985	0.992	0.995	0.997	0.998	0.998
30%	0.961	0.986	0.995	0.999	1.001	1.003	1.004	0.977	0.994	0.999	1.000	1.000	1.001	1.001
40%	0.977	0.996	1.001	1.004	1.005	1.005	1.006	0.991	1.000	1.001	1.002	1.002	1.002	1.003
50%	0.994	1.003	1.006	1.007	1.007	1.008	1.008	1.001	1.004	1.005	1.005	1.005	1.004	1.004
	Excluding the United Kingdom													
1%	0.647	0.876	0.910	0.939	0.948	0.955	0.965	0.765	0.900	0.940	0.961	0.971	0.976	0.980
5%	0.867	0.926	0.951	0.964	0.971	0.977	0.983	0.898	0.951	0.972	0.978	0.983	0.986	0.988
10%	0.905	0.950	0.967	0.975	0.984	0.989	0.993	0.933	0.971	0.979	0.986	0.989	0.992	0.994
20%	0.942	0.971	0.982	0.990	0.996	0.998	1.000	0.961	0.984	0.991	0.995	0.997	0.998	0.998
30%	0.963	0.984	0.994	0.998	1.001	1.002	1.003	0.977	0.994	0.998	0.999	1.000	1.001	1.001
40%	0.978	0.995	1.000	1.003	1.004	1.005	1.005	0.990	1.000	1.001	1.002	1.002	1.002	1.002
50%	0.993	1.002	1.005	1.006	1.007	1.007	1.007	1.001	1.004	1.004	1.004	1.004	1.004	1.004
	Excluding Germany													
1%	0.647	0.872	0.900	0.934	0.950	0.958	0.965	0.765	0.893	0.937	0.958	0.972	0.976	0.979
5%	0.853	0.922	0.947	0.965	0.971	0.978	0.984	0.895	0.951	0.971	0.979	0.983	0.986	0.988
10%	0.901	0.950	0.966	0.976	0.981	0.988	0.993	0.927	0.970	0.979	0.986	0.989	0.993	0.994
20%	0.937	0.971	0.982	0.991	0.994	0.998	1.000	0.960	0.984	0.991	0.995	0.997	0.998	0.998
30%	0.963	0.984	0.993	0.998	1.001	1.002	1.003	0.977	0.993	0.998	0.999	1.000	1.001	1.001
40%	0.976	0.995	0.999	1.003	1.004	1.004	1.005	0.989	1.000	1.001	1.002	1.002	1.002	1.003
50%	0.990	1.002	1.005	1.006	1.006	1.007	1.007	1.000	1.004	1.004	1.004	1.004	1.004	1.004
	Excluding Japan													
1%	0.647	0.876	0.934	0.950	0.960	0.969	0.971	0.778	0.905	0.952	0.967	0.974	0.976	0.980
5%	0.867	0.941	0.963	0.970	0.976	0.982	0.986	0.899	0.958	0.973	0.979	0.983	0.986	0.988
10%	0.913	0.959	0.974	0.978	0.985	0.990	0.993	0.936	0.973	0.980	0.986	0.989	0.992	0.994
20%	0.950	0.975	0.987	0.991	0.996	0.999	1.001	0.964	0.985	0.990	0.994	0.997	0.998	0.998
30%	0.965	0.987	0.995	0.998	1.002	1.003	1.004	0.978	0.994	0.998	0.999	1.000	1.001	1.001
40%	0.980	0.996	1.001	1.004	1.005	1.006	1.006	0.990	1.000	1.001	1.002	1.003	1.002	1.002
50%	0.994	1.003	1.006	1.007	1.008	1.008	1.008	1.001	1.004	1.004	1.004	1.005	1.004	1.004
NOBS	276	2024	5000	5000	5000	5000	5000	465	4495	5000	5000	5000	5000	5000

[a] All the possible groupings.

[b] 5,000 random groupings.

Table A4: **List of Countries in Language and Regional Groups**

	Source	Countries in Group						
Language-Based Groups								
1	Spanish	Argentina	Chile	Spain	Uruguay	Mexico		
2	English	US	UK	New Zealand	Ireland	Canada	Australia	S. Africa
Geography-Based Groups								
1	URUG	Brazil	Argentina					
2	SWIS	Italy	Germany	France	Austria			
3	AUSTR	Germany	Italy	Switz.				
4	ITAL	France	Switz.	Austria				
5	GER	France	Belguim	Neth.	Switz.	Austria		
6	FRA	Spain	UK	Belguim	Germany	Switz.	Italy	
7	SPA	France	Portugal					
8	ARGN	Chile	Bolivia	Paraguay	Brazil	Uruguay		
9	SWED	Norway	Finland	Denmark				
10	US	Canada	Mexico					
11	BELLU	France	Neth.	Germany	UK			
12	CHIL	Bolivia	Peru	Argentina				
13	UK	Ireland	France	Belguim	Neth.			
14	NZ	Austalia	Fiji					
15	SAFR	Zimbabwe	Botswana	Swaziland	Mozambique			
16	NOR	Denmark	Sweden					
17	DEN	Germany	Sweden	Norway				
18	NETH	Belguim	Germany	UK				
19	ICE	UK	Ireland	Norway				
20	MEX	US	Guatamala					
21	JAPAN	S. Korea	Taiwan	Hong Kong	Phillipines			
22	AUSTL	NZ	Pap. N. Guinea					

