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LONG AND SHORT RUN RELATIONSHIPS BETWEEN INDUSTRIAL AND DEVELOPING COUNTRIES

BY

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Has been accepted in partial fulfillment of the requirements for the Degree of

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Economics

MENTOR

READER

READER

to my Parents,

Robert and Marcella,

my Sister,

Helen

(and Dave, too)

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Introduction

The purpose of this study is to use empirical methods to search for macroeconomic connections between industrial and developing countries, in particular to find channels through which economic events in industrial countries influence the economies of developing countries. Macroeconomic connections between industrial and developing countries are discussed routinely in the financial press, typically in a textbook Keynesian framework.[1] For example, economic strength in the United States during the late 1990s is thought to have raised demand for the exports of many of the United States' trading partners, even possibly helping to mitigate the effects of the East Asian Financial Crisis. Alternatively, weakness in eastern Asia during the crisis is thought to have reduced demand for commodities and helped the United States to avert inflation despite a rapidly growing economy and an historically low unemployment rate.

Cross-country correlations of output innovations and growth rates between industrial and developing countries are examined to see if there is evidence of a world business cycle across many nations. Several papers, such as Backus, Kehoe, and Kydland (1995) and Stockman and Tesar (1995) report positive and fairly substantial business cycle correlations among the major industrial countries. In fact, an important strand of the international real business cycle literature is devoted to explaining why output correlations are stronger than consumption correlations, while standard two-country business cycle models with no restrictions on trade imply the reverse. Incorporating into the models non-traded goods (Stockman and Tesar, 1995), restrictions on asset trade (Baxter and Crucini, 1995), or transactions costs (Obstfeld and Rogoff, 2000) reduce cross-country capital flows in response to supply shocks and raise the cross-country output

[1]See, for example, The Economist, July 1, 2000, pages 69-70.

correlations, while also preventing agents from completely insuring their country-specific risks, thereby reducing the cross-country consumption correlations.

The evidence on cross-country output correlations between industrial and developing is not as clear. Chyi (1998) computes cross-country correlations for a small set of industrial and developing countries, finding no consistent pattern. This study expands on Chyi's work by using a much larger set of developing countries and considering correlations between Hodrick-Prescott filtered innovations and also growth rates. The results support Chyi's findings as the correlation analysis does not detect a consistent business cycle relationship between industrial and developing countries. Even if only pairs of close industrial-developing country trading partners are considered, average correlations are still very small compared to the average correlations found among the industrial countries themselves.

While evidence of short run relationships between industrial and developing countries is not established by the correlation analysis, this does not rule out the possibility of a long run relationship. Temple (1999), for example, demonstrates that the ratio of RGDP per capita between the United States and a number of developing countries has been stable for many years, indicating that the economies of the United States and some developing countries have grown at the same pace. Cointegration analysis is used to test for the existence of a long run relationship between the RGDPs per capita of industrial and developing countries. Finding evidence of cointegration means that while the time series may fluctuate separately in the short run, they do not drift apart in the long run. In other words, the time series are driven by the same stochastic trend over the long run. Johansen's (1988) cointegration method is used to test if there are long run relationships between the RGDPs per capita of industrial and developing country trading

partners. Neusser (1991) employs a similar methodology to look for cointegration between six industrial countries, finding little supportive evidence. The evidence in this paper is somewhat stronger, finding cointegration between a significant number of trading partner pairs, although such a relationship is far from universal, in particular when the industrial country in question is the United States.

In cases where cointegration is present, Johansen's method can also be used to test for weak exogeneity to determine which country adjusts to shocks that disrupt the equilibrium relationship. The results of the weak exogeneity tests are mixed. In some cases, only the developing country appears to adjust to shocks, which indicates that developing countries are subject to shocks in industrial countries, but not the reverse. However, in other cases both the industrial and the developing countries adjust to shocks, which may indicate that global shocks cause short run fluctuations and that both countries experience an adjustment process to reestablish the long run equilibrium relationship.

The final section of the paper is devoted to identifying channels through which economic events in industrial countries may influence the economies of developing countries. The motivation for the empirical work comes mainly from a model developed by Basu and McLeod (1992a) that links international real interest rates and the terms of trade to economic growth in small open economies. International real interest rates are expected to have a negative effect on growth in developing countries because higher rates mean higher debt service payments and thus discourage investment. The terms of trade is expected to have a positive effect on growth because and improvement in the terms of trade raises export revenues and allows the economy to purchase more capital goods.

Panel regressions are used to show that international real interest rates have a negative influence, as implied by the model, on growth in developing countries. The significance of the international real interest rate holds up under two specifications of the variable, and in sub-panels varying by region, income level, debt level, and export type. The evidence for the terms of trade is not nearly as strong. The terms of trade has a positive and significant effect on growth only in the sub-panels of Asian countries and diverse exporters, or in the full panel of 35 developing countries if it is the only explanatory variable. This is surprising given the extensive use of the terms of trade in the literature on growth in developing countries. (See Basu and McLeod, 1992b; and Mendoza, 1997)

Export demand from the industrial countries, as proxied by the growth rate of RGDP in the G-7 countries, is also shown to have a positive and significant effect on economic growth in the developing countries, under most model specifications. Openness also appears to have a positive influence on growth in developing countries, although its significance is not robust across model specifications.

Lastly, the capital income tax rate in the United States is shown to have a positive and significant effect on growth in developing countries, although the size of the coefficient is rather small. This is further evidence of the importance of the interest rate channel, since higher capital taxes in the U.S. mean lower after tax returns, which may push capital to seek higher returns in the developing countries.

Cross-Country Correlation Analysis

The international real business cycles literature demonstrate that output innovations are positively correlated across industrial countries. See, for example, Backus and Kehoe (1992) and Stockman and Tesar (1995). Chyi (1998) extends this analysis to look for correlation of output innovations between industrial and developing countries, with very mixed results. Some pairs of industrial and developing countries exhibit positive correlation, while other country pairs exhibit negative correlation. On average, the correlation of output innovations between industrial and developing country pairs is close to zero. Chyi's paper, however, uses data from just seven developing countries, which raises the question of whether the results will hold for a larger sample.

Correlations of Output Innovations

Tables 1 through 5 below report correlations of innovations to the log of RGDP per capita between the G-7 industrial countries and 37 developing countries.[2] Innovations were calculated using the Hodrick-Prescott filter[3], which computes a smoothed trend line through the data. (Hodrick and Prescott, 1980) The trend line is then subtracted from the actual data to calculate the innovations. Chyi's (1998) results are largely confirmed, with an average correlation between industrial and developing countries of just 0.050 for the African countries, 0.016 for the Asian countries, and 0.131 for both the North/Central American and South American countries. In contrast, the average correlation among the G-7 industrial countries is 0.366. All of the industrial country pairs have positive correlation of output innovations, while a

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[2]Data are described in the data appendix.

[3]The smoothing parameter was set at 400, as is common with annual data.

number of developing countries are, on average, negatively correlated with the industrial countries. For example, Indonesia, Senegal, Sri Lanka, and Tunisia all have average correlation of less than -0.2 with the industrial countries. Yet several developing countries exhibit rather strong correlation with the industrial countries. Chile, Costa Rica, Korea, and Tanzania all have average correlation of greater than 0.3 with the industrial countries.

Close Trading Partners

Perhaps the diversity of the results is due to the fact that many of the country pairs studied are not important trading partners. Without trade, it is less likely that shocks will be transmitted across borders, and therefore it is less likely that business cycles will be synchronized across countries.[4] The bold-faced correlation coefficients in tables 1 through 4 indicate the G-7 countries that were judged to be close trading partners with each individual developing country. Data from the United Nation's International Trade Statistics Yearbook (various issues) was used to make these judgements, with the standard being at least 10% of the developing country's imports coming from, or 10% of exports going to, the G-7 country. Regional averages are actually slightly less when only close trading partners are considered. The African average falls to 0.034, the Asian average to -0.020, the North/Central American average to 0.096, and the South American average to 0.119.

Correlations of Output Growth Rates

Tables 6 through 10 below report cross country correlations of output growth rates, rather than output innovations. Similar results are found, with average correlation being quite low and

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[4]Shocks could be transmitted via foreign direct investments or portfolio investments as well.

much diversity among the countries. In general, the developing countries that exhibit positive (negative) correlation of innovations also exhibit positive (negative) correlation of growth rates. As with the correlations of innovations, close trading partners exhibit slightly lower correlation of growth rates on average than the regional group as a whole.

Correlations are calculated using both Hodrick-Prescott filtered innovations and growth rates because the appropriate detrending method is depends on the time series properties of the variables. If RGDP per capita is a trend stationary process, then innovations are the proper measure of business cycle fluctuations. If RGDP per capita is a difference stationary process, then growth rates are the proper measure. Since the evidence regarding the time series properties of RGDP per capita is not conclusive, it is safest to report correlations using both measures.

Rationale for Diverse Results

The diversity of the results of the correlation analysis between industrial and developing countries is somewhat surprising given that the international real business cycle literature finds that common shocks are the most important factor in explaining the business cycle correlation found among industrial countries. For example, Canova and Marrinan (1998) find that cross-country output dynamics in the short run are almost entirely dominated by common shocks rather than the transmission of shocks across borders. Canova and Dellas (1993) find that trade is of moderate significance in the transmission of shocks across countries and that the significance of trade as a channel of transmission is not robust to the choice of detrending method.

If common shocks are the primary cause of positive business cycle correlations across industrial countries, why are many developing countries absent from this global business cycle? Perhaps this should not be surprising, given the diversity of the developing countries, especially

relative to the homogeneity of the G-7 economies. For example, some developing countries rely heavily on the export of a handful of primary goods. Terms of trade fluctuations will likely be experienced differently in these countries than in industrial countries or developing countries with more diversified economies. Developing countries also differ greatly in their fiscal policies as evidenced by debt levels. Countries with heavy debt levels leave themselves exposed to shocks in the international capital markets and will likely experience a different pattern of business cycle fluctuations than those countries that employ a more conservative debt policy. All in all, the mitigating factors that can cause fluctuations to differ among the developing countries may be enough that simple correlations are not sufficient to capture the short run relationships between industrial and developing countries.

Correlation analysis is, of course, only one empirical method of searching for relationships between industrial and developing countries, and the previous analysis only addresses short run connections. Temple (1999) argues that RGDP per capita in many large developing countries has maintained its position relative to that of the United States over the years 1960 to 1990, indicating perhaps that a long run growth relationship exists between industrial and developing countries. Chapter 3 uses cointegration analysis to search for such a long run relationship.

Table 1: Correlation of Output Innovations - Africa

	Canada	France	Germany	Italy	Japan	U.K.	U.S.A.	Average
Cameroon	0.127	**-0.381**	-0.371	0.075	-0.185	-0.072	0.048	-0.108
Ivory Coast	0.429	**0.230**	0.321	0.013	-0.187	0.273	0.273	0.193
Kenya	0.467	0.357	**0.171**	-0.018	**-0.031**	**0.282**	0.316	0.221
Morocco	-0.011	**0.128**	-0.191	0.364	0.194	0.012	0.100	0.085
Senegal	-0.200	**-0.283**	-0.275	-0.268	-0.244	-0.187	-0.208	-0.238
South Africa	0.369	0.450	**-0.131**	0.162	**0.369**	**0.099**	**0.181**	0.214
Tanzania	0.713	0.396	**0.281**	0.140	0.112	**0.656**	0.531	0.404
Tunisia	-0.007	**-0.138**	**0.087**	**-0.228**	-0.451	-0.316	-0.438	-0.213
Zimbabwe	0.006	0.153	**-0.031**	-0.214	-0.049	**-0.265**	**-0.344**	-0.106
Column Average	0.210	0.101	-0.015	0.003	-0.052	0.054	0.051	0.050

Trading Partner Average = 0.034

Table 2: Correlation of Output Innovations - Asia

	Canada	France	Germany	Italy	Japan	U.K.	U.S.A.	Average
Bangladesh	-0.262	-0.139	-0.109	0.178	0.059	-0.212	**-0.031**	-0.074
Hong Kong	0.244	0.304	0.308	0.202	**0.097**	0.253	**0.481**	0.270
India	-0.248	-0.159	0.291	0.077	-0.074	0.135	**-0.343**	-0.046
Indonesia	-0.222	-0.397	-0.166	-0.147	**-0.493**	-0.467	**-0.603**	-0.356
Korea	0.523	0.585	0.264	0.050	**0.227**	0.400	**0.373**	0.346
Malaysia	-0.223	0.189	0.198	0.174	**0.009**	-0.383	**-0.208**	-0.035
Pakistan	0.104	0.205	-0.362	0.215	**0.450**	0.127	**0.459**	0.171
Philippines	-0.091	0.096	0.316	0.223	**-0.238**	-0.147	**-0.243**	-0.012
Singapore	0.055	0.257	0.226	0.129	**0.020**	0.001	**-0.298**	0.056
Sri Lanka	-0.354	-0.501	-0.093	-0.092	-0.385	**-0.379**	**-0.301**	-0.301
Thailand	-0.146	0.482	-0.206	0.344	**0.478**	0.033	**0.149**	0.162
Column Average	-0.056	0.084	0.061	0.123	0.014	-0.058	-0.051	0.016

Trading Partner Average = -0.020

Table 3: Correlation of Output Innovations - North/Cental America

	Canada	France	Germany	Italy	Japan	U.K.	U.S.A.	Average
Costa Rica	0.430	0.306	0.502	0.206	0.011	0.333	**0.391**	0.311
Dom. Republic	0.271	0.296	0.033	0.167	-0.115	0.052	**-0.073**	0.090
El Salvador	0.468	0.293	**0.187**	0.026	-0.025	0.322	**0.498**	0.253
Guatemala	0.098	0.393	0.206	0.230	-0.039	0.139	**-0.018**	0.144
Honduras	0.463	0.358	0.188	0.127	-0.029	0.099	**0.396**	0.229
Mexico	0.006	0.270	0.109	0.140	0.048	-0.387	**-0.075**	0.016
Panama	-0.224	-0.014	**-0.311**	0.032	0.266	-0.504	**-0.131**	-0.127
Column Average	0.216	0.272	0.131	0.133	0.017	0.008	0.141	0.131

