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Trade Intensity and Business Cycle Synchronization: Are Developing Countries any Different?

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Abstract*

Some key criteria in the optimal currency area literature are that countries should join a currency union if they have closer international trade links and more symmetric business cycles. However, both criteria are endogenous. Frankel and Rose (1998) find that trade intensity increases cycle correlation among industrial countries. We study whether the same result holds true for the case of developing countries, as their different patterns of international trade and specialization may lead to cyclical asymmetries among them and between industrial and developing countries. We gather annual information for 147 countries for 1960-99 (33,676 country pairs) and find: (i) countries with higher bilateral trade exhibit higher business cycle synchronization, with an increase of one standard deviation in bilateral trade intensity raising the output correlation from 0.05 to 0.09 for all country pairs; (ii) countries with more asymmetric structures of production exhibit a smaller business cycle correlation; (iii) the impact of trade integration on business cycles is higher for industrial countries than both developing and industrial-developing country pairs; (iv) a one standard deviation increase in bilateral trade intensity leads to surges in output correlation from 0.25 to 0.39 among industrial countries, from 0.08 to 0.10 for our sample of industrial-developing country pairs, and from 0.03 to 0.06 among developing countries; (v) the impact of trade intensity on cycle correlation is smaller the greater the production structure asymmetries between the countries.

Keywords: Bilateral Trade, Business Cycle Synchronization, de-trending techniques

JEL Classification Numbers: E32, F15

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1. Introduction

The recent creation of the European Monetary Union (EMU) and the recent debate on dollarization in several developing countries have renewed the interest in the economics of currency unions. Countries forming a currency union typically benefit from the reduction in transaction costs associated to trade and investment flows and thus may benefit from economic specialization (Rose, 2000). However, these microeconomic efficiency benefits may be offset by the loss of macroeconomic flexibility associated with a common currency. In particular, countries joining a currency union may lose their ability to stabilize cyclical fluctuations through independent counter-cyclical monetary policy. Both the benefits and the costs of currency unions depend on the characteristics of the countries involved.

Traditional literature on optimal currency areas (OCAs)—which began during the early 1960s with the work of Mundell (1961) and McKinnon (1963)—aims at establishing the conditions under which the benefits of joining a currency union would outweigh its costs. Among the key criteria considered in the OCA literature is the degree of trade integration among the potential members, as well as the degree of symmetry of their business cycles.[1] The degree of integration matters because the reduction in transaction costs associated with the use of a common currency will have a larger impact the larger the size of the trade and investment flows among the member countries. The symmetry of the business cycle, in turn, plays a key role in determining the cost of sacrificing an independent monetary policy. In summary, countries with close international trade links are more likely to be members of an OCA, whereas countries with asymmetric business cycles are less likely to be members of an OCA.

While the traditional OCA literature treats these criteria as exogenous, recent literature argues that both trade integration and cycle synchronization are in fact endogenous (Frankel and Rose, 1997 and 1998). First, currency unions can affect trade intensity. In fact, recent empirical literature stresses the large positive effects of currency unions on trade (Rose, 2000; Glick and Rose, 2001).[2] Trade intensity, in turn, may affect cycle correlation. Empirical studies for the case

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[1] Additional OCA criteria, such as the degree of labor mobility, wage flexibility, or the existence of fiscal transfers among the members, relate to the cost of processing the necessary adjustments in the case of asymmetric shocks among the member countries when independent monetary policy has been foregone.

[2] New evidence suggests that Rose and associates might be overestimating the impact of currency unions on trade due to: (a) problems of sample selection and non-linearities (Persson, 2001), and (b) not adequately taking into account the possibility that joining a currency union could be an endogenous decision (Tenreyro, 2001). A recent paper by Micco, Stein and Ordoñez (2002) finds the impact of EMU on trade to be on the order of 15 percent.

of industrial countries (Frankel and Rose, 1997, 1998; Fatas, 1997; Clark and van Wincoop, 2001) provide evidence that countries with closer trade linkages exhibit highly correlated business cycles. This finding motivated Frankel and Rose to state that countries that are *ex ante* poor candidates to enter a monetary union could satisfy the criteria *ex post* because entry to the currency union *per se* may provide an additional impulse for trade expansion that may result, in turn, in higher business cycle correlation.

As is obvious from the discussion above, the link between trade intensity and business cycle correlation plays a crucial role when considering the merits of a currency union among countries that *a priori* do not seem to comply with the OCA criteria. But are the lessons derived from the experience of industrial countries useful in helping to guide policy decisions in developing countries? Theory suggests that, in the case of developing countries, the lessons derived from the experience of industrial countries should be handled with a great deal of caution.

According to the theoretical literature, the impact of trade integration on business cycle correlation could go either way. On the one hand, if the demand channel is the dominant force driving business cycles, we expect trade integration to increase cycle correlation. For instance, positive output shocks in a country might increase its demand for foreign goods. The impact of this shock on the cycle of the country's trading partners should depend on the depth of the trade links with each of the partners. On the other hand, if industry-specific shocks are the dominant force in explaining cyclical output, the relationship would be negative if increasing specialization in production leads to *inter-industry* trade (as usually observed in developing countries). In this case, trade integration leads to specialization in different industries, which in turn leads to asymmetric effects of industry-specific shocks. In contrast, if *intra-industry* trade prevails (as observed in industrial countries), specialization does not necessarily lead to asymmetric effects of industry-specific shocks, since the pattern of specialization occurs mainly within industries. In summary, the total effect of trade intensity on cycle correlation is theoretically ambiguous and poses a question that could only be solved empirically. However, the important differences in the pattern of trade and specialization among country pairs of different type suggest that the impact of trade integration on cycle correlation in developing countries may differ substantially from that among industrial countries.

Our paper extends the study of Frankel and Rose (1998) in order to analyze the impact of trade integration on business cycle correlation not only among industrial countries but also among developing countries, as well as among "mixed" (industrial-developing) country pairs. By working with a sample of 147 industrial and developing countries, we are able to test whether the links between trade intensity and business cycle correlation are different depending on the nature of the countries involved. We expect the impact to differ across groups of countries, due to their different patterns of trade and specialization (i.e., inter- vs. intra-industry trade patterns). Our prior is that trade intensity should have a positive effect on cyclical output correlation among industrial countries, and a smaller (and ambiguous) effect among other country pairs.

In studying the effects of trade intensity on cycle correlation, we follow the recent OCA literature by taking into account the fact that trade intensity itself may be endogenous (Frankel and Rose, 1998), through at least two different channels. First, cycle correlation could lead to currency unions, which in turn could lead to increased trade intensity. Second, by joining a currency union, countries reduce transaction costs, and at the same time link their monetary policies to that of their partners. While lower transaction costs increase trade links, convergence in macroeconomic policies (i.e., countries sharing a common monetary policy stance) might lead to higher output correlation. Therefore, a positive relationship between trade intensity and cycle correlation could potentially be due to both variables being explained by a third factor, namely the formation of a currency union. Among our main findings, we conclude that:

(1) On average, higher trade integration leads to higher business cycle synchronization. This result is robust to changes in the measure of bilateral trade intensity, to the de-trending techniques used to compute cyclical output, or the estimation method (OLS or IV).

(2) Our coefficient estimates suggest that the correlation between cyclical output increases from a starting mean of 0.05 to 0.09 when the bilateral trade intensity increases by one standard deviation.

(3) The impact of trade intensity on business cycle correlation for industrial countries is significantly higher than the one for the sample of developing countries and the sample of "mixed" country pairs. In particular, a one standard deviation increase in our coefficient of bilateral trade leads to a surge

in our business cycle correlation from a starting mean of: (a) 0.25 to 0.399 for industrial countries, (b) 0.075 to 0.104 for our sample of mixed country pairs, and (c) 0.031 to 0.059 for our sample of developing countries. Note that the result in (a) is similar to the one found by Frankel and Rose (1998), although we are working with a larger sample and different time period.

(4) We find robust evidence of a negative interaction effect between trade integration and an index of asymmetries in the structure of production (which we use as a proxy for the extent of inter-industry trade). As expected, the impact of trade intensity on cycle correlation is larger when countries have similar production structures.

The rest of the paper is organized as follows. Section 2 provides some theoretical insights regarding the relationship between trade integration and the synchronization of business cycles. Section 3 discusses the data and presents the econometric methodology used in our empirical evaluation. Section 4 discusses the main empirical results and relevant extensions. Finally, Section 5 concludes.

2. Some Theoretical Insights

In order to understand the different channels through which trade intensity can impact business cycle synchronization, we follow Frankel and Rose (1998) in using Stockman's (1988) decomposition of the growth rate of the economy at time t, $dlny_{it}$, as the weighted average of the growth rates in every sector of the economy $d\,lny_{kit}$ (with $k=1,...,n$), with the weights (ω_{ki}) being approximated by the share of sector k's output in total output (with $\Sigma_k \omega_{ki} = 1$), that is:

$$d \ln y_{i,t} = \sum_k \omega_{ki} d \ln y_{kit} \qquad (1)$$

If we express the growth rate in sector k at time t as deviations from the country's average growth rate of output at time t, $d\ ln\ y_{\bullet it}$, we can express (1) as:

$$d \ln y_{it} = \sum_k \omega_{ki} \xi_{kit} + \eta_{it} \qquad (2)$$

where the growth rate of real output for the domestic country at time t ($d\ln y_{it}$) consists of the weighted average of sector-specific deviations of the growth rate of output in sector k at time t ($\xi_{kit} = d\ln y_{kit} - d\ln y_{\bullet it}$) and the average growth rate of total output of the country at time t (η_{it}).

