

GLOBAL BUSINESS CYCLES: CONVERGENCE OR DECOUPLING?*

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We analyze the evolution of the degree of global cyclical interdependence over the period 1960–2008. Using a dynamic factor model, we decompose macroeconomic fluctuations in output, consumption, and investment into a global factor, factors specific to country groups, and country-specific factors. We find that during 1985–2008, there is some convergence of business cycle fluctuations among industrial economies and among emerging market economies. Surprisingly, there is a concomitant decline in the relative importance of the global factor. We conclude that there is evidence of business cycle convergence *within* each of these two groups of countries but divergence (or decoupling) *between* them.

1. INTRODUCTION

The global economic landscape has shifted dramatically since the mid-1980s. First, there has been a rapid increase in trade and financial linkages across countries. Second, emerging market economies (EMEs) have become major players and now account for about a quarter of world output and a large share of global growth. Third, the impressive growth performance of emerging market economies, especially China and India, seemed to have been unaffected by relatively weak growth followed by growth slowdowns in a number of industrial countries (INCs) over the period 2003–2007. These developments led some observers to conjecture that emerging markets had “decoupled” from industrial economies, in the sense that their business cycle dynamics were no longer tightly linked to industrial country business cycles.

The notion of decoupling appeared to have been rejected during the early stages of the 2008–2009 global financial crisis, which started in the United States, spread to other industrial countries, and then hit the emerging market economies. Interestingly, growth in the emerging markets, in fact, held up fairly well even as the major industrial economies were undergoing significant contractions during 2008. Moreover, the discussions about decoupling between advanced and emerging market economies appear to have come full circle over the past year, with the latter group recovering more rapidly from the global financial crisis. These developments have reinvigorated the debate about decoupling.²

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²The debate on decoupling has become a topic of major interest among academics and in the financial press during the past three years. A number of recent papers have analyzed this issue, using as a baseline reference the earlier version of our article dated August 2008 (see, e.g., Mumtaz et al., 2010; Flood and Rose, 2010; Walti, 2009; Kim et al., 2009; Fidrmuc and Korhonen, 2010).

We attempt to shed light on a broader issue—whether shifts in the global economy have altered the patterns of international business cycle comovement. Conventional wisdom suggests that globalization has increased cross-border economic interdependence and led to convergence of business cycle fluctuations. Greater openness to trade and financial flows should make economies more sensitive to external shocks and increase comovement by widening the channels for spillovers of these shocks across countries. But the recent experience of emerging markets, which should have become more vulnerable to external shocks due to their rising integration into global trade and financial flows but instead maintained solid growth during the global crisis, has raised questions about the extent of international business cycle transmission. These two views of cross-border interdependence have very different implications for the evolution of global business cycles and can only be settled by empirical analysis.

In this article, we construct a dynamic latent factor model and use it to document a rich set of results about the evolution of global business cycles. We decompose macroeconomic fluctuations in national output, consumption, and investment of a large group of countries into the following factors: (i) a global factor, which picks up fluctuations that are common across all variables and countries; (ii) three factors specific to each group of countries (industrial countries, emerging market economies, other and developing economies), which capture fluctuations that are common to all variables and all countries in a given group; (iii) country factors that are common across all variables in a given country; and (iv) idiosyncratic factors specific to each time series.

Our first major result is that there has been a decline over time in the relative importance of global factors in accounting for business cycle fluctuations. There is no evidence of global convergence of business cycles during the recent period of globalization. If we use a broader definition of global business cycle convergence by taking the total contribution of all common factors—global and group-specific—there has been little change in overall business cycle synchronicity. This sum has been stable over time because the contribution of group-specific factors to business cycles has increased substantially. This brings up our next interesting result.

During the recent period of globalization that began in the mid-1980s, there has been a modest convergence of business cycles among industrial countries and, separately, among emerging market economies. That is, group-specific factors have become more important than global factors in driving cyclical fluctuations in these two groups of countries. This phenomenon of group-specific business cycle convergence is a robust feature of the data—it is not limited to countries in any particular geographic region and is not a mechanical effect of episodes of crises. The distinction between emerging markets and other developing economies is crucial for uncovering this result. This distinction has become sharper over time as there has been little change in the relative importance of group-specific factors for the latter group, where business cycle fluctuations are largely driven by idiosyncratic factors.