Trading Partner Average = 0.096

Table 4: Correlation of Output Innovations - South America

	Canada	France	Germany	Italy	Japan	U.K.	U.S.A.	Average
Argentina	0.303	0.283	0.156	0.143	0.090	0.126	**0.117**	0.174
Bolivia	0.269	0.585	-0.111	0.321	0.451	**-0.058**	**0.377**	0.262
Brazil	0.310	0.161	0.317	0.164	-0.210	0.218	**-0.113**	0.121
Chile	0.059	0.467	**0.230**	0.556	**0.516**	0.094	**0.351**	0.325
Colombia	0.379	0.315	**0.448**	0.266	0.072	0.310	**0.242**	0.290
Ecuador	0.207	-0.052	0.004	-0.025	-0.378	-0.143	**-0.006**	-0.056
Paraguay	-0.087	-0.011	**0.025**	0.138	**-0.255**	-0.476	**-0.204**	-0.124
Peru	0.295	0.047	**-0.244**	0.116	0.010	0.140	**0.105**	0.067
Uruguay	0.162	0.229	**0.457**	0.299	-0.058	0.032	**0.026**	0.164
Venezuela	0.141	0.184	0.391	-0.092	-0.131	-0.036	**0.136**	0.085
Column Average	0.204	0.221	0.167	0.189	0.011	0.021	0.103	0.131

Trading Partner Average = 0.119

Table 5: Correlation of Output Innovations - G-7 Countries

	Canada	France	Germany	Italy	Japan	U.K.
France	0.468					
Germany	0.067	0.205				
Italy	0.107	0.524	0.238			
Japan	0.143	0.699	0.008	0.568		
U.K.	0.589	0.435	0.276	0.283	0.292	
U.S.A.	0.748	0.521	0.102	0.285	0.478	0.646
G-7 Average	0.366					

Table 6: Correlation of Output Growth Rates - Africa

	Canada	France	Germany	Italy	Japan	U.K.	U.S.A.	Average
Cameroon	0.378	**0.113**	-0.034	0.381	0.011	0.008	0.148	0.144
Ivory Coast	0.380	**0.413**	0.331	0.112	0.351	0.377	0.329	0.328
Kenya	0.137	0.146	**-0.033**	-0.064	**-0.107**	**0.117**	0.202	0.057
Morocco	-0.091	**0.112**	-0.029	0.210	0.206	-0.014	-0.157	0.034
Senegal	-0.206	**-0.115**	-0.111	-0.130	0.008	-0.002	-0.269	-0.118
South Africa	0.219	0.371	**0.055**	0.388	**0.243**	**0.033**	**0.069**	0.197
Tanzania	0.326	0.293	**0.121**	0.067	0.061	**0.303**	0.297	0.210
Tunisia	0.087	**-0.118**	**0.061**	**-0.163**	-0.016	-0.191	-0.087	-0.061
Zimbabwe	-0.099	0.079	**-0.072**	-0.095	-0.060	**-0.246**	**-0.369**	-0.123
Column Average	0.126	0.144	0.032	0.078	0.077	0.043	0.018	0.074
Trading Partner Average =		0.022						

Table 7: Correlation of Output Growth Rates - Asia

	Canada	France	Germany	Italy	Japan	U.K.	U.S.A.	Average
Bangladesh	-0.259	-0.066	-0.123	0.169	-0.121	-0.261	**-0.321**	-0.140
Hong Kong	0.379	0.364	0.371	0.254	**0.152**	0.279	**0.530**	0.333
India	-0.249	-0.134	-0.028	-0.071	0.055	0.125	**-0.261**	-0.080
Indonesia	-0.097	-0.328	-0.072	-0.173	**-0.244**	-0.238	**-0.247**	-0.200
Korea	-0.249	-0.134	-0.028	-0.071	**0.055**	0.125	**-0.261**	-0.080
Malaysia	-0.039	0.188	0.214	0.295	**0.077**	-0.043	**0.060**	0.107
Pakistan	0.052	0.138	-0.044	0.176	**0.069**	0.186	**0.135**	0.102
Philippines	-0.005	0.343	0.260	0.357	**0.127**	0.111	**-0.090**	0.158
Singapore	0.158	0.140	0.027	0.100	**0.111**	0.070	**0.046**	0.093
Sri Lanka	-0.102	-0.090	-0.010	0.026	-0.298	**-0.139**	**0.035**	-0.083
Thailand	-0.136	0.112	-0.147	-0.041	**0.099**	0.155	**-0.032**	0.001
Column Average	-0.050	0.048	0.038	0.093	0.007	0.034	-0.037	0.019
Trading Partner Average =		-0.005						

Table 8: Correlation of Output Growth Rates - North/Central America

	Canada	France	Germany	Italy	Japan	U.K.	U.S.A.	Average
Costa Rica	0.314	0.180	0.439	0.353	0.148	0.221	**0.390**	0.292
Dom. Republic	0.225	0.387	-0.006	0.298	0.101	0.009	**0.060**	0.153
El Salvador	0.397	0.315	**0.298**	0.134	0.148	0.243	**0.467**	0.286
Guatemala	0.237	0.395	0.110	0.315	0.190	0.001	**0.147**	0.199
Honduras	0.539	0.382	0.195	0.206	0.235	0.245	**0.522**	0.332
Mexico	0.137	0.231	0.124	0.143	0.242	-0.175	**0.058**	0.109
Panama	-0.135	0.037	**-0.082**	0.036	0.131	-0.434	**-0.214**	-0.094
Column Average	0.245	0.275	0.154	0.212	0.171	0.016	0.204	0.182
Trading Partner Average =		0.183						

Table 9: Correlation of Output Growth Rates - South America

	Canada	France	Germany	Italy	Japan	U.K.	U.S.A.	Average
Argentina	0.069	0.247	0.264	0.241	0.171	0.112	**0.046**	0.164
Bolivia	0.245	0.317	0.174	0.240	0.309	**0.021**	**0.330**	0.234
Brazil	0.157	0.326	0.264	0.379	0.182	0.167	**-0.018**	0.208
Chile	0.235	0.196	**0.144**	0.335	**0.163**	-0.007	**0.330**	0.199
Colombia	0.232	0.216	**0.252**	0.171	0.132	0.297	**0.214**	0.216
Ecuador	0.115	0.177	-0.014	0.149	0.014	0.012	**0.033**	0.069
Paraguay	0.023	-0.041	**-0.113**	0.096	**-0.103**	-0.359	**-0.056**	-0.079
Peru	0.089	0.289	**0.113**	0.307	0.219	-0.051	**-0.036**	0.133
Uruguay	-0.004	0.118	**0.123**	0.203	0.063	0.061	**0.066**	0.090
Venezuela	0.065	0.257	0.351	0.065	0.160	0.017	**0.154**	0.153
Column Average	0.123	0.210	0.156	0.219	0.131	0.027	0.106	0.139
Trading Partner Average =		0.092						

Table 10: Correlation of Output Growth Rates - G-7 Countries

	Canada	France	Germany	Italy	Japan	U.K.
France	0.396					
Germany	0.217	0.524				
Italy	0.226	0.641	0.493			
Japan	0.140	0.674	0.510	0.585		
U.K.	0.333	0.394	0.375	0.343	0.361	
U.S.A.	0.747	0.361	0.394	0.321	0.298	0.551
G-7 Average	0.423					

Cross-Country Cointegration Analysis

The existence of long run relationships between industrial and developing countries can be tested using Johansen's (1988) cointegration technique. Cointegration means that while time series may be individually integrated of order *n*, I(n), there exists a linear combination of the time series that is integrated of order *n-1*, I(n-1). Intuitively, the time series do not drift apart over the long run, although they may fluctuate independently in the short run. For example, if the RGDPs per capita of two countries are individually I(1) but there exists a linear combination of the two series that is stationary, i.e. I(0), then the RGDPs per capita of the two countries are cointegrated. A long run equilibrium relationship between the time series exists and an error correction process restores the equilibrium following a shock. The advantage of using Johansen's cointegration technique rather than other methods of cointegration analysis is that Johansen's method allows both long run and short run relationships to be tested using the same statistical model. This is important because endogenous growth theory requires that growth and fluctuations be treated in the same framework. For example, if time series are shown to be cointegrated, an individual series can then be tested for weak exogeneity. That is, when a shock disrupts the long run equilibrium, how do the series adjust to restore the equilibrium? If a particular series does not adjust to restore the equilibrium, it is considered weakly exogenous, and the other series in the cointegrating relationship must therefore adjust to reestablish the equilibrium.

Cointegration among Industrial Countries

Neusser (1991) uses Johansen's technique to test whether the log of RGDP per capita is cointegrated across industrial countries. The paper explains that the log of RGDP per capita will

be cointegrated across countries under the following conditions: (1) a single common growth component to technology, (2) production and trade of a single good, and (3) complete markets. Multi-country business cycle models often utilize such a framework, but most examine just the short run implications while the long run implications are ignored.[5] Neusser rejects the hypothesis that a single common factor has driven the outputs per capita of six industrial countries, and fails to find cointegration between two pairs of similar countries, Canada and the United States, and Austria and Germany.

Gambera (2000) also fails to find cointegration between the RGDP per capita of large industrial country pairs, and also in panels of industrial countries. However, there is evidence of cointegration between consumption per capita of industrial country pairs and in panels of industrial countries. Gambera claims that this demonstrates international risk sharing. Consumption is cointegrated not because output is driven by a common factor, but instead because people diversify away their country specific risks over the long run.

Technological Progress in Developing Countries

This study extends Neusser's analysis to use Johansen's method to look for cointegration between industrial and developing countries. Industrial and developing countries may share a common long run growth factor because technological progress in developing countries is not exogenous to events in industrial countries. Coe, Helpman, and Hoffmaister (1997) show that total factor productivity in developing countries is positively and significantly related to trade with research-producing industrial countries. Trade with industrial countries propagates the

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[5]See, for example, Backus, Kehoe and Kydland (1995).

benefits of research and development to developing countries through a number of channels.[6] Trade allows a country to use a larger variety of intermediate products and capital equipment, which enhances the productivity of the country's own resources. Trade opens channels of communication that stimulate cross-border learning of production methods, product design, and market conditions. Trade also enables a country to copy foreign technologies and speed its progress toward the technological frontier.

Statistical Model

The presence of long run relationships between industrial and developing countries is tested in two ways. First, developing countries are paired with important trading partners from among the industrial countries. For example, Costa Rica is paired with its closest trading partner from among the G-7 industrial countries, the United States. Second, regional groups of developing countries are tested for cointegration with a common important industrial country trading partner. For example, France and five African countries are grouped together in one test of cointegration. Grouping countries allows one to determine how many common growth factors drive output per capita over the long run in the group.

The statistical model is as follows:

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + \Pi Z^*_{t-1} + \mu_2 + \varepsilon_t$$

where Z_t is a vector of the logs of the per capita outputs of the countries in question and ε_t is white noise error. Z_t must contain at least two variables that are integrated of order one [I(1)].

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[6]The following is taken from Coe, Helpman, and Hoffmaister (1997).

Π and Z^*_{t-1} are defined as follows:

$$\Pi = \alpha \begin{bmatrix} \beta \\ \mu_1 \\ \delta \end{bmatrix}' , \quad Z^*_{t-1} = \begin{pmatrix} Z'_{t-1} \\ 1 \\ t \end{pmatrix}$$ where β is the matrix of long run coefficients and

α is a matrix of coefficients that measures the average speed of adjustment towards the long run equilibrium. μ_1 is the intercept in the long run model, which accounts for the units of measurement of the variables in Z_t, μ_2 is the intercept in the short run model, which accounts for linear trend in the levels of the data, and δ allows the long run model to contain time (t) as a trend stationary variable, to account for exogenous growth of technological progress.

Searching for cointegration involves testing the rank of the Π matrix. If the rank of Π is zero, then there are no linear combinations of the variables in Z_t that are stationary and thus there is no long run relationship among the variables in Z_t. If Π is of full rank, then the variables in Z_t are individually I(0) and cointegration analysis is not an appropriate method of searching for relationships among the variables in Z_t. In the case of country pairs, if one

cointegrating vector is found, then there exists a long run relationship between the two countries. In the case of m countries, finding $m-1$ cointegrating vectors indicates that there is one common trend driving the variables in the system. In general, if r cointegrating vectors are found, then there are $m-r$ linear trends or common random walks in the system.[7]

Two tests of the rank of Π are employed, the maximum eigenvalue test and the trace test.[8] The null hypothesis of the maximum eigenvalue test is of r cointegrating vectors which is tested against the alternative hypothesis of $r+1$ cointegrating vectors. The null hypothesis of the trace test is of r cointegrating vectors which is tested against the alternative hypothesis of more than r cointegrating vectors. If the tests differ in the number of cointegrating vectors chosen, Johansen and Juselius (1990) explain that the maximum eigenvalue test has "more clear cut results" because it excludes information on vectors that have been found to be not significantly different than zero.

Weak Exogeneity

If cointegrating vector(s) are found, a test for weak exogeneity can then be performed. This is a test of the significance of the elements of the α matrix. If an element is found to be statistically not different from zero, then the variable to which it is attached is weakly exogenous: it does not adjust to a shock that disturbs the long run equilibrium. If cointegration tests show that there is a long run linkage between outputs per capita in industrial and developing countries, then weak exogeneity tests reveal the short run adjustment process; namely, which country

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[7]See Greene (2000, page 793.)

[8]See Hansen and Juselius (1995) for details on the calculation of these two statistics.

adjusts to reestablish the equilibrium relationship, the industrial country, the developing country, or both.