Analogously, we define the growth rate of the foreign country (country j) as:

$$d\ln y_j = \sum_k \omega_{kj}{}^* \xi_{kjt} + \eta_{jt} \qquad (2^*)$$

Following Stockman (1988) we assume that: (i) $\{\xi_{kit}\}$ is distributed independently of each other across both sector and time, with sectoral variance σ_k^2; (ii) $\xi_{kit} = \xi_{kjt}$, that is industry shocks are similar across countries, and have the same variance σ_k^2; (iii) $\{\eta_{it}\}$ is distributed independently over time; (iv) $\{\xi_{kit}\}$ and $\{\eta_{it}\}$ are independent from each other. Given these assumptions, we can compute the covariance between the growth rates of the domestic and foreign countries, i.e., $\sigma(y_i ,y_j)= cov(d\ln y_{it}, d\ln y_{jt})$:

$$\sigma(y_i, y_j) = \sigma_k^2 \sum_i \omega_{ki}\omega_{kj} + \sigma(\eta_i, \eta_j) \qquad (3)$$

where $\sigma(\eta_i,\eta_j)$ is the covariance between country-specific aggregate shocks. In terms of correlation coefficients, we can reformulate (3) as:

$$\rho(y_i, y_j) = \sum_k \tilde{\omega}_{ki}\tilde{\omega}_{kj}{}^* \sigma_k^2 + \omega_{\eta,y}\rho_{\eta,\eta^*} \qquad (4)$$

where $\rho(y_i,y_j)$ represents the output correlation, $\rho(\eta_i,\eta_j)$ is the correlation between country-specific aggregate shocks, $\hat{\omega}_{ki} = \omega_{ki}/\sigma(y_i)$ and $\omega_{\eta,y} = [\sigma(\eta_i)/\sigma(y_i)]/[\sigma(\eta_j)/\sigma(y_j)]$ represent the weights for the variance of industry shocks (σ_k^2) and for the correlation of country-specific aggregate shocks $\rho(\eta_i,\eta_j)$, respectively. The former set of weights, $\hat{\omega}_{ki}$ and $\hat{\omega}_{kj}$, are a direct function of the shares in total output of the different industries in Home and Foreign countries (countries i and j), respectively; whereas the latter set of weights, $\omega_{\eta,y}$, depend directly on the relative volatility of the aggregate shock (with respect to output) in both countries.

According to the literature, the impact of greater trade integration on business cycle synchronization is theoretically ambiguous. Standard trade theory (Heckscher-Ohlin paradigm) predicts that openness to trade would lead to an *increasing specialization in production along industry lines, and inter-industry patterns of international trade* (as typically observed among developing countries). If business cycles are dominated by *industry-specific shocks*, ξ_{kit}, we would expect that higher trade integration, by bringing about deeper specialization, would lead to decreasing business cycle correlations (*i.e.* given that σ_k^2 is always positive, we expect a negative correlation between $\hat{\omega}_{ki}$ and $\hat{\omega}_{kj}$). Kalemli-Ozcan, Sorensen and Yosha (2001) find another mechanism that will render a negative correlation between trade integration and business cycle correlations. With higher integration in both international financial markets and goods markets, countries should be able to insure against asymmetric shocks through diversification of ownership and can afford to have a specialized production structure. In this case, better opportunities for income diversification induce higher specialization in production, which are associated with more asymmetric business cycles.

On the other hand, if patterns of specialization in production and international trade are dominated by *intra-industry trade* (as frequently observed among industrial countries), deeper trade links will not necessarily result in deeper specialization along industry lines, as predicted by standard trade theory. In this case, then, industry specific shocks will not necessarily affect different countries more asymmetrically as they become more integrated (see Krugman, 1993). In terms of the model, deeper trade integration does not necessarily lead to a negative correlation between $\hat{\omega}_{ki}$ and $\hat{\omega}_{kj}$. Consistent with the intra-industry perspective, it has been shown that an increasing amount of trade is vertical or fragmented (Hummels, Ishii and Yi, 2001), that is, countries are increasingly specializing in particular stages of a good's production sequence, instead of producing the entire good.[3] Kose and Yi (2001) argue that allowing for more of this *"back-and-forth"* trade might lead to a greater response of the business cycle correlations to higher trade integration.

Finally, theoretical advances and empirical evidence supports the existence of different channels through which higher integration might have an impact on the *correlation between country-specific aggregate shocks*, $\rho(\eta_i,\eta_j)$. First, spillover effects from aggregate demand shocks might increase $\rho(\eta_i,\eta_j)$. In this case, surges in income in one country might lead to higher demand for both foreign and domestic goods. This effect might be even stronger if trade integration leads to more coordinated policy shocks (Frankel and Rose, 1998).[4] Second, higher trade integration might lead to a more rapid spread of productivity shocks through a more rapid diffusion of knowledge and technology (Coe and Helpman, 1995) or via inward FDI and

[3] Yi (2001) shows that models of international trade with vertical specialization can explain about 70 percent of growth in world trade.
[4] In the presence of fiscal consolidation or more coordinated monetary policies, the impact of spillovers from aggregate demand is even larger.

technology sourcing (Lichtenberg and van Pottelsberghe, 1998). Table 1 provides a summary of the effects discussed above.

As we can observe from the table above, the relationship between trade integration and business-cycle-synchrony is theoretically ambiguous. While the impact is positive if country-specific aggregate shocks dominate business cycles, the effect of trade integration is not clear if industry-specific shocks are the main source of business cycle. In the latter case, the nature of the relationship between trade integration and cyclical output correlations depend on the patterns of specialization in production once the economy is open to international markets. Given the observed patterns of specialization in the world economy, we expect a positive correlation between trade integration and business cycle correlations among industrial countries, and a more ambiguous relationship (i.e., positive and smaller than among industrial countries, and in some cases negative) among industrial-developing country pairs and among developing countries.

3. Data and Methodology

3.1 The Data

The core of our empirical analysis lies in the measurement of both bilateral trade intensity and the bilateral correlations of real economic activity. First, the *bilateral intensity of international trade* between countries i and j at time τ is approximated with the following measures:

$$xm(i,\, j)_{\tau}^{1} = \frac{1}{\tau}\sum_{t=1}^{\tau}\frac{f_{ijt}}{F_{it} + F_{jt}} \qquad (5a)$$

$$xm(i,\, j)_{\tau}^{2} = \frac{1}{\tau}\sum_{t=1}^{\tau}\frac{f_{ijt}}{Y_{it} + Y_{jt}} \qquad (5b)$$

In equations (5a)-(5b), f_{ijt} denotes total bilateral trade flows of (exports to and imports from) countries i and j, whereas F_{kt} represents total trade flows (aggregate exports and imports) of country k (with k=i,j). Our two measures of bilateral trade intensity follow Frankel and Rose (1997, 1998). In equation (5a), we compute $xm(i,j)_{\tau}^{1}$ as the ratio of bilateral trade flows between countries i and j divided by the sum of countries i and j's total trade flows. Our second measure,

$xm(i,j)^2_\tau$ in equation (5b), is the ratio of bilateral trade flows between countries i and j to output in both countries (Y_{it} and Y_{jt}, respectively).[5]

The bilateral trade data are taken from the International Monetary Fund's Direction of Trade data set, whereas nominal and real GDP data are taken from the World Bank's World Development Indicators. We have annual data for the 1960-99 period on bilateral trade flows for the 147 countries in our sample (see Appendix 2 for our list of countries), and we used exports FOB and imports CIF in order to construct the measures specified in equations (5a)-(5b).[6] A problem that is typical of bilateral trade data is that export flows from country i to country j are not necessarily equal to import flows of country j from country i. In this case, we have always relied on the data reported by the country with higher income in the country-pair. Since it is not clear whether it is more appropriate to build the measures of trade intensity normalizing by trade or total output, we conduct our econometric tests using both. The other key variable in our study is the *degree of business cycle synchronization between* countries i and j at time τ. To measure this variable, we follow Frankel and Rose (1997 and 1998) and compute the correlation between the cyclical components of output for countries i and j,

$$corr(y_i^c, y_j^c) = \frac{cov(y_i^c, y_j^c)}{\sqrt{var(y_i^c)\, var(y_j^c)}} \qquad (6a)$$

where y^c is the cyclical component of output (y). Our measure of output (y) is the (log of the) real GDP in local currency at constant prices, taken from the World Bank's World Development Indicators.[7] The cyclical component of output (y^c) is obtained using different de-trending techniques, as discussed below. Once we obtain the cyclical component of output for all countries, we compute bilateral correlations of real activity. Higher correlations imply a higher degree of synchronization. Bayoumi and Eichengreen (1997 and 1998) have developed an

[5] In addition to these two measures of trade intensity, we also used a theoretical measure of bilateral trade intensity derived by Deardorff (1998), in which the bilateral trade is divided by the product of the GDPs, and multiplied by the world GDP. For reasons of space, we have not included these results in the present version. They are qualitatively similar to the results using our other measures and are available upon request.

[6] Although there was data for imports FOB on the IMF's Direction of Trade Statistics, the data availability was more limited. That is, it represents at most 20 percent of the coverage with imports CIF.

[7] In addition to output, Frankel and Rose (1997 and 1998) use alternative measures of economic activity, such as industrial production, employment, and unemployment. Since these measures are not widely available for the much larger sample of countries included in our study, all of our results are based on measures of output correlation. In any case, it is reassuring that the results in Frankel and Rose (1997 and 1998) do not seem to be sensitive to the measure of economic activity used.

alternative measure of business cycle coherence. They compute an indicator of business cycle asymmetries for countries i and j, as follows

$$asymm(y_i, y_j) = \sigma\left(\frac{y_{it}}{y_{jt}} - \frac{y_{i,t-1}}{y_{j,t-1}}\right) \qquad \text{(6b)}$$

where *y* represents output (in logs), and $\sigma(\cdot)$ represents the standard deviation computed over τ periods; hence, *asymm*(y_i, y_j) is the standard deviation of changes in the log of relative output between countries i and j. The lower the value of *asymm*(y_i, y_j), the higher the degree of business cycle synchronization.[8]

3.2 Empirical Strategy

We have collected annual data for 147 countries over the period 1960-99on both real GDP and bilateral trade. After transforming our output data, we compute our measures of business cycle synchronization between countries i and j over a given span of time τ. We split our sample into four equally sized parts: 1960-69, 1970-79, 1980-89, and 1990-99. In addition, we compute averages of our annual bilateral trade intensities over each decade.