We also find that country-specific factors have become more important for the group of emerging market economies in the recent period of globalization, whereas they have become less important for industrial economies. The rising comovement among output, consumption, and investment in the former group ties it with a recent literature, showing that countries with intermediate levels of financial integration—i.e., emerging market economies—have not been able to achieve improved risk sharing during the globalization period (Kose et al., 2009). Moreover, the more successful emerging market economies have relied more on domestic savings rather than foreign capital to boost investment (Aizenman et al., 2007; Prasad et al., 2007; Gourinchas and Jeanne, 2009). On the other hand, countries with high levels of financial integration—mostly industrial countries—have been able to use international financial markets to more efficiently share risk and delink consumption and output.

These empirical results are useful in interpreting different classes of theoretical models that deliver varying predictions about the impact of increased trade and financial linkages on cross-country output comovement. For example, rising financial linkages could result in a higher degree of business cycle comovement via the wealth effects of external shocks. However, they could reduce cross-country output correlations by stimulating specialization of

production through the reallocation of capital in a manner consistent with countries' comparative advantage. Trade linkages generate both demand- and supply-side spillovers across countries, which can result in more highly correlated output fluctuations.

On the other hand, if stronger trade linkages facilitate increase specialization of production across countries, and if sector-specific shocks are dominant, then the degree of output comovement could decline (Baxter and Kouparitsas, 2005). As for other macroeconomic aggregates, the resource-shifting effect in standard business cycle models implies that global integration should reduce investment correlations by shifting capital to and raising investment growth in countries with relatively high productivity growth. By contrast, rising financial integration should increase consumption correlations by enabling more efficient risk sharing. The empirical validity of these (sometimes conflicting) theoretical predictions remains an open issue.

Our objective in this article is to shed some light on the relevance of these alternative predictions by providing a comprehensive empirical characterization of global business cycle linkages among a large and diverse group of countries. We focus on the following questions: First, what are the major factors driving business cycles in different groups of countries? Are these factors mainly global or are there distinct factors specific to particular groups? Second, how have these factors evolved as the process of globalization has picked up in pace over the past two decades? The answers to these questions have important implications for the debate on whether global business cycles are converging or decoupling.

In the process, we extend the research program on global business cycles in several dimensions. First, our study is more comprehensive than earlier studies as we use a larger data set (106 countries) with a longer time span (1960–2008). With few exceptions, the prior literature on international business cycles has focused on industrial countries.³ Given the rising prominence of emerging markets, and particularly in the context of an analysis of international business cycle spillovers, this narrow focus is no longer tenable. Our large sample of countries allows us to draw a sharp contrast across different groups of countries in terms of their exposure to external shocks. In addition, the relatively long time span of the data compared to most previous studies enables us to consider distinct subperiods and to analyze the changes in business cycles that have taken place during the recent wave of globalization (1985–2008) relative to earlier periods.

Second, unlike most existing studies, we specifically consider the roles played by global cycles and distinguish them from cycles common to specific groups of countries—industrial economies, emerging markets, and other developing economies. This distinction between the latter two groups of nonindustrial countries turns out to be important for our analysis.

Third, we analyze global business cycle comovement based on a few key macroeconomic variables rather than focusing solely on output. A key insight from our brief discussion of theory above is that the common practice of measuring business cycles and spillovers based on just output fluctuations is rather restrictive. Indeed, our approach of using multiple macroeconomic indicators rather than just GDP to characterize business cycles can be traced back to classical scholars of business cycles (Burns and Mitchell, 1946; Zarnowitz, 1992). The NBER also looks at a variety of indicators for determining turning points in U.S. business cycles.⁴

We implement recently developed techniques for the estimation of dynamic factor models to analyze these questions. Our model simultaneously captures contemporaneous spillovers of shocks as well as the dynamic propagation of business cycles in a flexible manner, without a priori restrictions on the directions of spillovers or the structure of the propagation mechanism. The dynamic factor model we employ can be seen as a reduced-form solution of a standard open economy dynamic stochastic general equilibrium (DSGE) model in the sense that data generated from a DSGE model have a representation as a dynamic factor model (Crucini et al., 2010). However, typical DSGE models face the curse of dimensionality that limits the number of

³Kose et al. (2008b) and Kose et al. (2009) survey that literature.