Since the economies of the G-7 industrial countries are so much larger than the economies of the developing countries, it is possible that developing countries will bear the entire burden of adjustment, as shocks to developing countries would have little impact on the industrial countries. However, if global shocks are the cause of global business cycles, as found by Canova and Dellas (1993) and Canova and Marrinan (1997), then perhaps both industrial and developing countries will adjust, as both would be subject to global shocks.

Prior to testing for cointegration, it is important to establish that the time series are indeed nonstationary. This is accomplished with a likelihood ratio test based on the same statistical model that is used to test for cointegration. The null hypothesis of the test is that the time series are stationary. Table 11 reports the likelihood ratio statistics for pairs of close trading partners. An * indicates that the test rejects the null of stationarity at the 5% level. Only those pairs of countries in which both countries are found to be nonstationary are then tested for cointegration.

Results: Country Pairs

Tables 12 through 16 present the results of the cointegration tests of pairs of close trading partners.[9] Of the 47 pairs of close trading partners tested, 13 (28% of the total) are found to be cointegrated at the 95% significance level. The United States is cointegrated with just 4 of 29 (14%) of its developing country trading partners, including 3 of 6 in east Asia (Hong Kong, Indonesia, and Singapore), and 1 of 17 in the western hemisphere (Costa Rica). For the other industrial countries, the results are somewhat stronger. Japan is cointegrated with 5 of 8 of its

[9]The CATS in RATS program is used to estimate the cointegrating vectors.

close developing country trading partners (Hong Kong, Indonesia, Kenya, Thailand, and South Africa), the United Kingdom is cointegrated with 2 of 6 trading partners (Kenya and Sri Lanka). Germany is cointegrated with 1 of 3 trading partners (Tunisia), and Italy is cointegrated with Tunisia as well. If the United States is excluded from the analysis, the industrial countries are cointegrated with developing country trading partners in 9 of 18 cases.

A possible explanation for the scarcity of long run relationships between the United States and developing countries is that the United States may have been in steady-state growth for the entire time period under consideration while this is a less realistic assumption for the developing countries.[10] It is also doubtful that Germany, Italy, Japan, and the United Kingdom experienced steady-state growth for the entire time period under consideration since all faced tremendous reconstruction after World War II.

Tables 12 through 16 also report the results of weak exogeneity tests of those country pairs that were found to be cointegrated. The probability value of a likelihood ratio test with the null hypothesis of weak exogeneity is reported in the tables for both the G-7 country and the developing country. For example, the probability values of the pair of Italy and Tunisia are reported in Table 12. Italy's probability value of 0.35 means that the null hypothesis of weak exogeneity is not rejected, while Tunisia's probability value of 0.00 means that the null of weak exogeneity is rejected. Thus, Tunisia alone adjusts to shocks that disturb the long run equilibrium relationship between the two countries.

Neither country is found to be weakly exogenous in 5 of the 13 cases, and the industrial country alone is found to be weakly exogenous in 6 cases. Adjustment in both countries may be

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[10]Neusser (1991) offers a similar explanation.

evidence of global shocks, as both countries would experience fluctuations in response to a global shock. Alternatively, adjustment in the developing country alone is evidence that the developing country is subject to shocks to its industrial country trading partner, while the industrial country is not subject to shocks to the developing country. However, both Kenya and Sri Lanka are found to be weakly exogenous in their relationships with the United Kingdom, indicating that the United Kingdom alone adjusts to reestablish these long run relationships.

Table 11: Likelihood Ratio Test for Stationarity - Country Pairs

5% Critical Value = 5.99

France	1.09	Cameroon	5.80
France	1.60	Ivory Coast	9.91 *
France	4.71	Morocco	3.98
France	3.98	Senegal	3.29
France	6.10 *	Tunisia	5.12
Germany	4.10	Chile	12.81 *
Germany	5.94	Colombia	11.06 *
Germany	4.36	El Salvador	3.85
Germany	4.69 *	Kenya	8.18
Germany	1.61	Panama	2.71
Germany	6.24 *	Paraguay	11.62 *
Germany	4.49	Peru	14.03 *
Germany	1.69	South Africa	5.79
Germany	10.72 *	Tanzania	8.97 *
Germany	24.88 *	Tunisia	24.60 *
Germany	3.47	Uruguay	13.59 *
Germany	3.03	Zimbabwe	3.29
Italy	15.58 *	Tunisia	14.85 *
Japan	12.44 *	Chile	15.05 *
Japan	12.52 *	Hong Kong	10.50 *
Japan	13.98 *	Indonesia	10.51 *
Japan	23.82 *	Kenya	13.70 *
Japan	2.33	Korea	5.61
Japan	4.35	Malaysia	5.62
Japan	10.69 *	Pakistan	13.10 *
Japan	5.23	Paraguay	2.21
Japan	7.64 *	Philippines	4.91
Japan	17.13 *	Singapore	16.48 *
Japan	17.23 *	South Africa	16.59 *
Japan	7.49 *	Thailand	9.74 *

Table 11 Continued: Likelihood Ratio Test for Stationarity - Country Pairs

5% Critical Value = 5.99

United Kingdom	14.55 *	Bolivia	14.88 *
United Kingdom	16.63 *	Kenya	16.00 *
United Kingdom	9.14 *	South Africa	10.95 *
United Kingdom	23.28 *	Sri Lanka	11.51 *
United Kingdom	9.13 *	Tanzania	6.92 *
United Kingdom	10.95 *	Zimbabwe	8.98 *
United States	7.83 *	Argentina	7.68 *
United States	12.23 *	Bangladesh	9.50 *
United States	11.82 *	Bolivia	11.48 *
United States	12.27 *	Brazil	11.42 *
United States	6.93 *	Chile	6.67 *
United States	13.32 *	Colombia	13.18 *
United States	16.98 *	Costa Rica	12.90 *
United States	7.48 *	Dominican Republic	6.79 *
United States	8.14 *	Ecuador	7.44 *
United States	8.34 *	El Salvador	3.65
United States	7.99 *	Guatemala	6.63 *
United States	7.70 *	Honduras	6.58 *
United States	14.65 *	Hong Kong	13.26 *
United States	14.88 *	India	14.57 *
United States	33.04 *	Indonesia	28.61 *
United States	4.85	Korea	7.64 *
United States	8.36 *	Malaysia	9.13 *
United States	9.12 *	Mexico	8.87 *
United States	8.78 *	Pakistan	9.29 *
United States	9.57 *	Panama	8.89 *
United States	9.32 *	Paraguay	8.80 *
United States	11.01 *	Peru	11.24 *
United States	13.66 *	Philippines	10.19 *
United States	18.25 *	Singapore	18.68 *
United States	10.09 *	South Africa	10.96 *
United States	9.42 *	Sri Lanka	11.51 *
United States	13.47 *	Thailand	14.80 *
United States	11.96 *	Uruguay	8.50 *
United States	9.39 *	Venezuela	3.54
United States	14.98 *	Zimbabwe	11.73 *

Table 12: Cointegration Analysis: Germany, Italy, and UK and Developing Countries

Hypotheses		95% Critical Value
Max Eigenvalue Test (L-Max)	Ho: r = 0 against H1: r = 1	18.96
	Ho: r = 1 against H1: r = 2	12.25
Trace Test	Ho: r = 0 against H1: r > 0	25.32
	Ho: r = 1 against H1: r > 1	12.25

				Weak Exogeneity p-value of Likelihood Ratio test	
				Ho: $\alpha = 0$	
	L-Max	Trace	Rank of Pi	G7 Country	Developing Country
Germany					
Paraguay	17.95	22.39	r = 0		
	4.44	4.44			
Tanzania	14.04	20.14	r = 0		
	6.10	6.10			
Tunisia	26.95 *	31.51 *	r = 1	0.01	0.00
	4.56	4.56			
Italy					
Tunisia	20.94 *	27.04 *	r = 1	0.35	0.00
	6.10	6.10			
United Kingdom					
Bolivia	15.56	16.86	r = 0		
	1.30	1.30			
Kenya	17.84	26.46 *	r = 1	0.00	0.93
	8.61	8.61			
South Africa	14.36	19.63	r = 0		
	5.27	5.27			
Sri Lanka	26.36 *	30.92 *	r = 1	0.00	0.06
	4.56	4.56			
Tanzania	12.53	18.18	r = 0		
	5.65	5.65			
Zimbabwe	12.08	15.63	r = 0		
	3.55	3.55			

Table 13: Cointegration Analysis: Japan and Developing Countries

Hypotheses		95% Critical Value
Max Eigenvalue Test (L-Max)	Ho: r = 0 against H1: r = 1	18.96
	Ho: r = 1 against H1: r = 2	12.25
Trace Test	Ho: r = 0 against H1: r > 0	25.32
	Ho: r = 1 against H1: r > 1	12.25

	L-Max	Trace	Rank of Pi	Weak Exogeneity p-value of Likelihood Ratio test Ho: $\alpha = 0$ Japan	Developing Country
Chile	18.79 3.89	22.68 3.89	r = 0		
Hong Kong	17.94 8.26	26.20 * 8.26	r = 1	0.78	0.00
Indonesia	33.68 * 5.78	39.46 * 5.78	r = 1	0.01	0.00
Kenya	28.81 * 4.87	33.68 * 4.87	r = 1	0.00	0.00
Pakistan	17.10 2.69	19.80 2.69	r = 0		
Singapore	25.13 * 17.11 *	42.24 * 17.11 *	r = 2		
South Africa	22.19 * 3.79	25.98 * 3.79	r = 1	0.08	0.00
Thailand	20.80 * 7.33	28.12 * 7.33	r =1	0.55	0.00

Table 14: Cointegration Analysis: United States and Asian Countries

Hypotheses		95% Critical Value
Max Eigenvalue Test (L-Max)	Ho: r = 0 against H1: r = 1	18.96
	Ho: r = 1 against H1: r = 2	12.25
Trace Test	Ho: r = 0 against H1: r > 0	25.32
	Ho: r = 1 against H1: r > 1	12.25

				Weak Exogeneity p-value of Likelihood Ratio test Ho: $\alpha = 0$	
	L-Max	Trace	Rank of Pi	U.S.A.	Developing Country
Bangladesh	12.92 4.91	17.83 4.91	r = 0		
Hong Kong	18.02 8.22	26.24 * 8.22	r = 1	0.08	0.00
India	15.03 3.07	18.10 3.07	r = 0		
Indonesia	33.68 * 5.78	39.46 * 5.78	r = 1	0.01	0.00
Malaysia	9.39 5.66	15.05 5.66	r = 0		
Pakistan	9.35 8.78	18.13 8.78	r = 0		
Philippines	16.73 3.25	19.97 3.25	r = 0		
Singapore	22.91 * 5.33	28.24 * 5.33	r = 1	0.01	0.01
Sri Lanka	12.77 4.12	16.89 4.12	r = 0		
Thailand	17.70 4.81	22.50 4.81	r = 0		

Table 15: Cointegration Analysis: United States and North/Central American and African Countries

Hypotheses		95% Critical Value
Max Eigenvalue Test	Ho: r = 0 against H1: r = 1	18.96
(L-Max)	Ho: r = 1 against H1: r = 2	12.25
Trace Test	Ho: r = 0 against H1: r > 0	25.32
	Ho: r = 1 against H1: r > 1	12.25

				Weak Exogeneity p-value of Likelihood Ratio test	
				Ho: $\alpha = 0$	
	L-Max	Trace	Rank of Pi	U.S.A.	Developing Country
Costa Rica	20.96 *	25.41 *	r = 1	0.07	0.02
	4.46	4.46			
Dominican Republic	8.22	16.88	r = 0		
	2.66	2.66			
El Salvador	10.69	17.19	r = 0		
	6.50	6.50			
Guatemala	8.61	11.41	r = 0		
	2.80	2.80			
Honduras	8.26	12.37	r = 0		
	4.11	4.11			
Mexico	9.71	11.96	r = 0		
	2.24	2.24			
Panama	11.67	14.45	r = 0		
	2.77	2.77			
South Africa	14.29	18.88	r = 0		
	4.59	4.59			
Zimbabwe	15.72	17.80	r = 0		
	2.08	2.08			

Table 16: Cointegration Analysis: United States and South American Countries

Hypotheses		95% Critical Value
Max Eigenvalue Test (L-Max)	Ho: r = 0 against H1: r = 1	18.96
	Ho: r = 1 against H1: r = 2	12.25
Trace Test	Ho: r = 0 against H1: r > 0	25.32
	Ho: r = 1 against H1: r > 1	12.25

	L-Max	Trace	Rank of Pi	Weak Exogeneity p-value of Likelihood Ratio test Ho: $\alpha = 0$ U.S.A.	Developing Country
Argentina	9.85	11.65	r =0		
	1.80	1.80			
Bolivia	12.23	14.42	r =0		
	2.18	2.18			
Brazil	14.32	16.58	r =0		
	2.26	2.26			
Chile	7.56	11.57	r =0		
	4.01	4.01			
Colombia	13.73	19.58	r =0		
	5.85	5.85			
Ecuador	8.97	10.96	r =0		
	1.99	1.99			
Paraguay	9.87	16.50	r =0		
	6.63	6.63			
Peru	15.03	18.75	r =0		
	3.72	3.72			
Uruguay	13.75	20.03	r =0		
	6.28	6.28			
Venezuela	11.15	15.92	r =0		
	4.76	4.76			

Results: Regional Groups

Tables 17 through 25 report results of the cointegration tests between regional groups of developing countries and a common industrial country trading partner. Such a test is used to find the number of common trends in the system. In general, if m-k cointegrating vectors are found, then there are k common trends or random walks in the system, where m is the number of countries. For example, if one trend drives long run growth in all countries, then m-1 cointegrating vectors will be found. Finding a single common trend would be evidence that technological spillovers lead to a common long run growth pattern for close trading partners.

Prior to testing for cointegration, the groups of countries are first tested for stationarity using the same likelihood ratio test used to test for stationary among country pairs. The results of these tests are reported in Table 26 which is located after the cointegration results. Not all countries in the group must be nonstationary to test for cointegration, but at least two must be nonstationary, otherwise the cointegration test is meaningless. For each stationary variable included in the cointegration test, the rank of Π rises by one.