3.2.1 The Regression Framework

In order to test the impact of trade integration (approximated by coefficients of bilateral trade intensity) on business cycle synchronization (measured by the correlation between cyclical outputs), we run the following regression:

$$\text{corr}(y_{i\tau}, y_{j\tau}) = \mu + \gamma \ \ln(1+xm(i,j))_\tau + u(i,j)_\tau , \qquad \text{(6)}$$

where *corr*($y_{i\tau}$, $y_{j\tau}$) denotes the business cycle correlation between country i and country j over time period τ, and $xm(i,j)_\tau$ represents the average bilateral trade intensity between country i and country j over the time period τ.[9] Our main interest lies in the sign and the magnitude of the slope coefficient γ. If industry shocks are the dominant source of business cycles and openness to trade leads to complete specialization (as Heckscher-Ohlin would predict), we would expect γ to be

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[8] If *asymm*(y_i, y_j) = 0, if both countries have analogous cycles.

[9]The trade intensity enters the equation in logs, following Frankel and Rose (1997 and 1998). In our large sample of 147 countries, there are many observations in which trade intensity is zero. Obviously, we would not want to drop these observations, since they provide relevant information for the problem at hand. For this reason, we use ln (1+f(i,j)) rather than $_\tau$ ln (f(i,j)), a transformation that would be unnecessary in a sample of industrial countries, in which all country pairs have positive trade.

negative. On the other hand, if industry shocks lead to vertical specialization (and, therefore, more intra-industry trade), or if global shocks dominate economic fluctuations then we would expect γ to be positive.

A problem with equation (6) is that, as discussed earlier, trade intensity itself may be endogenous. Higher output correlation could encourage countries to become members of a currency union, which in turn could lead to increased trade intensity (Frankel and Rose, 1998 and 2002; Rose and Engel, 2002). Alternatively, both of our variables of interest, namely output correlation and trade intensity, could be explained by a third one, such as currency union, which at the same time reduces transactions costs in trade flows and links the macroeconomic policies of their members. Hence, countries joining a currency union might exhibit a positive correlation between trade integration and business cycle synchronization. In this context, running an OLS regression for equation (6) would yield biased and inconsistent estimates for γ. Given the problems mentioned above, we need instruments for the bilateral trade intensity in order to estimate γ consistently. We use the gravity model of bilateral trade to motivate our choice of instrumental variables. Following Wei (1996) and Deardorff (1998), the regression for bilateral trade we use is:

$$ln\,(1+xm_{ij}) \approx xm(i,j) = \beta_0 + \beta_1\, ln\, y_i + \beta_2\, ln\, y_j + \beta_3\, ln\, d_{ij}$$
$$+ \beta_4\, ln\, B_{ij} + \beta_5\, ln\, REM_i + \beta_5\, ln\, REM_j + Z'\gamma + \varepsilon_{ij} \qquad (7)$$

where f_{ij} is our measures of bilateral trade flows country i to country j, y_i and y_j represent initial output (real GDP) in countries i and j, d_{ij} is the distance between countries i and j (in logs), and B_{ij} is a dummy variable equal to one for countries that share a common border. We expect that bilateral trade between countries i and j will increase if their outputs increase, if they are closer in distance, and if they share a common border. Furthermore, we include an indicator of geographical remoteness for countries i and j that measures how far each country lies from alternative trading partners.[10]

Finally, the matrix Z comprises other variables that are used in the empirical literature of the gravity equation model of trade. Here, we additionally control for initial population and area

[10] Presumably, trade intensity would increase the farther the countries in the pair are to alternative markets. Following Wei (1996) and Deardorff (1998), we construct a formula for the remoteness of country i as the weighted average of that country's distances to all of its trading partners (except for the country j involved in a determined country pair), using as weights the share of the partner's output in world GDP. That is, for a determined (i,j)-country-pair, the that this measure complies with several desirable properties for a measure of remoteness.

in countries i and j, number of islands and landlocked countries in the (i,j) country pair, a dummy variable for countries with regional free trade agreements, and dummies for common geographical region, common language, common colonial origin, and common main trading partner.[11]

3.2.2 Robustness Checks

In order to check the robustness of γ, we first evaluate the sensitivity of our parameter of interest to changes in the de-trending technique used to compute business cycles and, second, we analyze the sensitivity of γ to the inclusion of additional controls.

Different business cycle filters. Our first step to check for the robustness of our results will be to check the sensitivity of γ to changes in the cyclical component used in order to compute the business cycle correlations. For that reason and given the lack of consensus about optimal de-trending techniques, we use four different procedures to decompose output into trend and cycle: (a) quadratic trend model, (b) first-differences, (c) the Hodrick-Prescott (HP) filter, and (d) the Band-Pass filter (Baxter and King, 1999). In addition, we use the index of business cycle asymmetries used by Bayoumi and Eichengreen (1997 and 1998), which we discussed above. Our preferred de-trending technique for the discussion of our results is the *band-pass filter* proposed by Baxter and King (1999). Unlike other trend-cycle decomposition techniques, this filter takes into account the statistical features of the business cycle.[12] In accordance with these statistical properties, Baxter and King showed that the desired filter is a *band-pass filter*, that is, a filter that passes through components of the time series with periodic fluctuations between 6 and 32 quarters, while removing components at higher and lower frequencies.[13] While much of the discussion will be based on the results using this de-trending technique, the results that we will present in Sections 4 and 5 are robust to any of the four trend-cycle decomposition techniques used in this paper.

[11] The specification of our gravity equation model follows Rose and Engel (2002).

[12] The NBER chronology lists 30 complete cycles since 1858. The shortest full cycle (peak to peak) was 6 quarters, and the longest 39 quarters, with 90 percent of these cycles being no longer than 32 quarters (Stock and Watson, 1999).

[13] Baxter and King (1999) argue that the ideal band-pass filter is a moving average process with infinite order. Due to practical reasons, we must approximate this filter with finite moving averages. They specifically recommend the use of a 7-year centered moving average when working with both quarterly and annual time series data. Finally, note that although we used the band-pass filter as our preferred de-trending technique, the results that we will present in Sections 4 and 5 are robust to any of the four trend-cycle decomposition techniques used in this paper.

Additional Controls. We also test the robustness of γ to the inclusion of possible omitted variables that could help explain business cycle synchronization. Similarities in the structure of production imply that industry-specific shocks tend to have similar effects on aggregate fluctuations across national borders. Evidence shows that these shocks will generate higher degree of business cycle synchronization among regions with similar production structures rather than among regions with asymmetric structures (Imbs, 1999; Loayza, López, and Ubide, 1999). Similarities in the structure of production are approximated using the absolute value index suggested by Krugman (1991). Letting $s_{k,i}$ and $s_{k,j}$ denote the GDP shares for industry k in countries i and j (k=1, 2, ...,N), the similarity of country j's and country k's production structures is measured as $\sum_{k=1}^{N} \left| s_{ki} - s_{kj} \right|$. Note that the higher is the value of this index, the greater is the difference in industry shares across countries i and j and, therefore, the greater are the differences in economic structure. Given that industry specialization may affect business cycle synchronization through different mechanisms, we measure specialization using the 9-sector classification from the 1-digit level ISIC code.[14] Data for the construction of these indices was obtained from the World Bank and UNIDO.[15]

4. Empirical Assessment

In this section, we present our empirical assessment on the relationship between trade integration and business cycle synchronization for the sample of all country pairs. As we stated in Section 3, we have annual data on output and bilateral trade for 147 countries over the 1960-99 period. In order to measure our dependent variable (business cycle correlation), we compute the business cycle of real GDP over our sample period using different de-trending techniques (i.e., log-linear, first differences, Hodrick-Prescott, and band-pass filter). Then, we compute the business cycle correlation between countries i and j over a given span of time. In this case, we split the 1960-99 period into four equally-sized sub-periods, and we are able to compute a total of 33,676 bilateral

[14] In the 1-digit level ISIC code we find the following sectors: (i) Agriculture, Hunting, Forestry, and Fishing; (ii) Mining and Quarrying; (iii) Manufacturing; (iv) Electricity, Gas, and Water; (v) Construction; (vi) Wholesale and Retail Trade; (vii) Transport, Storage and Communication; (viii) Finance, Insurance, Real Estate, and Business Services, (ix) Community, Social, and Personal Services.

[15] Alternatively, we also used a 3-sector version of this index, discriminating between agriculture, industry and services. While it is a much more rough indicator of production asymmetries, it is available for a somewhat larger

output correlations: 6,232 for the 1960s, 7,753 for the 1970s, 10,127 for the 1980s, and 9,564 for the 1990s). Likewise, our annual data on bilateral trade intensity is averaged over each decade to be compatible with our regression framework.[16]

4.1 Descriptive Statistics

In Table 2 we present some descriptive statistics on cyclical output correlation as well as the index of business cycle asymmetries for all country pairs, and the evolution of these average correlations over time. Before stating our results, we should observe that the degree of association between output correlations obtained with the quadratic trend and the correlations obtained with other filters is smaller than the degree of association among the latter ones.[17] On the other hand, business cycle correlations obtained with first-difference, Hodrick-Prescott, and band-pass filters are highly correlated among them, with their degree of association fluctuating between 0.77 and 0.94. Finally, we find that our index of business cycle asymmetries is negatively associated with our different measures of cyclical output correlation (as expected), with the correlation coefficient fluctuating between –0.13 (quadratic trend) and –0.25 (first differences).

On average, the measure of business cycle synchronization for all country pairs over the 1960-99 period (*"pooled"* correlation) fluctuates between 0.0372 (using first differences) and 0.065 (using the quadratic trend filter), with this correlation measure being weaker in the 1960s (around 0.0084 and 0.0234) and stronger in the 1990s (around 0.039 and 0.102).

In Table 3, we present the average business cycle synchronization across different groups of country pairs. We find that the highest cyclical output correlation is exhibited by the pairs of industrial countries, (IND,IND), with an average that fluctuates around 0.2255 (using first differences) and 0.2604 (using the quadratic trend filter). On the other hand, output correlations for country pairs of developing countries, (DEV,DEV), are quite small and they fluctuate around 0.0203 (using first differences) and 0.0547 (using the quadratic trend filter). Furthermore, we

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sample (25,632 *vs.* 20,131 observations). The results using this alternative index are basically unchanged, and for this reason we do not report them.