THE FOERDER INSTITUTE FOR ECONOMIC RESEARCH and THE SACKLER INSTITUTE FOR ECONOMIC STUDIES

The Eitan Berglas School of Economics
Tel–Aviv University

List of Recent Working Papers

28–94 (Foerder)	Assaf Razin Efraim Sadka	Resisting Migration: Wage Rigidity and Income Distribution
29–94 (Foerder)	Ariel Rubinstein	John Nash: The Master of Economic Modeling
30–94 (Sackler)	Oded Hochman David Pines and Jacques–Francois Thisse	On the Optimal Structure of Local Governments
31–94 (Foerder)	Neil Gandal	Sequential Auctions of Cable Television Licenses: The Israeli Experience
32–94 (Foerder)	David T.Coe Elhanan Helpman Alexander W.Hoffmaister	North–South R&D Spillovers
33–94 (Sackler)	Chaim Fershtman	Survival of Small Firms: Guerilla Warfare
1–95 (Foerder)	Robert Becker Itzhak Zilcha	Stationary Ramsey Equilibria Under Uncertainty
2–95 (Foerder)	Neil Gandal Shane Greenstein	Adoptions and Orphans in the Early Microcomputer Market
3–95 (Sackler)	Oved Yosha	Diversification and Competition: Financial Intermediation in a Large Cournot–Walras Economy
4–95 (Foerder)	Yishay Yafeh Oved Yosha	Large Shareholders and Banks: Who Monitors and How
5–95 (Foerder)	David M.Frankel	Commitment and Capital Taxation with an Infinite Horizon
6–95 (Sackler)	David M.Frankel	Search with Telephones and Differentiated Products

---

Copies of the working papers or a complete working paper list of the two Institutes can be obtained from: Mrs.Stella Padeh, The Foerder Institute for Economic Research, Tel–Aviv University, Tel–Aviv, 69978 Israel. Fax: 972–3–640–9908. e–mail: foerder@ccsg.tau.ac.il

7–95 (Foerder)	Pierfederico Asdrubali, Bent E. Sorensen & Oved Yosha	Channels of Interstate Risksharing: US 1963–1990
8–95 (Foerder)	Yoram Weiss	Growth and Labor Mobility
9–95 (Sackler)	Rebecca Henderson Adam B.Jaffe Manuel Trajtenberg	Universities as a Source of Commercial Technology: A Detailed Analysis of University Patenting 1965–1988
10–95 (Foerder)	Daniel M.G.Raff Manuel Trajtenberg	Quality–Adjusted Prices for the American Automobile Industry: 1906–1940
11–95 (Foerder)	Jean–Marie Viaene Itzhak Zilcha	Multiple Uncertainty, Forward–Futures Markets and International Trade
12–95 (Sackler)	M June Flanders	Plus Ca Change...Plus c'est (Presque) La Meme Chose – A Review of Barry Eichengreen's *Golden Fetters*
13–95 (Foerder)	Aba Schwartz	The Interrelation of the Time Series of Wage and Employment at the Firm Level, Common Features and Contrasts
14–95 (Foerder)	Elhanan Helpman	The Size of Regions
15–95 (Sackler)	Assaf Razin Efraim Sadka	Public Debt in Israel: Policy Lessons
16–95 (Foerder)	Ami Navon, Oz Shy & Jacques–Francois Thisse	Product Differentiation in the Presence of Snob and Bandwagon Effects
17–95 (Foerder)	Arthur Fishman	Imperfectly Informative Equilibria for Signalling Games
18–95 (Sackler)	Arthur Fishman	Search with Learning and Price Adjustment Dynamics
19–95 (Foerder)	Arthur Fishman	A Theory of Price Inertia
20–95 (Foerder)	David M.Frankel	A Pecuniary Reason for Income Mixing
21–95 (Sackler)	Ran Spiegler	Coordination and Matchmakers

22–95 (Foerder)	David M. Frankel	A Simple Model of Creative Bargaining
23–95 (Foerder)	Ariel Rubinstein Amos Tversky and Dana Heller	Naive Strategies in Competitive Games
24–95 (Sackler)	Zvi Eckstein Kenneth I.Wolpin	Estimating the Effect of Labor Market Discrimination on Black–White Differences in Wage Offers Using a Search–Matching–Bargaining Model
25–95 (Foerder)	Michael Kahneman	A Model of Bargaining Between Delegates
26–95 (Foerder)	Roberto Serrano & Oved Yosha	Decentralized Information and the Walrasian Outcome: A Pairwise Meetings Market with Private Values
27–95 (Sackler)	S.Rao Aiyagari Toni Braun and Zvi Eckstein	Transaction Services, Inflation and Welfare
28–95 (Foerder)	Benjamin Bental Zvi Eckstein	A Neoclassical Interpretation of Inflation and Stabilization in Israel
29–95 (Foerder)	Eran Yashiv	The Determinants of Equilibrium Unemployment: Structural Estimation and Simuluation of the Search and Matching Model
30–95 (Sackler)	Elhanan Helpman	Politics and Trade Policy
31–95 (Foerder)	Gene M.Grossman Elhanan Helpman	Rent Dissipation, Free Riding, and Trade Policy
32–95 (Foerder)	Chaim Fershtman Yoram Weiss	Social Rewards, Externalities and Stable Preferences
33–95 (Sackler)	Yoram Weiss Robert J.Willis	Match Quality, New Information and Marital Dissolution
34–95 (Foerder)	Yoram Weiss Menachem Gotlibovski	Immigration, Search and Loss of Skill
35–95 (Foerder)	Dan Ben–David	Trade and Convergence Among Countries