The chosen rank of Π is shown in bold print. A single common trend is found in only one of the nine groupings, that of the United States and seven eastern Asian countries. (Table 17) However, as Table 26 indicates, only the United States, Korea, Singapore are nonstationary at the chosen rank of Π. This means that the outputs per capita of these three countries follow the same common trend, while output per capita is trend stationary in the other four countries. Two common trends are found in three other groups: Japan and the seven eastern Asian countries (Table 17), Germany and five African countries (Table 20), and the United States and ten South

American countries (Table 24). In only one group, that of the United States and four southern Asian countries, is there no cointegration among the countries. (Table 18)

Since only one trend drives growth in the United States and its east Asian trading partners, in this case it is appropriate to test for weak exogeneity. The hypothesis of weak exogeneity is rejected for both the United States and the east Asian developing countries taken as a group, indicating that both sides adjust to reestablish the long run equilibrium relationship.

Table 17: United States and East Asian Trading Partners

Ho: r =	Max. Eigenvalue	Trace	95% Significance Level Max. Eigenvalue	Trace
0	142.86	380.13	55.50	182.82
1	78.57	237.27	49.42	146.76
2	43.66	158.70	43.97	114.90
3	39.71	115.04	37.52	87.31
4	26.16	75.33	31.46	62.99
5	21.65	49.17	25.54	42.44
6	19.56	27.51	18.96	25.32
7	**7.95**	**7.95**	**12.25**	**12.25**

East Asian Countries: r = 7, one common trend

Hong Kong
Indonesia
Korea
Malaysia
Philippines
Singapore
Thailand

Weak Exogeneity
p-value of Likelihood Ratio test

Ho: $\alpha = 0$

U.S.A.	Developing Countries as a Group
0.00	0.00

The U.S.A. and the developing countries adjust to reestablish the equilibrium relationship.

Table 18: Japan and East Asian Trading Partners

Ho: r =	Max. Eigenvalue	Trace	95% Significance Level Max. Eigenvalue	Trace
0	159.94	433.72	55.50	182.82
1	83.99	273.78	49.42	146.76
2	61.06	189.79	43.97	114.90
3	42.49	128.73	37.52	87.31
4	32.80	86.24	31.46	62.99
5	26.50	53.44	25.54	42.44
6	**15.38**	**26.94**	**18.96**	**25.32**
7	11.56	11.56	12.25	12.25

East Asian Countries:
Hong Kong
Indonesia
Korea
Malaysia
Philippines
Singapore
Thailand

r = 6, two common trends

Table 19: United States and South Asian Trading Partners

Ho: r =	Max. Eigenvalue	Trace	95% Significance Level Max. Eigenvalue	Trace
0	**33.23**	**82.27**	**37.52**	**87.31**
1	22.52	49.05	31.46	62.99
2	13.63	26.52	25.54	42.44
3	8.03	12.90	18.96	25.32
4	4.87	4.87	12.25	12.25

South Asian Countries:
Bangladesh
India
Pakistan
Sri Lanka

r = 0, there is no long run relationship

Table 20: France and African Trading Partners

Ho: r =	Max. Eigenvalue	Trace	95% Significance Level Max. Eigenvalue	Trace
0	59.12	182.03	43.97	114.90
1	38.89	122.91	37.52	87.31
2	**30.64**	**84.02**	**31.46**	**62.99**
3	24.59	53.38	25.54	42.44
4	17.76	28.79	18.96	25.32
5	11.02	11.02	12.25	12.25

Although the trace test indicates r = 5, only France and Cameroon are nonstationary with five cointegrating vectors. In contrast, all countries are nonstationary with r = 2, which is suggested by the maximum eigenvalue test.

African Countries:

Cameroon
Ivory Coast
Morocco
Senegal
Tunisia

r = 2, four common trends

Table 21: Germany and African Trading Partners

Ho: r =	Max. Eigenvalue	Trace	95% Significance Level Max. Eigenvalue	Trace
0	81.21	204.25	43.97	114.90
1	46.57	123.04	37.52	87.31
2	31.88	76.48	31.46	62.99
3	25.97	44.60	25.54	42.44
4	**10.93**	**18.64**	**18.96**	**25.32**
5	7.71	7.71	12.25	12.25

African Countries:

Kenya
South Africa
Tanzania
Tunisia
Zimbabwe

r = 4, two common trends

Table 22: United Kingdom and African Trading Partners

Ho: r =	Max. Eigenvalue	Trace	95% Significance Level Max. Eigenvalue	Trace
0	41.91	106.83	37.52	87.31
1	**29.66**	**64.92**	**31.46**	**62.99**
2	19.16	35.27	25.54	42.44
3	10.70	16.10	18.96	25.32
4	5.41	5.41	12.25	12.25

African Countries: r =1 , four common trends

Kenya
South Africa
Tanzania
Tunisia

Table 23: United States and North/Central American Trading Partners

Ho: r =	Max. Eigenvalue	Trace	95% Significance Level Max. Eigenvalue	Trace
0	66.44	264.40	55.50	182.82
1	64.49	197.96	49.42	146.76
2	**40.70**	**133.47**	**43.97**	**114.90**
3	30.59	92.76	37.52	87.31
4	25.93	62.18	31.46	62.99
5	21.04	36.25	25.54	42.44
6	10.45	15.21	18.96	25.32
7	4.76	4.76	12.25	12.25

North/Central American Countries: r = 2, six common trends

Costa Rica
Dominican Republic
El Salvador
Guatemala
Honduras
Mexico
Panama

Table 24: Germany and South American Trading Partners

Ho: r =	Max. Eigenvalue	Trace	95% Significance Level Max. Eigenvalue	Trace
0	52.20	165.94	43.97	114.90
1	40.12	113.43	37.52	87.31
2	**23.63**	**73.31**	**31.46**	**62.99**
3	22.35	49.68	25.54	42.44
4	15.47	27.33	18.96	25.32
5	11.86	11.86	12.25	12.25

South American Countries: r = 2, four common trends

Chile
Colombia
Paraguay
Peru
Uruguay

Table 25: United States and South American Trading Partners

Ho: r =	Max. Eigenvalue	Trace	95% Significance Level Max. Eigenvalue	Trace
0	144.74	634.09	72.72	310.81
1	100.57	489.34	66.23	263.42
2	93.79	388.78	61.29	222.21
3	75.82	294.99	55.50	182.82
4	64.40	219.17	49.42	146.76
5	38.36	154.77	43.97	114.90
6	37.06	116.41	37.52	87.31
7	28.33	79.35	31.46	62.99
8	25.02	51.02	25.54	42.44
9	**16.74**	**26.00**	**18.96**	**25.32**
10	9.27	9.27	12.25	12.25

Although the maximum eigenvalue test indicates r = 5, it is very close to the critical value, while the trace test is far above its critical value.
The trace test indicates that r = 10, but only Ecuador is nonstationary if r = 10.
If r = 9, only Chile, Uruguay, and Venezuela are stationary.

South American Countries:

Argentina
Bolivia
Brazil
Chile
Colombia
Ecuador
Paraguay
Peru
Uruguay
Venezuela

r = 9, two common trends

Table 26: Likelihood Ratio Test for Stationarity - Groups

United States and 7 East Asian Countries

r = 7, 5% critical value = 5.99

United States	6.04 *	Malaysia	5.98
Hong Kong	5.76	Philippines	3.75
Indonesia	5.81	Singapore	7.45 *
Korea	6.43 *	Thailand	5.46

Japan and 7 East Asian Countries

r = 6, 5% critical value = 7.81

Japan	18.36 *	Malaysia	17.71 *
Hong Kong	18.51 *	Philippines	13.68 *
Indonesia	17.71 *	Singapore	17.45 *
Korea	18.75 *	Thailand	19.26 *

France and 5 African Countries

r = 2, 5% crtitical value = 11.07

France	22.13 *	Morocco	21.23 *
Cameroon	25.77 *	Senegal	14.39 *
Ivory Coast	15.57 *	Tunisia	21.10 *

Germany and 5 African Countries

r = 4, 5% critical value = 7.81

Germany	18.44 *	Tanzania	16.19 *
Kenya	9.38 *	Tunisia	16.07 *
South Africa	15.59 *	Zimbabwe	10.32 *

Table 26 Continued: Likelihood Ratio Test for Stationarity

United Kingdom and 4 African Countries

r = 1, 5% critical value = 11.07

United Kingdom	33.22 *	Tanzania	30.16 *
Kenya	26.00 *	Zimbabwe	27.56 *
South Africa	25.23 *		

United States and 7 North/Central American Countries

r = 2, 5% critical value = 14.07

United States	57.51 *	Guatemala	56.06 *
Costa Rica	53.10 *	Honduras	53.81 *
Dominican Republic	54.70 *	Mexico	57.30 *
El Salvador	51.00 *	Panama	56.70 *

Germany and 5 South American Countries

r = 2, 5% critical value = 11.07

Germany	11.05	Paraguay	20.83 *
Chile	23.04 *	Peru	17.85 *
Colombia	14.29 *	Uruguay	26.72 *

United States and 10 South American Countries

r = 9, 5% critical value = 7.81

United States	7.92 *	Ecuador	14.63 *
Argentina	13.33 *	Paraguay	11.64 *
Bolivia	11.67 *	Peru	11.00 *
Brazil	13.28 *	Uruguay	6.00
Chile	5.02	Venezuela	6.54
Colombia	8.84 *		

Conclusions

While far from a general result, the cointegration analysis above shows that in a significant number of cases there are indeed long run equilibrium relationships between the outputs per capita of industrial and developing country trading partners. This indicates that technological advancements in industrial countries can influence long run economic growth in the developing world. Weak exogeneity tests generally indicate that both industrial and developing countries adjust to shocks that disturb long run equilibrium relationships, indicating that global shocks drive fluctuations in the short run.

The above analysis only addresses one channel through which industrial countries can influence developing countries, namely technological diffusion through trade. The search for more channels that link the economies of industrial and developing countries is taken up in the next section.

Interest Rates and the Terms of Trade

There are a number of channels through which events in large industrial countries may influence economic growth in developing countries. Basu and McLeod (1992a) construct a small open economy stochastic growth model that highlights one such channel: the terms of trade adjusted international real interest rate. In the model economy, a small country produces a single good using domestic capital and an imported input. Domestic output can be traded abroad for the foreign input, but export prices are uncertain and exogenous to events in the small country. The small country may also buy or sell bonds on an international capital market; thus purchases of the foreign input can also be financed with debt. However, the small country is assumed to have no influence over the international real interest rate.

The gross terms of trade adjusted international real interest rate, i.e. the return on foreign assets in terms of domestic prices, is defined as follows:

$$(1+r_t) = (1+r^*)\left(\frac{P_{t-1}}{P_t}\right)$$

where r^* is the international real interest rate and P_t is the terms of trade at time t.

The effect of changes in either the international real interest rate or the terms of trade on economic growth in the small country depends on whether the country is a net creditor (foreign asset holdings are positive) or a net debtor (foreign asset holdings are negative). If the country is a net creditor, an increase in the international real interest rate raises the return on foreign assets

held, thus improving the country's ability to accumulate domestic capital or the foreign input, therefore improving growth. On the other hand, an improvement in the terms of trade reduces the return on foreign assets, as the return is paid in terms of foreign goods, which have lost value relative to domestic goods. However, the effect of the terms of trade on the return to foreign assets is likely to have a small impact on economic growth, unless the country derives a large percentage of its income from foreign assets. More generally, an improvement in the terms of trade raises export revenues, which allows the country to import more of the foreign input, which enhances the productivity of domestic capital and improves growth.

The effects of the international real interest rate and the terms of trade are somewhat different for net debtors. An increase in the international real interest rate raises interest payments abroad, thereby reducing the ability of the small country to accumulate domestic capital or purchase the foreign input, thus reducing growth. An improvement in the terms of trade reduces payments abroad, since it requires fewer units of the domestic good to purchase a given quantity of the foreign good. In addition, as was the case with the net creditor, an improvement in the terms of trade enables a country to purchase more of the foreign input with a given quantity of exports, therefore improving growth. Since the majority of developing countries (in particular those in this study) are net debtors, it is assumed that the international real interest rate will have a negative effect, while the terms of trade will have a positive effect, on economic growth in developing countries.

Interest Rates: Empirical Literature

Additional arguments about the importance of the international real interest rate to the economies of developing countries can be found in the literature on capital flows. Calvo,

Leiderman, and Reinhart (1993) explain that the return of private capital flows to Latin America in the early 1990s was in part due to low interest rates in the United States. While not discounting the fact that fiscal reforms following the debt crisis of the early 1980s made Latin American markets more attractive for investment, falling interest rates and recession in the United States encouraged investors to seek investment opportunities in the region. Fernandez-Arias (1996) finds that improved country creditworthiness attracted private capital to middle income countries in the early 1990s. Country creditworthiness is, however, not just a function of domestic factors such as debt policy but also external economic conditions such as international interest rates. Low international interest rates raise the present value of developing country wealth, thus raising developing country creditworthiness and stimulating capital flows to developing countries. In short, capital flows to developing countries are dependent not only on domestic realities such as growth, inflation, debt policies, and political stability, but also on opportunities that exist in the international capital markets, which are largely influenced by events in the industrial economies. Although both papers empirically link the international interest rate to capital flows, the impact of international interest rates on economic growth in developing countries has not been directly tested in the empirical literature.

The literature on real business cycles in small open economies also analyzes the effects of international real interest rate shocks. Mendoza (1991) explains that international real interest rate shocks effect small open economies in three ways: shocks induce (1) a wealth effect, the direction of which depends on whether the country is a net creditor or debtor, (2) a consumption substitution effect, since the international real interest rate is the intertemporal relative price of consumption, and (3) a substitution effect between physical capital and foreign assets, since the

international real interest rate is the rate of return on foreign assets. A calibrated model demonstrates that shocks to the international real interest rate have minimal effects on the equilibrium stochastic process of the model economy. But Mendoza cautions that this is not necessarily a general result, since the model economy is calibrated to the experience of Canada, a country with relatively low debt exposure. Countries with higher debt exposure would likely be more sensitive to international interest rate shocks. Correia, Neves, and Rebelo (1995), in a similar model economy, find that a reduction in the international real interest rate raises investment, output, and consumption in a small open economy, but that the effects on output and consumption are small relative to the effect on investment.