[16] In addition to our pooled data analysis, we also conducted our regression analysis in a purely cross-sectional dimension. That is, we compute the business cycle correlations for countries i and j over the whole sample period, and we averaged the annual bilateral trade data over the 1960-99 period. That is, we have one observation per country pair (instead of four). The results are qualitatively and quantitatively similar to the results presented here, and are available from the authors upon request.

find that the output correlation among mixed industrial-developing country pairs, (IND,DEV), are larger than the correlations for (DEV,DEV) pairs. These correlations fluctuate around 0.0581 (using first differences) and 0.0862 (using HP filter). From these observations, we can see that both North-North and North-South cycles are more synchronized than South-South cycles regardless of the de-trending technique used (see Table 3).[18]

Finally, we find that (IND,IND)-country-pairs have higher bilateral trade intensity (0.35) than the one exhibited by (IND,DEV) and (DEV,DEV) country pairs (0.04 for both groups of country pairs) if we use the bilateral trade intensity as a percentage of the country-pair's real GDP. Finally, we find that (IND,IND) country pairs have the lowest value for the index of economic structure asymmetries.[19]

4.2 Correlation Analysis

Before conducting our regression analysis, we present the correlation analysis between output correlation and bilateral trade intensity for the sample of all country pairs and different sub-samples of country pairs. This provides a rough first look at the link between our main variables of interest (see Table 4). In the first panel of Table 4, we show the simple correlation between trade intensity and cyclical output correlation. For the whole sample of country pairs, we find a positive and significant relationship between our two variables of interest. This positive relationship is robust to changes in the measures of bilateral trade intensity and to changes in the de-trending procedure to compute cyclical components. Whether we normalize by output or total trade, we find that this correlation fluctuates between 0.047 and 0.089 across the different de-trending techniques. As expected, we also find that our index of cycle asymmetries is inversely related to bilateral trade intensity, with their correlation fluctuating from –0.063 to –0.097.

In the second panel of Table 4, we compute the correlation between bilateral trade intensity and business cycle synchronization *conditional* on geographical factors and income measures (i.e., national borders, distance and remoteness, number of islands and landlocked countries, common geographical region, common language, common main trading partner,

[17] The degree of between the quadratic trend correlations and the other filters fluctuates between 0.37 and 0.41.
[18] These results are corroborated by our index of cycle asymmetries, with the group of industrial countries showing a more symmetric behavior than developing countries, while mixed country-pairs are somewhere in between.
[19] These sample statistics are not reported but available from the authors upon request.

colony, dummy for regional free trade agreements, output, area, and population).[20] We find that the conditional correlations are not only positive and significant but also higher than the simple correlations. The correlation between output correlation and bilateral trade intensity (as a percentage of either total trade or GDP) fluctuates around 0.11, whereas the correlation between the index of cyclical asymmetries and trade intensity fluctuates from –0.1598 and –0.2063.

In Table 4, we also present the correlation analysis between cycle synchronization and trade intensity for different groups of country pairs. We generally find that (IND, IND) country pairs display the highest correlation between trade intensity and cycle synchronization among the different groups of country pairs, with a conditional correlation that fluctuates between 0.191 and 0.268. The co-movement between our two variables of interest for (DEV, DEV) country pairs is also positive and significant (with the conditional correlation fluctuating from 0.067 and 0.085), while that for (IND, DEV) fluctuates within the range (-0.0045, 0.0657). This first look at the evidence provides support to the hypothesis that the link between trade intensity and cycle correlation is stronger among industrial countries. We do find, however, that such a link is positive and significant for every country pair grouping we have considered.

4.3 Regression Analysis

We begin by presenting the estimates for our parameter of interest γ in equation (6) for our sample of all country pairs (Table 6). We then check whether the results are different for different country pair groups (Tables 7 and 8), as well as across time (Table 9). In the discussion of the results, we will focus mostly on the estimates using the band-pass filter, although our main results are robust to the use of other de-trending techniques.

4.3.1 All Country-Pairs

We run our regression equation (6) for different measures of our dependent variable (i.e., cyclical output correlation and index of cyclical asymmetries) and measures of bilateral trade normalized by total trade and output for all country pairs.[21] Our OLS estimates of the coefficient

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[20] This implies the calculation of a *partial correlation* between trade integration and business cycle synchronization, after taking into account geographical features and output levels that could affect both bilateral trade and output correlation.

[21] Our regressions include time dummies for the 1970-79, 1980-89 and 1990-99 periods, with the constant representing the 1960-69 period (base category). Although the estimates for the time dummies are not reported, they are jointly significant in the majority of cases.

γ in equation (6) are biased and inconsistent due to the endogeneity of bilateral trade. Hence, we need to find instruments for bilateral trade in order to estimate our coefficient of interest more efficiently. We take advantage of the vast literature on the gravity equation of international trade in order to choose our set of instruments for the bilateral trade intensity (Frankel and Romer, 1999; Rose, 2000)

According to the literature, bilateral trade intensity between countries i and j is instrumented with the following variables: distance between countries i and j, remoteness of countries i and j, output, population, and area of both countries, dummy variables for common border, common geographical region, common language, colony, common main trading partner, dummy for regional free trade agreement, number of islands in the (i,j) country pair, and number of landlocked countries in the (i,j) country pair. Except for the dummy variables, the determinants are expressed in logs.

Our results for the gravity equation model of trade (i.e., first stage regressions) are presented in Table 5. In general, we find that countries that share a common border, that are closer in distance and have trading partners that are farther away from the rest of the world, are members of the same region, speak the same language, have the same colonial origin and the same common main trading partner, higher GDP, smaller population, and engage in regional free trade agreements, trade more intensively.

In Table 6 we present our OLS and IV estimates of equation (6) for the sample of all country pairs. There we present our basic bivariate model (i.e. model M0), and the model M1, which is the basic model that includes the asymmetries in economic structures as an additional explanatory variable. Our OLS estimates show a positive and significant association between bilateral trade intensity and output correlation, which is robust to changes in the measure of the trade integration and the de-trending technique used to compute the cyclical fluctuations of output (see panel I of Table 6).[22] Regarding the magnitude of the effect, using our estimates for the band-pass filtered output correlations and the augmented model M1, we obtain that a surge in bilateral trade of one standard deviation starting from the mean would be associated with a

[22] As expected, when we use the business cycle asymmetry index, the sign is reversed.

increase in the output correlation from an average of 0.05 to 0.0884 (if bilateral trade is normalized by total trade) and 0.0777 (if normalized by output).[23]

In panel II of Table 6, we present our IV estimates for the impact of trade integration on output correlation. Our coefficient of interest is also positive and significant, thus suggesting that higher bilateral trade intensity generates more synchronized business cycles. However, unlike the OLS results, the impact of trade intensity appears somewhat larger in magnitude. An increase in the bilateral trade intensity of one standard deviation starting from the sample mean would increase the (band-pass filtered) bilateral output correlation from 0.05 to 0.086 (if normalized by total trade) and to 0.088 (if normalized by output).[24] Meanwhile, asymmetries in economic structure across countries have the expected negative sign with cyclical output correlation (and positive with cyclical asymmetries) although it is significant in some specifications. This implies that countries tend to respond similarly to productivity shocks or shocks to the composition of import demand from other countries if they have similar structures of production, and therefore, they tend to exhibit higher cyclical output correlation.

While our results suggest that the impact of trade intensity is positive and significant, it is much smaller than in Frankel and Rose (1998), who find that a one standard deviation increase in bilateral trade intensity raises cycle correlation from 0.22 to 0.35. This suggests that the impact may be smaller in the case of developing or mixed country pairs, which were absent in the Frankel and Rose paper. Next, we investigate whether the effects are different for different types of country pairs.

4.3.2 Industrial Countries (IND) vs. Developing Countries (DEV)

In Table 7 and 8, we present a set of regressions in which the bilateral trade intensity is interacted with slope dummies corresponding to country pairs of industrial countries, (IND,IND), country pairs of developing countries (DEV,DEV), and mixed pairs of industrial and developing

[23] The final correlation reported is equal to the mean of the band-pass filtered output correlation (0.0501) plus the coefficient estimated multiplied by the standard deviation of the bilateral trade intensity measure. That is, 0.0501+10.1942*0.0038=0.0884 (when normalized by trade) and 0.0501+12.1055*0.0023=0.0777. Note that 10.1942 and 12.1055 represent the estimated OLS coefficients from model M1 in Table 5, when using band-pass filtered output correlations. In addition, 0.0038 and 0.0023 are the standard deviations of bilateral trade intensity when normalized by trade and output, respectively.

[24] Using the IV estimated coefficient from the model M1 when the dependent variable is the (band-pass filtered) output correlations, cyclical synchrony jumps from 0.0501 on average to 0.0501+14.7555*0.0024=0.086 (when normalized by trade) and to 0.0501+29.6755*0.0013=0.088 (when normalized by output).

countries (IND,DEV). Therefore, we can obtain separate coefficients for trade intensity for each one of the country-pair groupings. Results for our basic model are presented in Table 7, whereas OLS and IV estimates for the augmented model (which includes asymmetries in economic structures) are reported in Table 8.

Based on the estimates reported in Tables 7 and 8, we find that the impact of trade intensity on output correlation is larger among industrial country-pairs (North-North) than among any other group of country pairs. Also, the impact is smaller among developing country-pairs (South-South), than among the other groups in most cases. Using our IV estimates of model M1 (which includes the 9-sector index of asymmetric economic structures) with the dependent variable being the (band-pass filtered) output correlations, we find that one standard deviation increase in the measure of bilateral trade intensity from the mean will generate an increase in output correlation:

- From 0.25 to 0.373 (0.359) when normalized by output (trade) among industrial countries using the basic model (M0), and to 0.399 (0.381) when normalized by output (trade) among industrial countries using the augmented model (M1).
- From 0.075 to 0.104 (0.097) when normalized by output (trade) among mixed industrial-developing country pairs using the basic model (M0), and to 0.1043 (0.0957) when normalized by output (trade) among industrial countries using the augmented model (M1).
- From 0.031 to 0.0523 (0.053) when normalized by output (trade) among industrial countries using the basic model (M0), and to 0.0588 (0.0579) when normalized by output (trade) among industrial countries using the augmented model (M1).