⁴These include real GDP, real income, employment, industrial production, and wholesale–retail sales. Blanchard and Quah (1989) use real GDP and unemployment to analyze sources of business cycles. King et al. (1991) study joint fluctuations in output, consumption, and investment to identify trends and cycles.

shocks and number of driving variables that can be analyzed in these models. Our factor model provides a parsimonious representation of the data, allowing us to consider a large number of macroeconomic variables to study the evolution of business cycles.

The estimated factors in our model—global, group-specific, and country factors—reflect elements of commonality of fluctuations in different dimensions of the data. The importance of studying all of these factors in one model is that they obviate problems that could be caused by studying a subset of factors, which could lead to a mischaracterization of commonality. For instance, group-specific factors estimated in a smaller model may simply reflect global factors that are misidentified as being specific to a particular group. Moreover, by including different macroeconomic aggregates, we get better measures of the commonality of fluctuations in overall economic activity. The dynamic factors capture intertemporal cross correlations among the variables and thereby allow for the effects of propagation and spillovers of shocks to be picked up. This methodology is also useful to analyze how the global and group-specific factors have affected the nature of business cycles within each group of countries over time.

Our approach builds on the work of Kose et al. (2003, 2008b). Unlike those and earlier studies using alternative techniques that have explored business cycle correlations among countries in specific geographic regions, we focus on country groups that reflect levels of development rather than geography and also provide a joint analysis of within-group and overall business cycle synchronicity over different periods. This analysis, along with the use of recent data, turns out to be essential to uncover the results reported in this article, especially the result that comovement has increased among developed economies and among emerging markets (greater within-group coupling of business cycles), whereas between-group correlations have fallen (decoupling).

2. METHODOLOGY AND DATA

We first discuss the main features of our empirical model, present a schematic approach for interpreting the results, and then briefly describe the data set.

2.1. A Dynamic Factor Model. Dynamic factor models have become a popular econometric tool for quantifying the degree of comovement among macroeconomic time series. The motivation underlying these models is to identify a few common factors that drive fluctuations in large multidimensional macroeconomic data sets. These factors can capture common fluctuations across the entire data set (i.e., the world) or across subsets of the data (e.g., a particular group of countries). The factor structure is directly motivated by general equilibrium models (see Altug, 1989, and Sargent, 1989). We do not interpret the factors as representing specific types of shocks such as technology—instead, we view them as capturing the effects of many types of common shocks, including technology shocks, monetary policy shocks, etc.

We construct a model that contains (i) a global factor common to all variables (and all countries) in the system, (ii) a factor common to each group of countries, (iii) a country factor common to all variables in each country, and (iv) an idiosyncratic component for each series. Since our primary interest is in comovement across all variables in all countries (or groups of countries), we do not include separate factors for each of the macroeconomic aggregates (including factors in yet another dimension would also make the model intractable for the number of countries we study). The dynamic relationships in the model are captured by modeling each factor and idiosyncratic component as an autoregressive process. Specifically, let $Y_t^{i,j,k}$ denote the growth rate of the i th observable variable in the j th country of economy type k . Here, we have three variables per country (indexed by i), three economy types (indexed by k), and 106 countries (indexed by j). The model can then be written as

$$(1) \quad Y_t^{i,j,k} = \beta_{global}^{i,j,k} f_t^{global} + \beta_{economy k}^{i,j,k} f_t^{economy k} + \beta_{country j}^{i,j,k} f_t^{country j} + \varepsilon_t^{i,j,k},$$

$$(2) \quad f_t^m = \phi^m(L)f_{t-1}^m + \mu_t^m \quad \text{for } m = 1 \dots (1+K+J),$$

$$(3) \quad \varepsilon_t^{i,j,k} = \phi^{i,j,k}(L)\varepsilon_{t-1}^{i,j,k} + v_t^{i,j,k},$$

where $\phi^{i,j,k}(L)$ and $\phi^m(L)$ are lag polynomial operators, $v_t^{i,j,k}$ are distributed $N(0, \sigma_{i,j,k}^2)$, μ_t^m are distributed $N(0, \sigma_m^2)$, and the innovation terms μ_t^m and $v_t^{i,j,k}$ are mutually orthogonal across all equations and variables in the system. The β parameters are called factor loadings and capture the sensitivity of each observable variable to the latent factors. For each variable, the estimated factor loadings quantify the extent to which that variable moves with the global factor, the factor for its economy type, and the country-specific factor, respectively. The lag polynomials can, in principle, be of different order; however, for simplicity and parsimony, we restrict them to be AR(3) for each factor and idiosyncratic term. Since we are using annual data, this should capture most spillovers, either contemporaneous or lagged, across variables and countries.