Terms of Trade: Empirical Literature

A number of studies have tested the effect of the terms of trade on economic growth. Mendoza (1997) uses panel regressions to test the impact of the growth rate of the terms of trade on annual economic growth in a set of 31 developing and 9 industrial countries. In general, the panel regressions support the hypothesis that faster growth of the terms of trade raises economic growth, while cross-sectional regressions show that greater variability in the terms of trade reduces economic growth. However, individual country regressions raise questions about the importance of the terms of trade to economic growth in developing countries. While the growth rate of the terms of trade has a positive and significant effect on economic growth in all 9 of the industrial countries in the panel, the effect is positive and significant in just 8 of the 31 developing countries. In addition, the significance of the growth rate of the terms of trade is not robust in panels that breakdown the countries by region or between different measures of economic growth.

Fischer (1993) uses the growth rate of the terms of trade in panel regressions of the growth rates of output, productivity, and the capital stock. The results indicate that the growth rate of the terms of trade has a positive and significant effect on the growth rates of output and productivity, while the effect on the growth rate of the capital stock is insignificant. Similar to Mendoza (1997), Fischer's (1993) regressions use data from both industrial and developing countries.

Basu & McLeod (1992b) test the long-run impact of terms of trade fluctuations on economic growth using impulse response functions. A temporary terms of trade shock is shown to have a permanent and positive effect on output levels in 11 of the 12 developing countries tested. Additionally, impulse response functions show that an increase in the variance of the terms of trade has a negative effect on growth, although most of the countries tested reverted to trend growth in about 3 years.

Barro and Sala-i-Martin (1995) include the growth rate of the terms of trade as a regressor in panel regressions of economic growth in a large set of industrial and developing countries. But rather than using annual data as in Mendoza (1997), Barro and Sala-i-Martin use ten year average growth rates, from 1965 to 1975 and 1975 to 1985, thus leaving the time dimension of the panels equal to just two periods. The growth rate of the terms of trade is found to have a positive and significant effect on economic growth under most specifications.

Export Demand

Little et al. (1993) identify international interest rate and terms of trade shocks as important contributors to economic weakness in developing countries in the early 1980s, and identify a third type of external shock: export demand from industrial countries. Economic

growth slowed in the OECD countries in the early 1980s, and as a result, export volumes declined in a number of developing countries. Reductions in export volumes reduce the income earned from exports, which constrains resource availability and reduces an economy's ability to invest in growth.

Openness

Note that all the channels through which industrial countries may influence developing countries depend on the developing countries being open to trade in goods or assets, or being open to direct investments. Harrison (1996) identifies openness as an important factor in explaining growth in developing countries. Openness enhances technological change in developing countries. Open countries have access to imported inputs which embody new technologies that would otherwise be unavailable and openness increases the size of the market facing producers which raises the returns to innovation. Using panel regressions, several different measures of openness are shown to have a positive and significant association with economic growth in developing countries. However, causality seems to run in both directions; openness seems to precede growth, while stronger growth seems to lead to greater openness.

Summary of Channels

In summary, four channels through which economic events in industrial countries may influence developing countries have been identified: (1) the international real interest rate, which is expected to have a negative effect on growth, (2) the growth rate of the terms of trade, which is expected to have a positive effect on growth, (3) export demand from industrial countries, which is expected to have a positive effect on growth, and (4) openness, which is expected to have a positive effect on growth.

Data Definitions

Panel regression are used to test the effects of these four factors on annual economic growth in a diverse set of 35 developing countries over the period 1967 to 1990.[11] The variables are defined as follows: Economic growth (*y*) is measured as the growth rate of RGDP per capita. The international real interest rate (*rr*) is the calculated by subtracting the rate of consumer price inflation from short term interest rates in each of the G-7 industrial countries. Two measures are employed, a RGDP weighted average of G-7 real interest rates, and the real interest rate from each developing country's closest G-7 trading partner.[12] The terms of trade (*tt*) are calculated as the export unit value divided by the import unit value, and the growth rate of the terms of trade is used in the regressions. Industrial country export demand (*ex*) is proxied by the growth rate of RGDP per capita in the G-7 industrial countries. Again, two measures are employed, a RGDP weighted average of G-7 growth rates and the growth rate of RGDP per capita from the closest G-7 trading partner. Openness (*op*) is calculated as the sum of exports and imports, in current prices, divided by nominal GDP.[13]

Statistical Models

Three models are estimated. The first model, called OLS in the tables that follow, pools the data from the 35 developing countries and assumes a single constant term across all

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[11] Included in the regressions are all the developing countries used in the correlation and cointegration analyses, except Bangladesh and Tanzania, for which data was not available for all variables over the entire time period.

[12]Each developing country's closest G-7 trading partner is listed in Table 46 in the appendix. The judgement is subjective, based on data from the United Nation's International Trade Statistics Yearbooks.

[13] Data sources are listed in the data appendix.

countries. The model is estimated with ordinary least squares regression, which provides efficient and consistent estimates of the constant term and the regressor's coefficients. (The *i* subscript is the index for countries and the *t* subscript is the index for time.)

$$y_{i,t} = \alpha + b_1 rr_{i,t} + b_2 tt_{i,t} + b_3 ex_{i,t} + b_4 op_{i,t} + \varepsilon_{i,t}$$

The second model is a fixed effects model, which allows each country to have a unique, time invariant constant term. This model is estimated with partitioned least squares. The model is often called the least squares dummy variable model since the individual constants are coefficients on country dummies.

$$y_{i,t} = \alpha_i + b_1 rr_{i,t} + b_2 tt_{i,t} + b_3 ex_{i,t} + b_4 op_{i,t} + \varepsilon_{i,t}$$

The third model is a random effects model, which contains a constant term for the overall regression plus country-specific disturbances u_i, which are similar to $\varepsilon_{i,t}$ except that for each country there is a single draw that enters the regression identically in each period. The random effect, u_i, can be viewed as the collection of factors not in the regression that are specific to the growth process of that country. The model is estimated with generalized least squares.

$$y_{i,t} = \alpha + b_1 rr_{i,t} + b_2 tt_{i,t} + b_3 ex_{i,t} + b_4 op_{i,t} + u_i + \varepsilon_{i,t}$$

All the models correct for autocorrelation by modeling the error term as an AR(1) process:

$$\varepsilon_{i,t} = \rho \varepsilon_{i,t-1} + \eta_{i,t}.$$

There is some difficulty in deciding which model is most appropriate. The fixed effects model is reasonable if the differences between countries can be viewed as parametric shifts in the regression function. However, it might be more appropriate to view individual specific constant terms as randomly distributed across the countries, since the set of developing countries utilized are part of a larger population of developing countries. The random effects model is more efficient than the fixed effects model since the random effects model calculates coefficients using information across time and across countries. The fixed effects model calculates coefficients using only information across time. However, the random effects estimates are only consistent if the country-specific disturbances are uncorrelated with the explanatory variables.

Two tests can help select the most appropriate model.[14] A Lagrange multiplier test is used to test if the random effects model is superior to the OLS model, in other words if individual effects are present in the data. If individual effects are found, then a Hausman test is used to test if the country-specific disturbances found in the random effects model are orthogonal to the explanatory variables. If the random effects are orthogonal, then the random effects model is favored because it is more efficient than the fixed effects model. If the random effects are found to be correlated with the explanatory variables, then the fixed effects model is chosen. Tables 25 through 36 present the results of the regressions, with the chosen model, on the basis of the Lagrange multiplier and Hausman tests, in bold print. The prob values of these tests are also included in the tables. In a few cases, both the fixed effects and random effects models are chosen because the Limdep software could not invert a covariance matrix and the Hausman test could not be performed. In the tables, *** denotes significance at the 1% level, ** at the 5%

[14]See Greene (2000, pages 572 - 577) for a discussion of these tests.

level, and * at the 10% level. t-ratios are in parentheses.

Discussion of Results

Table 27 considers the full panel of 35 developing countries. The international real interest rate and export demand are correctly signed and significant at the 1% level in all three models and with both specifications of the variables. Openness is also correctly signed and significant in the OLS and random effects models, but insignificant in the fixed effects models. This is not surprising since openness varies much more across countries than across time within individual countries.

Tables 28 through 30 breakdown the panel into three regions, the Western Hemisphere, Africa, and Asia.[15] Both the international real interest rate and export demand are correctly signed and significant in the Western Hemisphere, while only the international real interest rate is significant in Africa. In the Asian panel, only the terms of trade is correctly signed and significant in all models. The R-squared is considerably lower in the African panel than the Asian or Western Hemisphere panels, indicating that African countries are less influenced economically by the industrial countries than are Asia or countries in the Western Hemisphere.

Tables 31 through 33 breakdown the panel into three income groups, upper-middle income, lower-middle income, and low income. Upper-middle income countries had, in 1993, GNP per capita between $8,625 and $2,786, lower-middle income countries were between $2,785 and $696, and low income countries were less than $695.[16] In the upper-middle income

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[15]See the data appendix for a listing of countries in each panel.

[16]Calculated by the World Bank using the Atlas method and listed in the World Bank's World Tables, 1995.

group, the international real interest rate and export demand are strongly significant. The international real interest rate and export demand are again significant for the lower-middle income countries, but none of the variables are consistently significant in the panel of low income countries. The R-squared indicates that the low income countries are less connected to the industrial countries than are the upper-middle or lower-middle income countries.

Tables 34 and 35 break the countries into groups of primary/fuel exporters or diverse exporters. A primary/fuel exporter is defined as having more than 50% of export revenues generated from sales of primary or fuel products. A diverse exporter means that none of primary/fuel, services, or manufactures amount to 50% of total export revenues. The international real interest rate and export demand are correctly signed and significant for both the primary/fuel and diverse exporters, while the growth rate of terms of trade is correctly signed and significant for the diversified exporters as well.

Tables 36 through 38 divide the countries into three categories according to debt exposure. Severely indebted countries have a present value of debt service greater than 80% of GNP or greater than 220% of exports. Moderately indebted countries have a present value of debt service of greater than 60% GNP or exports, but not beyond the critical values for severely indebted countries. The international real interest rate is correctly signed and significant in all models, regardless of the level of indebtedness. The absolute value of the coefficient on the international real interest rate is much higher for the severely indebted countries, indicating that countries with heavy debt levels are more sensitive to interest rates set in the industrial countries, as anticipated by Mendoza (1991). Export demand is correctly signed and significant in all the models except for the moderately indebted countries when it is proxied by the weighted average

of the G-7 growth rates. Openness is also correctly signed and significant for the less indebted countries in all six models.[17]

Capital Income Taxes

Since income from capital is taxed in industrial countries, tax policies in industrial countries affect the realized return on capital investments in these countries. Higher capital income taxes in industrial countries mean lower after tax returns to investors, which discourages investment and may push capital toward investment opportunities in developing countries. If capital is more freely available to the developing countries, more investment may take place, enabling developing countries to grow more quickly.

The effect of capital income tax rates in the United States on growth in developing countries is tested with panel regressions using the full panel of 35 developing countries. The capital income tax rates used in the regressions are ad-valorem rates calculated by Mendoza et al (1997).[18] The effective capital income tax rate is computed as the difference between post and pre tax capital income divided by pre tax capital income.

Tables 39 and 40 show that capital income taxes in the United States have a positive and significant effect on economic growth in developing countries. However, the effect is quite small, with a one percentage point increase in the tax rate resulting in an approximately 0.002 percentage point increase in the growth rate. The signs and significance of the international real interest rate and export demand from industrial countries are unaffected by the addition of the

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[17]Export type and debt exposure are also listed in the World Bank's World Tables.

[18]The capital income tax rates used can be found on Mendoza's web site: www.econ.duke.edu/~mendozae/.

capital income tax rate to the panel regressions.

The results are consistent with the findings of Mendoza et al (1997) that capital income taxes have a negative impact on domestic investment and economic growth in a panel of industrial countries, but that the effect is small on both counts. An increase in the capital income tax in an industrial country will discourage domestic investment and encourage investors to seek opportunities outside the domestic economy. Capital will flow out of the industrial country and some may find its way into developing economies, which will enhance its economic growth, while the process reduces growth, albeit slightly, in the industrial country.

Conclusions

By far the strongest result of this study is that international real interest rates have a negative effect on growth in developing countries. The significance of the variable is robust to changes in the specification of the international real interest rate, and to different groups of developing countries as well. Additional evidence of the importance of the interest rate channel is found in the positive effect and the significance of the capital income tax rate in the United States on growth in developing countries. This shows that sources of capital are sensitive to after-tax rates of return and will seek out higher returns worldwide. Capital flows to the developing world when investment opportunities in the industrial world yield substandard returns and the capital flows help the developing countries to build their capital stocks and therefore stimulate economic growth..

Export demand from the industrial countries also appears to have a positive impact on growth in the developing countries. The proxies for export demand both are correctly signed and significant in the majority of the panels. The evidences for openness and the growth rate of the

terms of trade is not as strong. Openness is found to have a positive and significant effect on growth that is robust to changes in the econometric model only in the panel of 35 developing countries and the panel of less indebted countries. This indicates that the benefits of openness, in terms of annual growth, outweigh the costs only if a country follows a conservative fiscal policy and does not rely too heavily on the international capital markets to finance growth. The terms of trade has a significant effect on annual growth in developing countries only in the groups of diverse exporters and Asian countries. Most of the Asian countries also fall into the category of diverse exporters. However, the growth rate of the terms of trade has a positive and significant effect on growth in the full panel of 35 countries only if it is the only explanatory variable included in the regression.