From these results there are two important implications relative to previous studies. First, our finding for industrial countries is very similar to the results in Frankel and Rose (1998). Using a more restricted sample (21 industrial countries), with different frequency of information (quarterly data for the 1959-1993 period), they find that a one standard deviation increase in bilateral trade intensity would raise the bilateral correlation of cross-country GDP (de-trended by differencing) from 0.22 to 0.35, a result that is almost identical to ours. Second, our regression results confirm our priors: The impact of trade integration among developing countries is still positive and significant, and significantly smaller than the impact of trade intensity on the output correlation among industrial countries. Finally, using the HP and BP filters, the impact of trade intensity on output correlation is larger in mixed industrial-developing country pairs than among developing countries, which suggest that North-South free trade agreements may enhance cyclical output correlation in a better way than South-South agreements.

4.3.4 The Impact of Trade Integration over Time

The magnitude of the impact of trade integration on business cycle synchronization may have varied over time, depending on the nature, size and type of disturbances that have affected the world economy.[25] In this section, we assess whether the impact of trade on business cycle synchronization has varied over the decades spanning the 1960-99 period. From the results reported in Tables 9 and 10, we might argue that the impact of trade is negligible during the 1960s in the majority of cases, whereas it is statistically significant for the other decades. Based on our estimates with HP- and band-pass-filtered output correlations, we find that the greatest impact of trade occurs in the 1970s and in the 1990s, when the world economy faced several global/regional shocks. Using the IV coefficients for trade integration (normalized by output) in the model M1 (that includes the 9-sector index of asymmetries in economic structures), we find that the impact of trade integration is negative and not significant for the 1960s, whereas the impact seems to be positive and significant for the other decades (see panel II in Table 10).

An economic interpretation of these results will imply that following a one standard deviation increase in bilateral trade (normalized by output) during the decade, cyclical output correlation during the 1960s (from 0.0234 vs. 0.0368), and that it will significantly increase for the rest of the decades from 0.0522 to 0.0992 in the 1970s, from 0.0588 to 0.0885 in the 1980s, and from 0.0567 to 0.1309 in the 1990s. One potential explanation for this may be the increased importance of intra-industry trade over time.

[25] Cyclical output co-movement among industrial countries and between industrial and developing countries has varied over time as a product of idiosyncratic shocks in countries belonging to these regions. Specifically, declining co-movement in the 1990s has been attributed to asymmetric shocks in the major advanced economies (e.g., German reunification and Japan's long recession), and a series of emerging market crises, especially in Asia and Latin America (IMF, 2001).

4.3.5. Trade Integration and Production Structure Asymmetries

In Table 11, we include the index of production asymmetries as a control variable. However, similarities in the production structure may affect the nature of the impact of trade integration on cycle correlation, since similar economies are more prone to show a pattern of intra-industry specialization. These considerations suggest the convenience of adding an interactive term, in order to look at complementarities between production asymmetries and trade intensity. We expect this interaction term to be negative and significant, suggesting that the impact of trade integration should be weaker among dissimilar countries.

We find evidence consistent with our prior, that is, we find a negative and statistically significant interaction effect between trade intensity and asymmetries in production. Moreover, this negative coefficient is robust to the bilateral trade measure, the de-trending technique and the estimation method (OLS or IV). See Table 11 for more detailed information. In Figure 1 we observe the change in output correlation following a one standard deviation increase in bilateral trade intensity. In this case, note that the impact of trade will be influenced by the asymmetries in production structure existent between a specific pair of countries. We find that the higher the extent of the asymmetries, the lower the change in output correlation following the positive trade shock. For example, the mixed industrial-developing country pairs exhibit asymmetries in production structures that are larger than the one for all country pairs (0.4456 vs. 0.3994) and the response of cyclical output correlation is lower than the world average (1.7 vs. 3.0). Furthermore, on average, industrial countries exhibit the most similar production structures (with a value for our index equal to 0.1331) and, hence, the largest change in output correlation (8.1).

5. Summary and Conclusions

One of the key criteria in the optimal currency area (OCA) literature is that countries should join a currency union if they have closer international trade links and more symmetric business cycles. However, both criteria (trade intensity and cycle correlation) are endogenous. After controlling for endogeneity, we want to know whether trade intensity increases cycle correlation in a more expanded set of countries. Although Frankel and Rose (1998) find that trade intensity increases cycle correlation among industrial countries, there are reasons to believe that this could be different among developing countries and among industrial-developing country pairs. Patterns of international trade among industrial countries (i.e., intra-industry trade) are quite different than the patterns followed among developing countries and among industrial-developing country pairs (i.e., inter-industry trade) suggesting that, in these cases, the impact of trade intensity on cycle correlation should be weaker, and of ambiguous sign.

In this paper we have attempted to provide an exhaustive analysis of the impact of trade integration on business cycle synchronization. Not only do we provide an efficient estimate for this effect (thanks to the use of the gravity equation for international trade), but we also conduct a sensitivity analysis to changes in the sample of countries, changes in the time period of the estimation, and the inclusion of interaction effects between trade intensity and direct sectoral linkages. Our prior is that trade intensity should have a positive effect on cyclical output correlation among industrial countries, and a smaller effect among other country pairs. After performing our regression analysis, we find the following:

First, countries that have close trade linkages would exhibit higher output co-movement. This result is robust to changes in our measures of bilateral trade and cyclical output, as well as the estimation method chosen. An economic interpretation of this result yields an increase in business cycle correlations from 0.05 to 0.09 if the bilateral trade intensity increases by one standard deviation. Second, the impact of trade integration on output fluctuations among industrial countries is higher than the impact among developing countries and the impact for industrial-developing country pairs. Also, we find that the impact of trade integration on business cycle synchronization is potentially higher in North-South cycles than in South-South cycles. An analogous result holds when we compare Industrial and Latin American countries. Third, a one standard deviation increase in bilateral trade intensity would raise cyclical output correlation from 0.25 to 0.381 (when normalized by trade) and 0.3985 (when normalized by output) among industrial countries. Note that although we use a different sample of countries, a slightly different time period and a different frequency of information, we obtain qualitatively similar results to Frankel and Rose (1998). On the other hand, the same increase in bilateral trade (when normalized by output) would lead to a surge in output correlation from 0.075 to 0.1043 for the industrial-developing country pairs, and from 0.031 to 0.0588 among developing countries. Fourth, we find that the impact of trade integration on business cycle has markedly changed over time. After being not significant in the 1960s, it became positive and large in the 1970s and 1990s. The greater impact of trade in these decades could be attributed to the occurrence of several global / regional shocks to the world economy. Finally, we find robust evidence of interaction effects between trade intensity and asymmetries in the economic structures across countries. After we take into account for these asymmetries, we find that a one standard deviation increase in bilateral trade (normalized by output) would raise output correlations from 0.05 to 0.08. A similar shock would increase the output correlation from 0.25 to 0.33 among industrial countries and from 0.03 to 0.06 among developing countries.

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Table 1. Effects of Integration on Trade

Type of Shocks	Impact on $\rho_{y,y*}$	References
Industry Shocks	(-): specialization in production through removal of tariff barriers. (-): specialization in production through better opportunities for income diversification.	Frankel and Rose (1998). Kalemli-Ozcan, Sorensen, and Yosha (2001).
	(-/+): Intra-industry Trade as main mechanism. (-/+): Vertical Specialization.	Krugman (1993) Kose and Yi (2001)
Aggregate Shocks	(+): Spillover effects from aggregate demand shocks. (+): Transmission of knowledge and technology diffusion.	Frankel and Rose (1998). Coe and Helpman (1995). Lichtengerg *et al*. (1998).

Table 2. Sample Statistics, 1960-99: Cycle Correlation over Time
Sample of ALL country pairs

Filter	1960-99	1960-69	1970-79	1980-89	1990-99
Quadratic Trend (QT)	0.0648	0.0084	0.0349	0.0872	0.1022
	(0.56)	(0.57)	(0.54)	(0.54)	(0.58)
First Differences (1D)	0.0372	0.0170	0.0465	0.0406	0.0391
	(0.37)	(0.37)	(0.37)	(0.37)	(0.38)
Hodrick-Prescott (HP)	0.0590	0.0191	0.0608	0.0713	0.0704
	(0.39)	(0.37)	(0.39)	(0.39)	(0.40)
Band-Pass (BP)	0.0501	0.0234	0.0522	0.0588	0.0567
	(0.38)	(0.38)	(0.38)	(0.38)	(0.38)
Index of Asymmetries	0.0671	0.0625	0.0751	0.0683	0.0620
(IA)	(0.04)	(0.04)	(0.05)	(0.04)	(0.05)

Note: Numbers in parenthesis represent the standard deviation of thecycle correlation.

Table 3. Sample Statistics, 1960-99: Cycle Correlation over Time
(Sub-samples of Country Pairs)
Note: Numbers in parenthesis represent the standard deviation of the cycle correlation. (IND,IND)

Filter	All	(IND,IND)	(IND,DEV)	(DEV,DEV)
Quadratic Trend (QT)	0.0648	0.2604	0.0689	0.0547
	(0.56)	(0.56)	(0.56)	(0.56)
First Differences (1D)	0.0372	0.2255	0.0581	0.0203
	(0.37)	(0.39)	(0.37)	(0.37)
Hodrick-Prescott (HP)	0.0590	0.2522	0.0862	0.0393
	(0.39)	(0.39)	(0.39)	(0.38)
Band-Pass (BP)	0.0501	0.2538	0.0750	0.0310
	(0.38)	(0.37)	(0.38)	(0.37)
Index of Asymmetries	0.0671	0.0288	0.0549	0.0737
(IA)	(0.04)	(0.01)	(0.04)	(0.04)

represent country pairs of industrial countries, (DEV,DEV) are country pairs of developing countries, whereas (IND,DEV) represent mixed country pairs of industrial and developing countries.