There are two related identification problems in the model given by Equations (1)–(3): neither the signs nor the scales of the factors and the factor loadings are separately identified. We identify the signs by requiring one of the factor loadings to be positive for each of the factors. In particular, we impose the conditions that the factor loading for the global factor is positive for U.S. output, country factors have positive factor loadings for the output of each country, and factors for each country group have positive loadings for the output of the first country listed in each group in the Appendix.⁵ Following Sargent and Sims (1977) and Stock and Watson (1989), we identify the scales by assuming that each σ_m^2 equals a constant. The constant is chosen based on the scale of the data so that the innovation variance is equal to the average innovation variance of a set of univariate autoregressions on each time series. The results are not sensitive to this normalization. Technical details about the estimation procedure are available in Appendix A of the working paper version of this article (Kose et al., 2008a).⁶

2.2. Advantages of Dynamic Factor Models. We now briefly review the advantages of our approach, first by contrasting it with some common alternatives. A standard approach to measuring comovement, and one that is widely used in the literature, is to calculate sets of bivariate correlations for all variables in a data set. Deriving summary measures from large data sets requires one to take averages across the estimated correlations, a procedure that can mask the presence of comovement across a subset of the data. One way to reduce the number of bivariate correlations is to specify a country or weighted aggregate to serve as the reference against which other countries' correlations are computed. However, changes in the reference country/aggregate often lead to significantly different results. Such weighting schemes also inevitably give rise to questions about the weights and concerns that a large country may dominate the global business cycle by virtue of its size when, in fact, that country may be disengaged from the rest of the world. Moreover, static correlations cannot capture the dynamic properties of the data, such as autocorrelations and cross-autocorrelations across variables.

⁵The sign restriction is a normalization that allows us to interpret the factors in an intuitive way. For instance, normalizing the factor loading for GDP growth in the United States on the global factor to be positive implies that the global factor falls in 1974 and 1981, consistent with the fact that most countries had a recession in those years.

⁶The procedure draws the group factor conditional on the world factor, and then the country factor conditional on the world and group factors. This imposes an orthogonality between the world and group factor innovations. The model assumes that the country factor innovations are orthogonal to each other. We do not impose this assumption, and it is not really necessary. There may be country factors that are correlated. One could, in principle, include group factors for these subsets of countries to render the remaining country factors orthogonal. This approach would increase the computation time and leave unchanged the main results. Since these "new" group factors would be estimated conditional on the world and group factors, the group factors would not be affected. The ordering of conditioning depends on the number of variables the group loads on, with the factor loading on the most variables ordered first.

Factor models obviate these problems. They do not require one to average across variables or define a “numeraire” country. Instead, they identify the common component and, at the same time, detect how each country responds to that component. For example, suppose that one country is positively affected by a shock although a second is negatively affected by the same shock. The factor model will assign a positive factor loading to one country and a negative one to the other, thereby correctly identifying the sign of how the common component affects each country. More importantly, factor models are flexible enough that multiple factors can be specified in a parsimonious way to capture the extent of synchronicity across the entire data set as well as the synchronicity specific to subsets of the data (e.g., particular groups of countries). Furthermore, since the factors are extracted simultaneously, we can assign a degree of relative importance to each type of factor.

In our dynamic latent factor model, country “weights” are derived as part of the estimation process. That is, the econometric procedure searches for the largest common dynamic component across countries (in static factor models, this is labeled the first principal component). For example, if the world contained one large country and a number of small countries, and the small countries moved together but were unrelated to the large country, our procedure would identify that common component across the smaller countries. Although some may view this as problematic in terms of country weighting, we consider this a virtue, since we are trying to characterize the degree of synchronicity of cycles across a large set of countries. In order to do so, we need to identify which countries, in fact, move together. Of course, in practice, large countries affect small ones through various linkages, and our procedure does capture this.

The factor model is well suited to studying the joint properties of fluctuations in output, consumption, and investment. Using multiple macroeconomic aggregates, rather than just output, allows us to derive more robust measures of national and global business cycles. Moreover, since each variable can respond with its own magnitude and sign to the common factors, the model simultaneously captures the effects of changes in comovement across different macroeconomic aggregates. For example, if consumption comovement goes up from one period to the next across two countries, we would observe an increase in the factor loading for consumption in both countries for either the global or group-specific factor (depending on how widespread the increase in consumption comovement is and which groups the countries belong to). At the same time, the size of the factor loading on the investment variables in those countries would decline. The same would happen, with a greater decline in the factor loading on investment, if the increase in consumption comovement was accompanied by a decline in investment comovement.