The weakness of the results regarding the growth rate of the terms of trade is surprising given its frequent use as an explanatory variable in growth regressions. In particular, one would expect a primary goods exporter that relies heavily on the sales of a handful of goods to be highly sensitive to changes in the terms of trade. Yet if primary exporters do not require imported inputs in their production processes, fluctuations in export revenues may not have much effect on the country's ability to produce output. Whereas a diverse exporter that requires imported inputs in its production process will be more dependent on export revenues, which are necessary to purchase foreign inputs.

Table 27: Panel Regression: 35 Developing Countries

Using G-7 weighted averages for the International Real Interest Rate and G-7 Export Demand.

	OLS	Fixed Effects	**Random Effects**
Constant	0.00822 **		**0.01025 ** **
	(2.498)		**(2.042)**
Openness	0.02058 ***	0.00087	**0.01740 *** **
	(6.542)	(0.077)	**(3.268)**
Growth Rate of Terms of Trade	0.00878	0.01223	**0.01062**
	(0.858)	(1.233)	**(1.077)**
International Real Interest Rate	-0.50345 ***	-0.49086 ***	**-0.50068 *** **
	(-7.110)	(-7.247)	**(-7.419)**
G-7 Export Demand	0.39585 ***	0.36908 ***	**0.39004 *** **
	(4.435)	(4.288)	**(4.579)**
R-Squared	0.10873	0.19162	**0.11316**
Lagrange Multiplier Test	0.00		
Hausman Test	0.53		

Using values from the closest G-7 trading partner for the International Real Interest Rate and G-7 Export Demand.

	OLS	Fixed Effects	**Random Effects**
Constant	0.00652 **		**0.00892 ** **
	(2.163)		**(1.969)**
Openness	0.02054 ***	-0.00106	**0.01777 *** **
	(6.578)	(-0.093)	**(3.598)**
Growth Rate of Terms of Trade	0.00936	0.01344	**0.01144**
	(0.925)	(1.364)	**(1.168)**
International Real Interest Rate	-0.45784 ***	-0.44496 ***	**-0.45328 *** **
	(-7.511)	(-7.533)	**(-7.712)**
G-7 Export Demand	0.41975 ***	0.34383 ***	**0.38351 *** **
	(5.851)	(4.674)	**(5.379)**
R-Squared	0.12187	0.19511	**0.12623**
Lagrange Multiplier Test	0.00		
Hausman Test	0.17		

Table 28: Panel Regression: Western Hemisphere Countries

Using G-7 weighted averages for the International Real Interest Rate and G-7 Export Demand.

	OLS	Fixed Effects	Random Effects
Constant	**0.00999**		0.00820
	(1.527)		(1.028)
Openness	**-0.00265**	0.02398	0.00134
	(-0.218)	(0.910)	(0.089)
Growth Rate of Terms of Trade	**-0.00954**	0.00132	0.00047
	(-0.085)	(0.116)	(0.042)
International Real Interest Rate	**-0.71140** ***	-0.69756 ***	-0.70846 ***
	(-7.417)	(-7.303)	(-7.450)
G-7 Export Demand	**0.62000** ***	0.62929 ***	0.62025 ***
	(5.157)	(5.259)	(5.204)
R-Squared	**0.14336**	0.15939	0.15215
Lagrange Multiplier Test	0.37		
Hausman Test	could not invert covariance matrix		

Using values from the closest G-7 trading partner for the International Real Interest Rate and G-7 Export Demand.

	OLS	Fixed Effects	Random Effects
Constant	**0.01583** **		0.01476 *
	(2.585)		(1.927)
Openness	**-0.00571**	0.00960	-0.00332
	(-0.477)	(0.369)	(-0.221)
Growth Rate of Terms of Trade	**0.00156**	0.00446	0.00314
	(0.141)	(0.400)	(0.285)
International Real Interest Rate	**-0.82624** ***	-0.81544 ***	-0.82385 ***
	(-8.504)	(-8.396)	(-8.547)
G-7 Export Demand	**0.53960** ***	0.54128 ***	0.53904 ***
	(5.353)	(5.408)	(5.396)
R-Squared	**0.16895**	0.18442	0.17748
Lagrange Multiplier Test	0.31		
Hausman Test	0.69		

Table 29: Panel Regression: African Countries

Using G-7 weighted averages for the International Real Interest Rate and G-7 Export Demand.

	OLS	Fixed Effects	Random Effects
Constant	**0.03661 ***		0.03020
	(1.689)		(1.104)
Openness	**-0.02225**	-0.00342	-0.01211
	(-0.666)	(-0.071)	(-0.290)
Growth Rate of Terms of Trade	**0.01511**	0.00813	0.01022
	(0.411)	(0.222)	(0.280)
International Real Interest Rate	**-0.52295 *****	-0.52080 ***	-0.52250 ***
	(-3.191)	(-3.199)	3.21400
G-7 Export Demand	**-0.03975**	-0.01334	-0.02418
	(-0.188)	(-0.063)	(-0.115)
R-Squared	**0.03943**	0.05755	0.06043
Lagrange Multiplier Test	0.55		
Hausman Test	0.87		

Using values from the closest G-7 trading partner for the International Real Interest Rate and G-7 Export Demand.

	OLS	Fixed Effects	Random Effects
Constant	**0.03149**		0.02787
	(1.338)		(0.991)
Openness	**-0.02130**	-0.00504	-0.01559
	(-0.604)	(-0.094)	(-0.370)
Growth Rate of Terms of Trade	**0.02484**	0.01683	0.02067
	(0.667)	(0.454)	(0.559)
International Real Interest Rate	**-0.23785 ****	-0.25959 **	-0.25040 **
	(-2.099)	(-2.279)	(-2.216)
G-7 Export Demand	**-0.02975**	0.00825	-0.01475
	(-0.133)	(0.036)	(-0.066)
R-Squared	**0.00857**	0.02972	0.03024
Lagrange Multiplier Test	0.47400		
Hausman Test	could not invert covariance matrix		

Table 30: Panel Regression: Asian Countries

Using G-7 weighted averages for the International Real Interest Rate and G-7 Export Demand.

	OLS	Fixed Effects	**Random Effects**
Constant	0.02898 ***		**0.03880 *** **
	(5.495)		**(3.703)**
Openness	0.01368 ***	-0.02097 *	**0.00319**
	(4.352)	(-1.777)	**(0.461)**
Growth Rate of Terms of Trade	0.05075 **	0.05271 **	**0.05146 ** **
	(2.244)	(2.498)	**(2.443)**
International Real Interest Rate	-0.14725	-0.04559	**-0.11646**
	(-1.255)	(-0.403)	**(-1.063)**
G-7 Export Demand	0.25123 *	0.16108	**0.22380**
	(1.677)	(1.142)	**(1.612)**
R-Squared	0.09510	0.23384	**0.11090**
Lagrange Multiplier Test	0.00		
Hausman Test	0.22		

Using values from the closest G-7 trading partner for the International Real Interest Rate and G-7 Export Demand.

	OLS	Fixed Effects	**Random Effects**
Constant	0.02653 ***		**0.03618 *** **
	(5.353)		**(3.618)**
Openness	0.01469 ***	-0.01800	**0.00531**
	(4.698)	(-1.549)	**(0.796)**
Growth Rate of Terms of Trade	0.04601 **	0.05071 **	**0.04865 ** **
	(2.070)	(2.424)	**(2.331)**
International Real Interest Rate	-0.21009 **	-0.12321	**-0.17724 * **
	(-2.033)	(-1.230)	**(-1.813)**
G-7 Export Demand	0.29498 ***	0.18400 *	**0.23892 ** **
	(2.840)	(1.679)	**(2.250)**
R-Squared	0.11855	0.24073	**0.13394**
Lagrange Multiplier Test	0.00		
Hausman Test	0.17		

Table 31: Panel Regression: Upper Middle Income Countries

Using G-7 weighted averages for the International Real Interest Rate and G-7 Export Demand.

	OLS	**Fixed Effects**	**Random Effects**
Constant	-0.00470 (-0.565)		**-0.00012** **(-0.007)**
Openness	0.04706 *** (3.406)	**0.02877** **(0.810)**	**0.03694** **(1.332)**
Growth Rate of Terms of Trade	-0.00060 (-0.037)	**0.01014** **(0.659)**	**0.00878** **(0.573)**
International Real Interest Rate	-0.52463 *** (-3.472)	**-0.49691 *** **(-3.419)**	**-0.50745 *** **(-3.554)**
G-7 Export Demand	0.66707 *** (3.536)	**0.64119 *** **(3.609)**	**0.65043 *** **(3.693)**
R-Squared	0.10698	**0.23837**	**0.12432**
Lagrange Multiplier Test	0.00		
Hausman Test	could not invert covariance matrix		

Using values from the closest G-7 trading partner for the International Real Interest Rate and G-7 Export Demand.

	OLS	Fixed Effects	**Random Effects**
Constant	0.00326 (0.443)		**0.00378** **(0.275)**
Openness	0.03330 ** (2.386)	0.02897 (0.831)	**0.03095** **(1.298)**
Growth Rate of Terms of Trade	0.00282 (0.175)	0.01183 (0.777)	**0.01023** **(0.677)**
International Real Interest Rate	-0.47303 *** (-3.711)	-0.50285 *** (-4.117)	**-0.49923 *** **(-4.193)**
G-7 Export Demand	0.50622 *** (3.387)	0.55174 *** (3.751)	**0.54592 *** **(3.844)**
R-Squared	0.10584	0.25081	**0.12320**
Lagrange Multiplier Test	0.00		
Hausman Test	0.43		

Table 32: Panel Regression: Lower Middle Income Countries

Using G-7 weighted averages for the International Real Interest Rate and G-7 Export Demand.

	OLS	**Fixed Effects**	**Random Effects**
Constant	0.01750 **		**0.01009**
	(2.135)		**(0.896)**
Openness	0.00802	**0.03519**	**0.02188**
	(0.576)	**(1.541)**	**(1.164)**
Growth Rate of Terms of Trade	0.01246	**0.00701**	**0.00889**
	(0.858)	**(0.498)**	**(0.634)**
International Real Interest Rate	-0.60487 ***	**-0.60136 *** **	**-0.60380 *** **
	(-6.407)	**(-6.636)**	**(-6.667)**
G-7 Export Demand	0.29575 **	**0.32215 *** **	**0.31002 *** **
	(2.495)	**(2.808)**	**(2.715)**
R-Squared	0.09829	**0.17152**	**0.10754**
Lagrange Multiplier Test	0.00		
Hausman Test	could not invert covariance matrix		

Using values from the closest G-7 trading partner for the International Real Interest Rate and G-7 Export Demand.

	OLS	**Fixed Effects**	Random Effects
Constant	0.01083		0.00926
	(1.370)		(1.028)
Openness	0.01427	**0.03947 ***	0.01888
	(1.047)	**(1.718)**	(1.219)
Growth Rate of Terms of Trade	0.00774	**0.00527**	0.00717
	(0.547)	**(0.378)**	(0.518)
International Real Interest Rate	-0.63615 ***	**-0.60332 *** **	-0.62548 ***
	(-7.383)	**(-7.132)**	(-7.437)
G-7 Export Demand	0.44958 ***	**0.34807 *** **	0.40736 ***
	(4.834)	**(3.542)**	(4.376)
R-Squared	0.14215	**0.18740**	0.15095
Lagrange Multiplier Test	0.00		
Hausman Test	0.02		

Table 33: Panel Regression: Low Income Countries

Using G-7 weighted averages for the International Real Interest Rate and G-7 Export Demand.

	OLS	Fixed Effects	Random Effects
Constant	**0.02568 ****		0.01836
	(2.052)		(1.120)
Openness	**-0.01438**	0.12621 **	-0.00067
	(-0.709)	(2.024)	(-0.025)
Growth Rate of Terms of Trade	**0.03971**	0.03674	0.03986
	(1.106)	(1.030)	(1.120)
International Real Interest Rate	**-0.29322 ***	-0.22181	-0.28629 *
	(-1.763)	(-1.325)	(-1.736)
G-7 Export Demand	**0.01131**	0.12977	0.02184
	(0.050)	(0.569)	(0.098)
R-Squared	**0.00503**	0.02490	0.02990
Lagrange Multiplier Test	0.43		
Hausman Test	0.26		

Using values from the closest G-7 trading partner for the International Real Interest Rate and G-7 Export Demand.

	OLS	Fixed Effects	Random Effects
Constant	**0.02436 ****		0.01773
	(2.053)		(1.144)
Openness	**-0.01455**	0.13393 **	-0.00254
	(-0.713)	(2.082)	(-0.095)
Growth Rate of Terms of Trade	**0.04093**	0.35385	0.04016
	(1.159)	(1.007)	(1.147)
International Real Interest Rate	**-0.15919**	-0.09843	-0.15423
	(-1.265)	(-0.766)	(-1.230)
G-7 Export Demand	**-0.03893**	0.12226	-0.01641
	(-0.200)	(0.603)	(-0.084)
R-Squared	**-0.00263**	0.01756	0.02243
Lagrange Multiplier Test	0.39		
Hausman Test	0.18		

Table 34: Panel Regression: Primary/Fuel Exporters

Using G-7 weighted averages for the International Real Interest Rate and G-7 Export Demand.

	OLS	Fixed Effects	**Random Effects**
Constant	-0.00703		**-0.00905**
	(-0.650)		**(-0.744)**
Openness	0.02102	0.06502	**0.02532**
	(1.047)	(1.636)	**(1.111)**
Growth Rate of Terms of Trade	-0.01366	-0.01201	**-0.01284**
	(-0.908)	(-0.776)	**(-0.845)**
International Real Interest Rate	-0.68745 ***	-0.66076 ***	**-0.68419 *** **
	(-4.869)	(-4.632)	**(-4.832)**
G-7 Export Demand	0.56784 ***	0.58156 ***	**0.56825 *** **
	(3.210)	(3.270)	**(3.205)**
R-Squared	0.10293	0.09941	**0.11860**
Lagrange Multiplier Test	0.50		
Hausman Test	could not invert covariance matrix		

Using values from the closest G-7 trading partner for the International Real Interest Rate and G-7 Export Demand.