Table 4. Correlation Analysis: Cycle Correlation (CC) and Bilateral Trade Intensity (BTI)

(*Sub-samples of Country Pairs, 1960-99)*

Filter	Trade Intensity Normalized by:	All Country Pairs Coeff.	(p-value)	(IND,IND) Country Pairs Coeff.	(p-value)	(IND,DEV) Country Pairs Coeff.	(p-value)	(DEV,DEV) Country Pairs Coeff.	(p-value)
I. Unconditional Panel Correlations									
Quadratic Trend (QT)	Total Trade:	0.0500	(0.000)	0.0484	(0.178)	-0.0129	(0.254)	0.0576	(0.000)
	Output:	0.0472	(0.000)	0.0985	(0.005)	-0.0144	(0.184)	0.0435	(0.000)
First Differences (1D)	Total Trade:	0.0838	(0.000)	0.1351	(0.000)	0.0301	(0.008)	0.0743	(0.000)
	Output:	0.0870	(0.000)	0.2018	(0.000)	0.0199	(0.067)	0.0762	(0.000)
Hodrick-Prescott (HP)	Total Trade:	0.0829	(0.000)	0.1222	(0.001)	0.0293	(0.010)	0.0702	(0.000)
	Output:	0.0841	(0.000)	0.1748	(0.000)	0.0364	(0.001)	0.0702	(0.000)
Band-Pass (BP)	Total Trade:	0.0885	(0.000)	0.1374	(0.000)	0.0357	(0.002)	0.0717	(0.000)
	Output:	0.0885	(0.000)	0.1841	(0.000)	0.0381	(0.000)	0.0736	(0.000)
Index of Asymmetries	Total Trade:	-0.0973	(0.000)	-0.0508	(0.157)	-0.0371	(0.001)	-0.0468	(0.000)
(IA)	Output:	-0.0634	(0.000)	-0.0802	(0.022)	-0.0146	(0.178)	-0.0304	(0.000)
II. Conditional Panel Correlations 1/									
Quadratic Trend (QT)	Total Trade:	0.0949	(0.000)	0.1909	(0.000)	-0.0045	(0.738)	0.0851	(0.000)
	Output:	0.0889	(0.000)	0.2115	(0.000)	0.0103	(0.429)	0.0733	(0.000)
First Differences (1D)	Total Trade:	0.1091	(0.000)	0.2549	(0.000)	0.0073	(0.588)	0.0778	(0.000)
	Output:	0.1092	(0.000)	0.2680	(0.000)	0.0299	(0.022)	0.0762	(0.000)
Hodrick-Prescott (HP)	Total Trade:	0.1098	(0.000)	0.2085	(0.000)	0.0347	(0.010)	0.0672	(0.000)
	Output:	0.1126	(0.000)	0.2154	(0.000)	0.0656	(0.000)	0.0703	(0.000)
Band-Pass (BP)	Total Trade:	0.1170	(0.000)	0.2051	(0.000)	0.0390	(0.004)	0.0734	(0.000)
	Output:	0.1173	(0.000)	0.2111	(0.000)	0.0657	(0.000)	0.0742	(0.000)
Index of Asymmetries	Total Trade:	-0.2063	(0.000)	-0.1174	(0.003)	-0.1501	(0.000)	-0.1223	(0.000)
(IA)	Output:	-0.1598	(0.000)	-0.1354	(0.000)	-0.1073	(0.000)	-0.0935	(0.000)

1/ Among the instruments we have the distance between the countries i and j, common border, remoteness of countries i and j in the pair, output, population, and area in both countries, number of islands and landlocked countries in the pair, dummies for countries with common geographical region, common language, common colonial origin, and common "main trading partner."

Table 5. Determinants of Bilateral Trade Intensity: First Stage Regressions
Dependent Variable: Bilateral Trade Intensity between countries i and j
Normalized by trade or output and expressed as log (1+ ratio)

Variable	Bilateral Trade Normalized by Trade		Bilateral Trade Normalized by Output	
	Coefficient	Std. Error	Coefficient	Std. Error
Constant	-0.0856	(0.0044) **	-0.0495	(0.0044) **
Distance (in logs)	-0.0007	(0.0001) **	-0.0008	(0.0001) **
Border Dummy	0.0059	(0.0007) **	0.0020	(0.0003) **
Remoteness Country i	0.0004	(0.0002) *	0.0006	(0.0002) **
Remoteness Country j	0.0001	(0.0002)	0.0009	(0.0002) **
GDP Country i (logs)	0.0173	(0.0008) **	0.0101	(0.0006) **
GDP Country j (logs)	0.0160	(0.0007) **	0.0085	(0.0005) **
Population Country i (logs)	-0.0030	(0.0005) **	-0.0015	(0.0003) **
Population Country j (logs)	-0.0030	(0.0006) **	-0.0018	(0.0003) **
Area Country i (logs)	-0.0004	(0.0003)	-0.0017	(0.0003) **
Area Country j (logs)	0.0002	(0.0002)	-0.0007	(0.0002) **
Free Trade Agreement Dummy	0.0047	(0.0005) **	0.0027	(0.0003) **
# Islands (i,j)	0.0006	(0.0001) **	0.0000	(0.0000)
# Landlocked Countries (i,j)	-0.0001	(0.0000) **	0.0000	(0.0000)
Common Region	0.0007	(0.0001) **	0.0001	(0.0001)
Common Language	0.0004	(0.0001) **	0.0002	(0.0001) **
Common Colonial Origin	0.0002	(0.0001) *	-0.0001	(0.0001) *
Common Trading Partner	0.0003	(0.0003)	0.0001	(0.0002)
Observations	15725		17027	
R**2	0.2964		0.2082	

Note: * (**) implies that the variable is significant at the 10 (5) percent level.

Table 6. Regression Analysis: Cycle Correlation (CC) and Bilateral Trade Intensity (BTI)
Sample of All Country Pairs, 1960-99

	Basic Model (M0)		Augmented Model (M1)	
	Bilateral Trade Normalized		Bilateral Trade Normalized	
Filter	by Trade	by Output	by Trade	by Output
I. Ordinary Least Squares				
Quadratic Trend (QT)	7.4428 **	10.9157 **	8.6083 **	9.5249 **
	(1.30)	(1.57)	(1.51)	(1.71)
First Differences (1D)	8.1436 **	13.7523 **	9.9164 **	12.2181 **
	(0.90)	(1.45)	(1.16)	(1.58)
Hodrick-Prescott (HP)	8.4923 **	13.8045 **	10.0101 **	11.7272 **
	(0.93)	(1.51)	(1.22)	(1.56)
Band-Pass (BP)	8.8118 **	14.2272 **	10.1942 **	12.1055 **
	(0.94)	(1.54)	(1.21)	(1.60)
Index of Asymmetries	-0.9587 **	-1.0999 **	-0.8159 **	-0.7529 **
(IA)	(0.08)	(0.15)	(0.09)	(0.12)
II. Instrumental Variables				
Quadratic Trend (QT)	19.2248 **	32.9861 **	18.0929 **	32.7439 **
	(1.79)	(3.36)	(2.44)	(4.63)
First Differences (1D)	16.1849 **	30.6538 **	13.5473 **	27.7425 **
	(1.26)	(2.37)	(1.68)	(3.20)
Hodrick-Prescott (HP)	16.5784 **	31.8238 **	14.1747 **	29.5442 **
	(1.33)	(2.48)	(1.79)	(3.38)
Band-Pass (BP)	17.5990 **	33.3613 **	14.7544 **	29.6755 **
	(1.31)	(2.45)	(1.75)	(3.32)
Index of Asymmetries	-3.0618 **	-4.7125 **	-2.1143 **	-3.3359 **
(IA)	(0.11)	(0.22)	(0.16)	(0.30)

Notes: The numbers in parenthesis are the standard errors of the estimated coefficients.
* (**) Implies that the variable is significant at the 10 (5) percent level.

Table 7. Regression Analysis: Cycle Correlation (CC) and Bilateral Trade Intensity (BTI)

Different Sub-Samples of Country Pairs, 1960-99

Basic Model (M0)

Filter	Trade Intensity Normalized by:	(IND,IND) Country Pairs Coeff.	Std. Dev.	(IND,DEV) Country Pairs Coeff.	Std. Dev.	(DEV,DEV) Country Pairs Coeff.	Std. Dev.
I. Ordinary Least Squares							
Quadratic Trend (QT)	Total Trade:	7.5665	(2.114) **	11.8804	(2.768) **	6.4435	(2.220) **
	Output:	18.7573	(3.292) **	34.5847	(6.316) **	8.3603	(1.884) **
First Differences (1D)	Total Trade:	8.2827	(1.441) **	6.3717	(1.517) **	8.8664	(1.320) **
	Output:	22.4093	(2.859) **	14.2492	(3.935) **	10.5755	(1.323) **
Hodrick-Prescott (HP)	Total Trade:	8.8427	(1.493) **	7.7693	(1.628) **	8.2792	(1.333) **
	Output:	22.7710	(2.938) **	22.7888	(3.988) **	9.7841	(1.279) **
Band-Pass (BP)	Total Trade:	9.3066	(1.540) **	7.9594	(1.554) **	8.4188	(1.350) **
	Output:	23.5032	(3.050) **	21.9179	(3.869) **	10.2064	(1.315) **
Index of Asymmetries	Total Trade:	-1.1881	(0.168) **	-1.6417	(0.172) **	-0.1924	(0.084) **
(IA)	Output:	-2.9894	(0.419) **	-4.2186	(0.389) **	-0.1490	(0.103)
II. Instrumental Variables							
Quadratic Trend (QT)	Total Trade:	31.7612	(2.906) **	13.5892	(4.638) **	13.2930	(2.682) **
	Output:	59.3682	(5.583) **	45.6975	(8.711) **	29.0123	(4.871) **
First Differences (1D)	Total Trade:	26.7157	(1.945) **	8.2716	(2.996) **	10.1369	(1.653) **
	Output:	51.8705	(3.752) **	22.3010	(5.566) **	17.9882	(3.060) **
Hodrick-Prescott (HP)	Total Trade:	28.4345	(2.017) **	13.9700	(3.147) **	8.1570	(1.758) **
	Output:	54.0954	(3.890) **	36.2188	(5.864) **	15.4333	(3.207) **
Band-Pass (BP)	Total Trade:	29.1540	(2.006) **	14.2814	(3.031) **	9.5898	(1.733) **
	Output:	55.2017	(3.892) **	36.1712	(5.647) **	17.6408	(3.173) **
Index of Asymmetries	Total Trade:	-4.3880	(0.154) **	-6.1239	(0.278) **	-1.2872	(0.152) **
(IA)	Output:	-8.0522	(0.278) **	-10.0059	(0.518) **	-1.2668	(0.308) **

Note: * (**) implies that the variable is significant at the 10 (5) percent level.