	OLS	Fixed Effects	Random Effects
Constant	**-0.00404**		-0.00611
	(-0.390)		(-0.520)
Openness	**0.01570**	0.06081	0.01994
	(0.778)	(1.508)	(0.871)
Growth Rate of Terms of Trade	**-0.00949**	-0.00843	-0.00881
	(-0.631)	(-0.545)	(-0.581)
International Real Interest Rate	**-0.59524 *** **	-0.56971 ***	-0.59294 ***
	(-4.702)	(-4.410)	(-4.663)
G-7 Export Demand	**0.49809 *** **	0.53529 ***	0.50431 ***
	(3.243)	(3.437)	(3.272)
R-Squared	**0.09392**	0.09151	0.10974
Lagrange Multiplier Test	0.53		
Hausman Test	0.44		

Table 35: Panel Regression: Diverse Exporters

Using G-7 weighted averages for the International Real Interest Rate and G-7 Export Demand.

	OLS	**Fixed Effects**	**Random Effects**
Constant	0.02087 ***		**0.01762 ** **
	(3.624)		**(2.152)**
Openness	0.01260	**0.04087 ***	**0.01903**
	(1.317)	**(1.720)**	**(1.360)**
Growth Rate of Terms of Trade	0.03883 ***	**0.03333 ** **	**0.03607 ** **
	(2.700)	**(2.350)**	**(2.561)**
International Real Interest Rate	-0.42219 ***	**-0.44364 *** **	**-0.42788 *** **
	(-4.842)	**(-5.149)**	**(-5.026)**
G-7 Export Demand	0.18896 *	**0.22676 ** **	**0.19923 ***
	(1.714)	**(2.054)**	**(1.845)**
R-Squared	0.06708	**0.11720**	**0.07564**
Lagrange Multiplier Test	0.00		
Hausman Test	could not invert covariance matrix		

Using values from the closest G-7 trading partner for the International Real Interest Rate and G-7 Export Demand.

	OLS	**Fixed Effects**	Random Effects
Constant	0.01827 ***		0.01807 ***
	(3.434)		(3.267)
Openness	0.08711	**0.04340 ***	0.00965
	(0.928)	**(1.796)**	(0.991)
Growth Rate of Terms of Trade	0.03511 **	**0.03140 ** **	0.03489 **
	(2.479)	**(2.231)**	(2.511)
International Real Interest Rate	-0.38794 ***	**-0.39315 *** **	-0.38694 ***
	(-5.493)	**(-5.524)**	(-5.579)
G-7 Export Demand	0.31512 ***	**0.26448 *** **	0.30390 ***
	(3.713)	**(2.769)**	(3.621)
R-Squared	0.09037	**0.12599**	0.09872
Lagrange Multiplier Test	0.04		
Hausman Test	0.00		

Table 36: Panel Regression: Severely Indebted Countries

Using G-7 weighted averages for the International Real Interest Rate and G-7 Export Demand.

	OLS	Fixed Effects	Random Effects
Constant	**0.01458**		0.01258
	(1.603)		(1.065)
Openness	**-0.00119**	0.03442	0.00286
	(-0.076)	(0.779)	(0.137)
Growth Rate of Terms of Trade	**0.01781**	0.01573	0.01780
	(0.876)	(0.769)	(0.880)
International Real Interest Rate	**-0.74556** ***	-0.71342 ***	-0.74177 ***
	(-5.795)	(-5.366)	(-5.780)
G-7 Export Demand	**0.42406** ***	0.44261 ***	0.42587 ***
	(2.618)	(2.726)	(2.645)
R-Squared	**0.11181**	0.12466	0.12473
Lagrange Multiplier Test	0.62		
Hausman Test	0.95		

Using values from the closest G-7 trading partner for the International Real Interest Rate and G-7 Export Demand.

	OLS	Fixed Effects	Random Effects
Constant	**0.01562** *		0.01418
	(1.798)		(1.270)
Openness	**0.00325**	0.03084	0.00001
	(0.208)	(0.685)	(0.001)
Growth Rate of Terms of Trade	**0.02221**	0.02033	0.02230
	(1.099)	(0.997)	(1.109)
International Real Interest Rate	**-0.66535** ***	-0.64297 ***	-0.66527 ***
	(-5.776)	(-5.349)	(-5.773)
G-7 Export Demand	**0.37138** ***	0.37848 ***	0.36658 **
	(2.597)	(2.593)	(2.565)
R-Squared	**0.10881**	0.12104	0.12178
Lagrange Multiplier Test	0.64		
Hausman Test	0.90		

Table 37: Panel Regression: Moderately Indebted Countries

Using G-7 weighted averages for the International Real Interest Rate and G-7 Export Demand.

	OLS	Fixed Effects	**Random Effects**
Constant	0.02658 ***		**0.02448 ** **
	(3.542)		**(2.139)**
Openness	-0.01382	-0.00173	**-0.00941**
	(-1.018)	(-0.058)	**(-0.449)**
Growth Rate of Terms of Trade	0.00355	0.00519	**0.00498**
	(0.292)	(0.430)	**(0.417)**
International Real Interest Rate	-0.31966 ***	-0.32497 ***	**-0.32075 *** **
	(-2.981)	(-3.091)	**(-3.077)**
G-7 Export Demand	0.15482	0.16634	**0.15865**
	(1.156)	(1.255)	**(1.215)**
R-Squared	0.02374	0.08645	**0.03685**
Lagrange Multiplier Test	0.00		
Hausman Test	0.99		

Using values from the closest G-7 trading partner for the International Real Interest Rate and G-7 Export Demand.

	OLS	**Fixed Effects**	Random Effects
Constant	0.02339 ***		0.02335 ***
	(3.299)		(2.924)
Openness	-0.13375	**-0.00056**	-0.01214
	(-1.000)	**(-0.018)**	(-0.805)
Growth Rate of Terms of Trade	0.00237	**0.00446**	0.00315
	(0.197)	**(0.371)**	(0.267)
International Real Interest Rate	-0.33443 ***	**-0.32513 *** **	-0.33083 ***
	(-3.593)	**(-3.527)**	(-3.640)
G-7 Export Demand	0.29060 ***	**0.20716 * **	0.26276 **
	(2.687)	**(1.797)**	(2.454)
R-Squared	0.04561	**0.09634**	0.05843
Lagrange Multiplier Test	0.01		
Hausman Test	0.02		

Table 38: Panel Regression: Less Indebted Countries

Using G-7 weighted averages for the International Real Interest Rate and G-7 Export Demand.

	OLS	Fixed Effects	**Random Effects**
Constant	-0.00930		**-0.00907**
	(-0.799)		**(-0.445)**
Openness	0.06020 ***	0.06051 **	**0.06046 ** **
	(3.586)	(2.270)	**(2.412)**
Growth Rate of Terms of Trade	0.02514	0.03205	**0.03162**
	(0.754)	(1.062)	**(1.048)**
International Real Interest Rate	-0.46329 ***	-0.46449 ***	**-0.46439 *** **
	(-3.163)	(-3.491)	**(-3.494)**
G-7 Export Demand	0.50402 **	0.48893 ***	**0.48984 *** **
	(2.538)	(2.693)	**(2.704)**
R-Squared	0.10849	0.27445	**0.12798**
Lagrange Multiplier Test	0.00		
Hausman Test	0.96		

Using values from the closest G-7 trading partner for the International Real Interest Rate and G-7 Export Demand.

	OLS	Fixed Effects	**Random Effects**
Constant	-0.00627		**-0.01094**
	(-0.588)		**(-0.641)**
Openness	0.05095 ***	0.06307 **	**0.05906 ** **
	(3.063)	(2.363)	**(2.520)**
Growth Rate of Terms of Trade	0.02972	0.03403	**0.03378**
	(0.937)	(1.173)	**(1.167)**
International Real Interest Rate	-0.35548 ***	-0.38520 ***	**-0.37945 *** **
	(-3.070)	(-3.604)	**(-3.571)**
G-7 Export Demand	0.43569 ***	0.45359 ***	**0.44600 *** **
	(3.185)	(3.216)	**(3.257)**
R-Squared	0.11595	0.28015	**0.13527**
Lagrange Multiplier Test	0.00		
Hausman Test	0.51		

Table 39: Panel Regression: Effect of U.S. Capital Income Tax Rate

Using G-7 weighted averages for the International Real Interest Rate and G7 Export Demand.

	OLS	Fixed Effects	**Random Effects**
Constant	-0.11143 ***		**-0.10862 *** **
	(-3.065)		**(-3.107)**
Openness	0.02081 ***	0.00401	**0.01797 *** **
	(6.653)	(0.354)	**(3.335)**
Growth Rate of Terms of Trade	0.00716	0.01045	**0.00898**
	(0.703)	(1.059)	**(0.916)**
International Real Interest Rate	-0.33149 ***	-0.32730 ***	**-0.33036 *** **
	(-3.787)	(-3.926)	**(-3.964)**
G7 Export Demand	0.56242 ***	0.53281 ***	**0.55565 *** **
	(5.512)	(5.399)	**(5.704)**
U.S. Capital Income Tax Rate	0.00264 ***	0.00254 ***	**0.00262 *** **
	(3.304)	(3.325)	**(3.440)**
R-Squared	0.11964	0.20209	**0.12512**
Lagrange Multiplier Test	0.00		
Hausman Test	0.79		

Table 40: Panel Regression: Effect of U.S. Capital Income Tax Rate

Using values from the closest G-7 trading partner for the International Real Interest Rate and G7 Export Demand.

	OLS	Fixed Effects	**Random Effects**
Constant	-0.08585 ***		**-0.07714 ** **
	(-2.735)		**(-2.521)**
Openness	0.02073 ***	0.00178 **	**0.01796 *** **
	(6.671)	(0.156)	**(3.487)**
Growth Rate of Terms of Trade	0.00892	0.01287	**0.01110**
	(0.886)	(1.311)	**(1.137)**
International Real Interest Rate	-0.34516 ***	-0.34940 ***	**-0.34844 *** **
	(-4.818)	(-5.047)	**(-5.045)**
G7 Export Demand	0.48697 ***	0.41039 ***	**0.44854 *** **
	(6.499)	(5.291)	**(5.982)**
U.S. Capital Income Tax Rate	0.00208 ***	0.00179 ***	**0.00194 *** **
	(2.957)	(2.621)	**(2.856)**
R-Squared	0.13028	0.20123	**0.13569**
Lagrange Multiplier Test	0.00		
Hausman Test	0.45		

Conclusions and Policy Recommendations

The panel regressions provide ample evidence of short run connections between industrial and developing countries through the channels of international real interest rates and export demand. Although fluctuations to international real interest rates and export demand from the large industrial countries are out of the realm of influence of developing countries, policy makers should certainly monitor events in their industrial country trading partners in order to adjust policies to compensate for the external environment. For example, the Federal Reserve of the United States has recently undertaken a program of raising interest rates in order to slow the growth rate of its economy. The evidence in this study shows that success in this endeavor will have negative consequences for growth in developing countries. And given that the negative effect of international real interest rates on growth developing countries is strongest for countries with high debt levels, developing countries that permit free flows of capital should adopt conservative fiscal policies which at least mitigate the risks of fluctuations in international real interest rates.

Additionally, the lack of significance of the terms of trade in the presence of the international real interest rate and the proxies for export demand supports the use of these as explanatory variables in growth regressions of developing countries. The external environment is certainly important for understanding growth in developing countries and it appears that the terms of trade is not sufficient to cover all the events that matter.

The long run evidence found in the cointegration analysis is not as strong as the short run evidence from the panel regressions, but a significant number of developing countries do seem to be tied to the growth paths of their industrial country trading partners. Openness to trade may

therefore allow technological advancements in the industrial countries to be spread to and benefit the developing countries in the long run, although the panel regressions indicate that openness benefits only the less indebted countries in the short run.

Bibliography

Backus, David K. and Patrick J. Kehoe (1992). "International Evidence on the Historical Properties of Business Cycles," *American Economic Review* vol. 82, no.4: 864-888.

Backus, David K., Patrick J. Kehoe, and Finn E. Kydland (1995). "International Business Cycles: Theory and Evidence," in Thomas F. Cooley, ed., *Frontiers of Business Cycle Research*, Princeton, NJ: Princeton University Press.

Barro, Robert J. and Xavier Sala-i-Martin (1995). *Economic Growth*, New York: McGraw Hill.

Basu, Parantap and Darryl McLeod (1992a). "Capital Mobility and Growth with Uncertain Terms of Trade," unpublished manuscript.

Basu, Parantap and Darryl McLeod (1992b). "Terms of Trade Fluctuations and Economic Growth in Developing Economies," *Journal of Development Economics* vol. 37: 89-110.

Baxter, Marianne and Mario J. Crucini (1993). "Explaining Saving-Investment Correlations," *American Economic Review* vol. 83, no. 3: 416-436.

Baxter, Marianne and Mario J. Crucini (1995). " Business Cycles and the Asset Structure of Foreign Trade," *International Economic Review* vol. 36, no. 4: 821-854.

Baxter, Marianne, and Alan C. Stockman (1989). "Business Cycles and the Exchange Rate Regime," *Journal of Monetary Economics* vol. 23: 377-400.

Calvo, Guillermo, Leonardo Leiderman, and Carmen Reinhart (1993). "Capital Inflows and Real Exchange Rate Appreciation in Latin America," *IMF Staff Papers* vol. 40, no. 1: 108-51.

Canova, Fabio (1998). "Detrending and Business Cycle Facts," *Journal of Monetary Economics* vol. 41, no. 3.

Canova, Fabio and Harris Dellas (1993). "Trade Interdependence and the International Business Cycle," *Journal of International Economics* vol. 34: 23-47.

Canova, Fabio and Jane Marrinan (1998). "Sources and Propagation of International Output Cycles: Common Shocks or Transmission?" *Journal of International Economics* vol. 46: 133-166.

Cantor, Richard and Nelson C. Mark (1987). "International Debt and World Business Fluctuations," *Journal of International Money and Finance* vol. 6: 153-165.

Cantor, Richard and Nelson C. Mark (1988). "The International Transmission of Real Business Cycles," *International Economic Review* vol. 29, no. 3: 493-507.

Chyi, Yih-Luan (1998). "Business Cycles Between Developed and Developing Economies," *Review of International Economics* vol. 6, no. 1: 90-104.

Coe, David, Elhanan Helpman, and Alexander Hoffmaister (1997). "North-South R&D Spillovers," *The Economic Journal* vol. 107, January: 134-149.

Correia, Isabel, Joao C. Neves, and Sergio Rebelo (1995). "Business Cycles in a Small Open Economy." *European Economic Review* vol. 39: 1089-1113.

Crucini, Mario J. (1997). "Country Size and Economic Fluctuations," *Review of International Economics* vol. 5, no. 2: 204-220.

Dellas, Harris (1986). "A Real Model of the World Business Cycle," *Journal of International Money and Finance* vol. 5: 381-394.

Dickey, David A., Dennis W. Jansen, and Daniel L. Thornton (1991). "A Primer on Cointegration with an Application to Money and Income," *Federal Reserve Bank of St. Louis Economic Review* March/April: 58-78.

The Economist (2000). "When America Comes to Earth," July1: 69-70.

Fernandez-Arias, Eduardo (1996). "The New Wave of Private Capital Inflow: Push or Pull?" *Journal of Development Economics* vol. 48, no. 2: 389-418.

Fischer, Stanley (1993). "The Role of Macroeconomic Factors in Growth," *Journal of Monetary Economics* vol. 32: 485-512.

Forbes, Kristin (2000). "A Reassessment of the Relationship between Inequality and Growth." *American Economic Review* September: vol. 90, no. 4: 869-887.

Gambera, Michele (2000). "International Business Cycles, Stochastic Trends, and Risk Sharing," Federal Reserve Bank of Chicago Working Paper.

Greene, William H. (2000). *Econometric Analysis*, Upper Saddle River, NJ: Prentice Hall.

Gujarati, Damodar N. (1995). *Basic Econometrics*, New York: McGraw-Hill.

Hamilton, James D. (1994). *Time Series Analysis*, Princeton, NJ: Princeton University Press.

Hansen, Henrik and Katarina Juselius (1995). *CATS in RATS: Cointegration Analysis of Time Series*, Evanston, IL: Estima.

Harris, Richard (1995). *Using Cointegration Analysis in Econometric Modelling*, London: Prentice Hall.

Harrison, Ann (1996). "Openness and Growth: A Time-Series, Cross-Country Analysis for Developing Countries," *Journal of Development Economics* vol. 48, no. 2: 419-447.

Head, Allen C. (1995). "Country Size, Aggregate Fluctuations, and International Risk Sharing," *Canadian Journal of Economics* vol. 28, no. 4b:1096-1119.

Hodrick, Robert and Edward Prescott (1980). "Postwar U.S. Business Cycles: An Empirical Investigation," Discussion Paper no. 451 (Carnegie-Mellon University, Pittsburgh, PA).

International Monetary Fund. *International Financial Statistics Yearbook*, various editions.

Johansen, S. (1988). "Statistical Analysis of Cointegrating Vectors," *Journal of Economic Dynamics and Control*, vol. 12: 231-254.

Little, I.M.D., Richard N. Cooper, W. Max Corden, and Sarath Rajapatirana (1993). *Boom, Crisis, and Adjustment: The Macroeconomic Experience of Developing Countries*, New York: Oxford University Press, published for the World Bank.

Maddala, G.S. and In-Moo Kim (1998). *Unit Roots, Cointegration, and Structural Change*, Cambridge, UK: Cambridge University Press.

Mendoza, Enrique G. (1991). "Real Business Cycles in a Small Open Economy," *American Economic Review* vol. 81, no. 4: 797-818.

Mendoza, Enrique G. (1997). "Terms-of-Trade Uncertainty and Economic Growth," *Journal of Development Economics* vol. 54: 323-356.

Mendoza, Enrique G., Gian Maria Milesi-Ferretti, and Patrick Asea (1997). "On the Ineffectiveness of Tax Policy in Altering Long Run Growth: Harberger's Superneutrality Conjecture," *Journal of Public Economics* vol. 66: 99-126.

Neusser, Klaus (1991). "Testing the Long-Run Implications of the Neoclassical Growth Model," *Journal of Monetary Economics*, vol. 27: 3-37.

Obstfeld, Maurice and Kenneth Rogoff (2000). "The Six Major Puzzles in International Macroeconomics: Is There a Common Cause?" *National Bureau of Economic Research* Working Paper.

Obstfeld, Maurice and Kenneth Rogoff (1997). *Foundations of International Macroeconomics*. Cambridge, MA: MIT Press.

Schmitt-Grohe, Stephanie (1998). "The International Transmission of Economic Fluctuations: Effects of U.S. Business Cycles on the Canadian Economy," *Journal of International Economics*, vol. 44: 257-287.

Summers, Robert and Alan Heston (1991). "The Penn World Table (Mark 5): An Expanded Set of International Comparisons," *Quarterly Journal of Economics* May: 327-368.

Summers, Robert and Alan Heston (1993). *The Penn World Table (Mark 5.6)* data taken from http://cansim.chass.utoronto.ca:5680/pwt/pwt.html

Stockman, Alan C. and Linda L. Tesar (1995). "Tastes and Technology in a Two-Country Model of the Business Cycle: Explaining International Comovements," *American Economic Review* vol. 85, no. 1: 168-185.

Temple, Jonathon (1999). "The New Growth Evidence," *Journal of Economic Literature* vol. 37, March: 122-156.

United Nations. *International Trade Statistics Yearbook*, various editions.

World Bank. *World Tables*, various editions.

Data Appendix

The data on RGDP per capita are from the Penn World Tables, Mark 5.6. (Summers and Heston, 1991) The developing countries were selected on the basis of a quality rating offered by Summers and Heston, with a C minus being the lowest mark accepted. Setting the bar any higher would have eliminated all the African countries from the study. Data ranges and quality ratings are listed in Table 41 below.

Table 41: Data Quality Ratings

Country	Data Range	Quality Rating	Country	Data Range	Quality Rating
Argentina	1950 - 90	C	Kenya	1950 - 92	C
Bangladesh	1959 - 92	C -	Korea	1953 - 91	B -
Bolivia	1950 - 92	C	Malaysia	1955 - 92	C
Brazil	1950 - 92	C -	Mexico	1950 - 92	C
Cameroon	1960 - 92	C -	Morocco	1950 - 92	C -
Canada	1950 - 92	A -	Pakistan	1950 - 92	C -
Chile	1950 - 92	C	Panama	1950 - 92	C
Colombia	1950 - 92	C	Paraguay	1950 - 92	C
Costa Rica	1950 - 92	C	Peru	1950 - 92	C
Dominican Republic	1950 - 92	C	Philippines	1950 - 92	C
Ecuador	1950 - 92	C	Senegal	1960 - 91	C -
El Salvador	1950 - 92	C	Singapore	1960 - 92	C
France	1950 - 92	A	South Africa	1950 - 92	C -
Germany	1950 - 92	A	Sri Lanka	1950 - 92	C -
Guatemala	1950 - 92	C	Tanzania	1960 - 88	C -
Honduras	1950 - 92	C	Thailand	1950 - 92	C -
Hong Kong	1960 - 92	B -	Tunisia	1960 - 92	C -
Indonesia	1950 - 92	C	United Kingdom	1950 - 92	A
India	1960 - 92	C	United States	1950 - 92	A
Italy	1950 - 92	A	Uruguay	1950 - 92	C -
Ivory Coast	1960 - 92	C -	Venezuela	1950 - 92	C
Japan	1950 - 92	A	Zimbabwe	1954 - 92	C -

The openness measure was also taken from the Penn World Tables, Mark 5.6.

Interest rates are from the International Financial Statistics (IFS) Yearbooks. The treasury bill rate, line 60c, is used for Canada, the United Kingdom, and the United States. The money market rate, line 61b, is used for France, Germany, and Japan. Italy was not used because IFS did not report a short term rate for the entire time period under consideration. The nominal

interest rates were converted to real rates by subtracting the consumer price inflation rate, also found in the IFS Yearbooks.

The terms of trade was taken from the World Bank's World Tables, various issues. The 1995 issue of World Tables was also used to breakdown the panel by income level, export type, and indebtedness. The countries included in each of the panels are listed in Tables 42 through 45 below.

Table 42: Country Panels - Regions

Africa	Asia	Western Hemisphere
Cameroon	Hong Kong	Argentina
Ivory Coast	India	Bolivia
Kenya	Indonesia	Brazil
Morocco	Korea	Chile
Senegal	Malaysia	Colombia
South Africa	Pakistan	Costa Rica
Tunisia	Philippines	Dominican Republic
Zimbabwe	Singapore	Ecuador
	Sri Lanka	El Salvador
	Thailand	Guatemala
		Honduras
		Mexico
		Panama
		Paraguay
		Peru
		Uruguay
		Venezuela

Table 43: Country Panels - Income Levels

Low	Lower-Middle	Upper-Middle
Honduras	Bolivia	Argentina
India	Cameroon	Brazil
Ivory Coast	Colombia	Chile
Kenya	Costa Rica	Korea
Pakistan	Dominican Republic	Malaysia
Sri Lanka	Ecuador	Mexico
Zimbabwe	El Salvador	South Africa
	Guatemala	Uruguay
	Indonesia	Venezuela
	Morocco	
	Panama	
	Paraguay	
	Philippines	
	Peru	
	Senegal	
	Thailand	
	Tunisia	

Table 44: Country Panels - Export Type

Primary or Fuel	Diverse	
Argentina	Brazil	Pakistan
Bolivia	Cameroon	Philippines
Chile	Colombia	Senegal
Guatemala	Costa Rica	South Africa
Honduras	Ecuador	Sri Lanka
Ivory Coast	India	Thailand
Paraguay	Indonesia	Tunisia
Peru	Kenya	Uruguay
Venezuela	Malaysia	
Zimbabwe	Mexico	
	Morocco	

Table 45: Country Panels - Indebtedness

Severe	Moderate	Less
Argentina	Chile	El Salvador
Bolivia	Colombia	Guatemala
Brazil	Costa Rica	Korea
Cameroon	Dominican Republic	Malaysia
Ecuador	India	Paraguay
Honduras	Indonesia	South Africa
Ivory Coast	Mexico	Sri Lanka
Kenya	Pakistan	Thailand
Morocco	Philippines	
Panama	Senegal	
Peru	Tunisia	
Uruguay	Venezuela	
	Zimbabwe	

Table 46: Developing Country's Closest G-7 Trading Partner

Argentina	United States	Malaysia	Japan
Bolivia	United States	Mexico	United States
Brazil	United States	Morocco	France
Cameroon	France	Pakistan	United States
Chile	United States	Panama	United States
Colombia	United States	Paraguay	United States
Costa Rica	United States	Peru	United States
Dominican Republic	United States	Philippines	United States
Ecuador	United States	Senegal	France
El Salvador	United States	Singapore	United States
Guatemala	United States	South Africa	United Kingdom
Honduras	United States	Sri Lanka	United States
Hong Kong	United States	Thailand	Japan
India	United States	Tunisia	France
Indonesia	Japan	Uruguay	United States
Ivory Coast	France	Venezuela	United States
Kenya	United Kingdom	Zimbabwe	United Kingdom
Korea	United States		

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Long and Short Run Relationships between Industrial and Developing Countries

Dissertation directed by Parantap Basu, Ph.D.

The purpose of this dissertation was to search for empirical macroeconomic relationships, in terms of growth or business cycles, that exist between industrial and developing countries. In particular, this dissertation is an attempt to identify the channels through which economic events in industrial countries are transmitted to the economies of developing countries.

First, correlation analysis was used to see if business cycles are synchronized between industrial and developing countries. Little supportive evidence was found, which is surprising given the tendency for common business cycles among the industrial countries.

Second, cointegration analysis is used to test whether RGDPs per capita of industrial and developing country trading partners follow the same stochastic growth path over the long run. This could be the case if the benefits of technological progress in the industrial countries are spread to developing countries by way of trade. Limited evidence of cointegration is found.

Third, panel regressions are used to identify channels that transmit economic events from industrial countries to developing countries. By far the strongest channel found was the international real interest rate, which has a negative and significant impact on economic growth in developing countries. Higher international real interest rates discourage the use of debt finance to build either domestic capital or to purchase imported productive inputs, thereby reducing growth. The negative effect of international real interest rates on growth is also much

stronger for developing countries with heavy debt levels. Openness to trade, on the other hand, is found to have a positive and significant effect on growth in developing countries, but only if the developing country has a low debt level. Openness enhances technological change in developing countries by enabling transfers of knowledge across borders. In terms of policy, the evidence in this dissertation shows that a developing country can reduce exposure to international interest rate fluctuations and reap benefits from international trade if a conservative fiscal policy is followed.

VITA

Robert John Derrell, the son of Robert Stanley Derrell and Marcella Mary Derrell, was born in Milwaukee, Wisconsin, on October 12, 1970. He grew up in Oak Creek, Wisconsin, graduating from Oak Creek Senior High School in 1988. He entered Marquette University in Milwaukee, Wisconsin in the fall of 1988, and graduated in May of 1992 with a Bachelor's degree in Business Administration.

In the fall of 1993, he entered Fordham University to pursue a Master's degree in Economics, which he earned in September of 1994. In the fall of 1994, he then entered the Ph.D. program at Fordham, finishing the course work for the degree in the spring of 1996. After completion of courses, he postponed further studies to work in the financial industry. In the spring of 1998, he returned to Fordham and taught introductory economics courses at Fordham College. In the fall of 2000, he began a full-time position at Manhattanville College in Purchase, New York, teaching both economics and finance courses.