Table 8.
Regression Analysis: Cycle Correlation (CC) and Bilateral Trade Intensity (BTI)
Different Sub-Samples of Country Pairs, 1960-99
Augmented Model (M1)

Filter	Trade Intensity Normalized by:	(IND,IND) Country Pairs Coeff.	Std. Dev.	(IND,DEV) Country Pairs Coeff.	Std. Dev.	(DEV,DEV) Country Pairs Coeff.	Std. Dev.	Asymmetries in Production Coeff.	Std. Dev.
I. Ordinary Least Squares									
Quadratic Trend (QT)	Total Trade:	6.7384	(3.902) *	12.8568	(3.988) **	8.0795	(2.517) **	-0.1467	(0.023) **
	Output:	11.7005	(3.577) **	36.1732	(9.062) **	9.4587	(2.153) **	-0.1523	(0.023) **
First Differences (1D)	Total Trade:	10.3704	(2.889) **	8.9507	(2.100) **	10.1606	(1.526) **	-0.0171	(0.014)
	Output:	16.0044	(4.112) **	18.1198	(5.631) **	11.4696	(1.631) **	-0.0190	(0.014)
Hodrick-Prescott (HP)	Total Trade:	13.6512	(3.100) **	9.5244	(2.367) **	9.4347	(1.516) **	0.0106	(0.015)
	Output:	18.5367	(5.061) **	24.5612	(5.584) **	10.2633	(1.478) **	0.0088	(0.015)
Band-Pass (BP)	Total Trade:	13.8959	(3.011) **	9.8139	(2.229) **	9.5695	(1.531) **	-0.0152	(0.015)
	Output:	18.7126	(5.311) **	24.1659	(5.403) **	10.7058	(1.529) **	-0.0183	(0.014)
Index of Asymmetries	Total Trade:	-0.9697	(0.340) **	-1.6720	(0.168) **	-0.4862	(0.088) **	0.0241	(0.002) **
(IA)	Output:	-1.1405	(0.443) **	-4.4830	(0.475) **	-0.5106	(0.091) **	0.0248	(0.001) **
II. Instrumental Variables									
Quadratic Trend (QT)	Total Trade:	26.5024	(6.389) **	25.1898	(7.400) **	13.4319	(3.013) **	-0.1380	(0.029) **
	Output:	49.3309	(11.436) **	66.2679	(13.606) **	28.6739	(5.634) **	-0.1475	(0.029) **
First Differences (1D)	Total Trade:	27.3236	(4.262) **	8.4744	(4.733) *	12.0838	(1.829) **	0.0038	(0.018)
	Output:	54.7655	(7.513) **	24.6038	(8.767) **	23.8845	(3.512) **	0.0007	(0.018)
Hodrick-Prescott (HP)	Total Trade:	34.4035	(4.370) **	13.7144	(4.990) **	11.0935	(1.955) **	0.0315	(0.019) *
	Output:	66.0169	(7.722) **	38.7101	(9.255) **	22.7004	(3.701) **	0.0313	(0.019) *
Band-Pass (BP)	Total Trade:	35.1521	(4.176) **	13.7439	(4.802) **	11.7204	(1.925) **	0.0074	(0.018)
	Output:	66.8851	(7.364) **	36.5847	(8.906) **	22.9917	(3.651) **	0.0053	(0.018)
Index of Asymmetries	Total Trade:	-3.3772	(0.482) **	-5.9970	(0.433) **	-1.4103	(0.170) **	0.0167	(0.002) **
(IA)	Output:	-5.9726	(0.836) **	-10.4117	(0.814) **	-2.0996	(0.325) **	0.0177	(0.002) **

Note: * (**) implies that the variable is significant at the 10 (5) percent level.

Table 9. Regression Analysis: Cycle Correlation (CC) and Bilateral Trade Intensity (BTI)

Different Sub-Samples of Country Pairs, 1960-99

Basic Model (M0)

Filter	Trade Intensity Normalized by:	1960-1969 Coeff.	1960-1969 Std. Dev.	1970-1979 Coeff.	1970-1979 Std. Dev.	1980-1989 Coeff.	1980-1989 Std. Dev.	1990-1999 Coeff.	1990-1999 Std. Dev.
I. Ordinary Least Squares									
Quadratic Trend (QT)	Total Trade:	3.2283	(3.511)	5.1781	(2.183) **	8.6838	(1.978) **	10.1318	(2.368) **
	Output:	2.6128	(4.473)	7.1674	(3.828) *	12.0848	(2.527) **	13.2342	(2.729) **
First Differences (1D)	Total Trade:	3.6393	(1.387) **	10.3275	(2.753) **	6.7504	(1.601) **	10.0801	(1.576) **
	Output:	6.9201	(3.097) **	18.6639	(3.998) **	11.7618	(1.625) **	14.4354	(2.484) **
Hodrick-Prescott (HP)	Total Trade:	4.6640	(1.509) **	10.5692	(3.206) **	7.4160	(1.527) **	9.9156	(1.482) **
	Output:	8.9171	(3.412) **	19.5376	(3.773) **	11.4716	(1.855) **	13.9978	(2.525) **
Band-Pass (BP)	Total Trade:	5.7939	(1.317) **	10.5881	(3.047) **	7.5856	(1.402) **	10.1258	(1.641) **
	Output:	10.1778	(3.876) **	19.3459	(3.683) **	11.9409	(1.834) **	14.4396	(2.615) **
Index of Asymmetries	Total Trade:	-1.1662	(0.260) **	-1.1570	(0.238) **	-0.7818	(0.134) **	-0.8560	(0.113) **
(IA)	Output:	-1.8326	(0.746) **	-1.5186	(0.347) **	-0.8035	(0.190) **	-0.9615	(0.219) **
II. Instrumental Variables									
Quadratic Trend (QT)	Total Trade:	8.7825	(4.493) **	17.6294	(3.701) **	17.3242	(3.309) **	26.5403	(3.172) **
	Output:	15.7422	(8.129) *	30.5264	(7.045) **	35.7887	(6.217) **	40.9276	(5.938) **
First Differences (1D)	Total Trade:	8.4553	(2.912) **	20.4096	(2.625) **	12.1038	(2.321) **	20.3492	(2.255) **
	Output:	17.7975	(5.310) **	39.3636	(4.942) **	26.0417	(4.404) **	35.2738	(4.282) **
Hodrick-Prescott (HP)	Total Trade:	9.6701	(3.070) **	22.3622	(2.723) **	13.1324	(2.499) **	18.9495	(2.369) **
	Output:	18.9593	(5.546) **	44.7085	(5.020) **	23.9252	(4.754) **	36.3989	(4.415) **
Band-Pass (BP)	Total Trade:	12.4491	(3.217) **	22.9224	(2.665) **	12.9314	(2.443) **	20.3172	(2.290) **
	Output:	24.3664	(5.922) **	44.7405	(4.934) **	23.8822	(4.639) **	38.0715	(4.297) **
Index of Asymmetries	Total Trade:	-3.7321	(0.253) **	-3.6278	(0.273) **	-2.1629	(0.196) **	-3.0499	(0.203) **
(IA)	Output:	-6.0977	(0.471) **	-5.7236	(0.553) **	-2.6211	(0.457) **	-4.9137	(0.339) **

Note: * (**) implies that the variable is significant at the 10 (5) percent level.

Table 10. Regression Analysis: Cycle Correlation (CC) and Bilateral Trade Intensity (BTI)

Different Sub-Samples of Country Pairs, 1960-99

Augmented Model (M1)

Filter	Trade Intensity Normalized by:	1960-1969 Coeff.	1960-1969 Std. Dev.	1970-1979 Coeff.	1970-1979 Std. Dev.	1980-1989 Coeff.	1980-1989 Std. Dev.	1990-1999 Coeff.	1990-1999 Std. Dev.
I. Ordinary Least Squares									
Quadratic Trend (QT)	Total Trade:	-1.9523	(3.768)	3.8100	(3.705)	10.7826	(2.813) **	12.1501	(2.460) **
	Output:	-2.6418	(3.886)	4.1741	(4.671)	11.4573	(2.751) **	12.0138	(2.938) **
First Differences (1D)	Total Trade:	1.5741	(2.649)	12.5286	(2.120) **	7.2716	(2.119) **	13.0013	(1.912) **
	Output:	2.0182	(1.806)	16.4613	(5.511) **	10.4317	(1.634) **	13.8281	(2.938) **
Hodrick-Prescott (HP)	Total Trade:	1.8865	(2.511)	14.3999	(2.274) **	8.1693	(2.480) **	11.6228	(1.851) **
	Output:	2.9691	(1.813) *	16.8733	(4.929) **	10.0439	(1.873) **	12.7641	(2.812) **
Band-Pass (BP)	Total Trade:	-0.0661	(3.016)	13.8212	(2.149) **	8.2517	(2.334) **	12.8312	(1.958) **
	Output:	1.1990	(2.788)	16.6408	(4.762) **	10.6946	(1.815) **	13.5265	(3.037) **
Index of Asymmetries	Total Trade:	-1.0067	(0.228) **	-1.1997	(0.219) **	-0.5668	(0.143) **	-0.7529	(0.131) **
(IA)	Output:	-0.8161	(0.373) **	-1.1657	(0.336) **	-0.5438	(0.139) **	-0.7442	(0.195) **
II. Instrumental Variables									
Quadratic Trend (QT)	Total Trade:	1.2121	(8.075)	12.8566	(5.071) **	21.1082	(4.325) **	20.4876	(4.022) **
	Output:	3.7124	(14.729)	25.7245	(9.768) **	41.1617	(8.357) **	32.0668	(7.613) **
First Differences (1D)	Total Trade:	6.1366	(5.154)	13.2783	(3.425) **	10.3631	(3.039) **	17.5662	(2.746) **
	Output:	15.1636	(9.785) *	31.4713	(6.581) **	23.7773	(5.817) **	31.5028	(5.192) **
Hodrick-Prescott (HP)	Total Trade:	7.3675	(5.103)	16.6669	(3.821) **	11.8337	(3.321) **	16.0512	(2.891) **
	Output:	16.6514	(9.757) *	39.3401	(7.344) **	22.5149	(6.289) **	32.5930	(5.342) **
Band-Pass (BP)	Total Trade:	3.8551	(5.493)	16.9013	(3.711) **	12.0964	(3.222) **	18.0056	(2.780) **
	Output:	11.2492	(10.401)	38.9636	(7.126) **	22.5063	(6.091) **	34.2963	(5.175) **
Index of Asymmetries	Total Trade:	-2.2795	(0.472) **	-2.4943	(0.420) **	-1.2276	(0.270) **	-2.4728	(0.254) **
(IA)	Output:	-3.3778	(0.920) **	-4.3176	(0.846) **	-1.6672	(0.500) **	-3.9507	(0.440) **

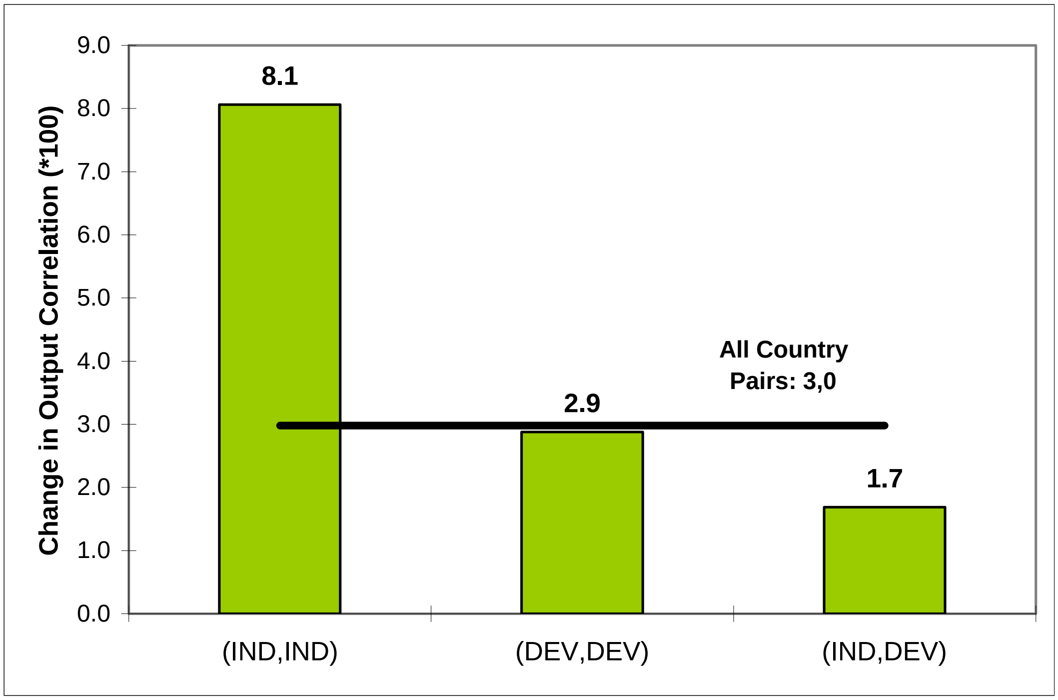
Note: * (**) implies that the variable is significant at the 10 (5) percent level.

Table 11.
Regression Analysis: Cycle Correlation (CC) and Bilateral Trade Intensity (BTI)
Different Sub-Samples of Country Pairs, 1960-99
Basic Model (M0)

Filter	Trade Intensity Normalized by:	Trade Intensity (BTI) Coeff.	Trade Intensity (BTI) Std. Dev.		BTI*Asym. Production Coeff.	BTI*Asym. Production Std. Dev.		Turning Point	% Above Threshold
I. Ordinary Least Squares									
Quadratic Trend (QT)	Total Trade:	14.1531	(2.748)	**	-14.8629	(5.631)	**	0.4761	32%
	Output:	15.9053	(3.660)	**	-16.0190	(7.676)	**	0.4965	29%
First Differences (1D)	Total Trade:	13.4657	(1.819)	**	-9.5140	(3.663)	**	0.7077	9%
	Output:	17.4772	(2.855)	**	-13.2035	(5.217)	**	0.6618	12%
Hodrick-Prescott (HP)	Total Trade:	13.0620	(2.086)	**	-8.1808	(4.128)	**	0.7983	5%
	Output:	16.3725	(2.871)	**	-11.6627	(4.992)	**	0.7019	9%
Band-Pass (BP)	Total Trade:	14.2175	(1.995)	**	-10.7847	(3.594)	**	0.6591	12%
	Output:	17.9102	(3.002)	**	-14.5734	(4.970)	**	0.6145	16%
Index of Asymmetries	Total Trade:	-0.7019	(0.168)	**	-0.30558	(0.407)		n/d	n/d
(IA)	Output:	-0.5578	(0.200)	**	-0.48975	(0.377)		n/d	n/d
II. Instrumental Variables									
Quadratic Trend (QT)	Total Trade:	29.6675	(4.359)	**	-44.4529	(12.986)	**	0.3337	57%
	Output:	55.6680	(8.257)	**	-89.7193	(24.718)	**	0.3102	61%
First Differences (1D)	Total Trade:	21.0451	(2.942)	**	-26.7136	(8.717)	**	0.3939	46%
	Output:	39.9461	(5.596)	**	-43.5974	(16.732)	**	0.4581	35%
Hodrick-Prescott (HP)	Total Trade:	22.7382	(3.133)	**	-30.5105	(9.178)	**	0.3726	50%
	Output:	42.7353	(5.944)	**	-47.1256	(17.603)	**	0.4534	35%
Band-Pass (BP)	Total Trade:	23.8062	(3.050)	**	-32.2501	(8.803)	**	0.3691	50%
	Output:	44.1518	(5.788)	**	-51.7167	(16.943)	**	0.4269	40%
Index of Asymmetries	Total Trade:	-0.8811	(0.289)	**	-4.3705	(0.854)	**	n/d	n/d
(IA)	Output:	-1.7349	(0.542)	**	-5.6741	(1.653)	**	n/d	n/d

Note: * (**) implies that the variable is significant at the 10 (5) percent level.

Figure 1. Impact of Trade Intensity on Output Correlation
Interaction between Trade Intensity and Production Asymmetries



Appendix 1.
Sample of Countries

I. Industrial Countries (23)

AUS	Australia	FIN	Finland	LUX	Luxembourg
AUT	Austria	FRA	France	NLD	Netherlands
BEL	Belgium	GBR	United Kingdom	NOR	Norway
CAN	Canada	GRC	Greece	NZL	New Zealand
CHE	Switzerland	IRL	Ireland	PRT	Portugal
DEU	Germany	ISL	Iceland	SWE	Sweden
DNK	Denmark	ITA	Italy	USA	United States
ESP	Spain	JPN	Japan		

II. Developing Countries (124)

East Asia and the Pacific (19)

BRN	Brunei	KOR	Korea, Rep.	SGP	Singapore
CHN	China	MMR	Myanmar (Burma)	SLB	Solomon Is.
COM	Comoros	MYS	Malaysia	THA	Thailand
FJI	Fiji	NCL	New Caledonia	TWN	Taiwan
HKG	Hong Kong	PHL	Philippines	VUT	Vanuatu
IDN	Indonesia	PNG	Papua New Guinea	WSM	Samoa
KIR	Kiribati				

Eastern Europe and Central Asia (10)

ALB	Albania	HUN	Hungary	ROM	Romania
BGR	Bulgaria	LVA	Latvia	RUS	Russian Fed.
CZE	Czech Rep.	POL	Poland	SVK	Slovak Rep.
EST	Estonia				

Latin American and the Caribbean (33)

ARG	Argentina	DMA	Dominica	NIC	Nicaragua
ATG	Antigua	DOM	Dominican Rep.	PAN	Panama
BHS	Bahamas	ECU	Ecuador	PER	Peru
BLZ	Belize	GRD	Grenada	PRI	Puerto Rico
BMU	Bermuda	GTM	Guatemala	PRY	Paraguay
BOL	Bolivia	GUY	Guyana	SLV	El Salvador
BRA	Brazil	HND	Honduras	SUR	Suriname
BRB	Barbados	HTI	Haiti	TTO	Trinidad & Tobago
CHL	Chile	JAM	Jamaica	URY	Uruguay
COL	Colombia	LCA	St. Lucia	VCT	St. Vincent
CRI	Costa Rica	MEX	Mexico	VEN	Venezuela

Middle East and North Africa (17)

ARE	Utd.Arab Em.	ISR	Israel	OMN	Oman
CYP	Cyprus	JOR	Jordan	SAU	Saudi Arabia
DZA	Algeria	KWT	Kuwait	SYR	Syria

EGY	Egypt	LBY	Libya	TUN	Tunisia
IRN	Iran	MAR	Morocco	TUR	Turkey
IRQ	Iraq	MLT	Malta		

South Asia (6)

BGD	Bangladesh	IND	India	NPL	Nepal
BTN	Bhutan	LKA	Sri Lanka	PAK	Pakistan

Sub-Saharan Africa (39)

AGO	Angola	GNB	Guinea-Bissau	RWA	Rwanda
BDI	Burundi	KEN	Kenya	SDN	Sudan
BEN	Benin	LBR	Liberia	SEN	Senegal
BFA	Burkina Faso	LSO	Lesotho	SLE	Sierra Leone
BWA	Botswana	MDG	Madagascar	SOM	Somalia
CAF	C.Africa R.	MLI	Mali	SWZ	Swaziland
CIV	Ivory Coast	MOZ	Mozambique	SYC	Seychelles
CMR	Cameroon	MRT	Mauritania	TCD	Chad
COG	Congo	MUS	Mauritius	TGO	Togo
ETH	Ethiopia	MWI	Malawi	ZAF	South Africa
GAB	Gabon	NAM	Namibia	ZAR	Congo, Dem. Rep.
GHA	Ghana	NER	Niger	ZMB	Zambia
GMB	Gambia	NGA	Nigeria	ZWE	Zimbabwe