Factor models have the advantage that they are motivated by DSGE models, as was first noted by Sargent (1989) for a general equilibrium model. Recent research on international business cycles shows that one can view the dynamic factor model we employ as a reduced-form solution of a standard open-economy DSGE model as the data generated from a standard DSGE model have a representation as a dynamic factor model (Crucini et al., 2010). The typical DSGE model suffers from the curse of dimensionality, limiting the number of shocks and number of driving variables that can be analyzed using such models. The advantages of the dynamic factor model employed here are that it is parsimonious and allows one to consider larger, more interesting data sets than if one was estimating a multicountry DSGE model.

There is a rich literature on large dynamic factor models that are closely related to our work (see, e.g., Forni and Reichlin, 1998; Forni et al., 2000; Bai and Ng, 2002; Stock and Watson, 2002; Doz et al., 2008). We adopt a Bayesian approach to estimating the dynamic factor model. Since the methodology we use is developed elsewhere (Otrok and Whiteman, 1998), we do not provide a full comparison with other approaches. The main difference between our approach and those listed above is our reliance on a fully parametric model. This approach can have efficiency gains if the parametric structure is correct. The alternatives listed above will have an advantage if the model is misspecified, as they are designed to be robust to certain types of misspecification. Our approach to dealing with the misspecification is to estimate many variations of the benchmark model and show that changes have no impact on the benchmark results.

2.3. *Variance Decompositions.* We use variance decompositions to measure the relative contributions of the global, group-specific, and country-specific factors to business cycle fluctuations in each country. This provides an empirical assessment of how much of a country's business cycle fluctuations are associated with global fluctuations or fluctuations among a group of countries. We estimate the share of the variance of each macroeconomic variable attributable to each of the three factors and the idiosyncratic component. With orthogonal factors, the variance of the growth rate of the observable quantity $Y_t^{i,j,k}$ can be written as follows:⁷

$$\begin{aligned} \text{var}(Y_t^{i,j,k}) &= (\beta_{global}^{i,j,k})^2 \text{var}(f_t^{global}) + (\beta_{economyk}^{i,j,k})^2 \text{var}(f_t^{economyk}) \\ &+ (\beta_{countryj}^{i,j,k})^2 \text{var}(f_t^{countryj}) + \text{var}(\varepsilon_t^{i,j,k}). \end{aligned}$$

Then, the fraction of volatility due to, say, the global factor would be

$$\frac{(\beta_{global}^{i,j,k})^2 \text{var}(f_t^{global})}{\text{var}(Y_t^{i,j,k})}.$$

These measures are calculated at each pass of the Markov chain; dispersion in their posterior distributions reflects uncertainty regarding their magnitudes.

2.4. *Effects of Trade and Financial Integration on Comovement: A Simple Schematic Approach.* A key question at this stage is whether it is possible to disentangle the different aspects of global integration that could account for changes in business cycle synchronization across countries. We address this question using a simple schematic approach that yields the following conclusions: (i) There is no strong prediction from theory about the net effects of greater trade and financial integration on the extent of business cycle synchronization; (ii) it is not possible, even with extensive bilateral and multilateral data on trade and financial flows, to disentangle the different mechanisms underlying changes in cross-country correlations of business cycles; hence, the effect of globalization on business cycle synchronicity can only be resolved empirically; and (iii) our particular formulation of a dynamic factor model is crucial for detecting changes in patterns of synchronization across different levels of aggregation.

The effects of various forms of cross-border integration on the transmission of different shocks to macroeconomic variables can be traced through their impact on the estimated factor loadings on those shocks. In our notation, β_{global}^{ijk} is the factor loading on the global factor for variable j in country i , which is in country group k . It can be written as a function of a country's level of trade and financial integration:

$$\beta_{global}^{ijk} = F(T_{iw}, F_{iw}, S_i),$$

where T_{iw} is the degree of trade integration of country i with the rest of the world and F_{iw} represents the corresponding measure of financial integration. S_i represents a variety of other factors such as level of development, depth of financial markets, and extent of diversification of the production structure that could affect transmission of global shocks to country i . The corresponding factor loading on the group factor can be written as

$$\beta_{economy}^{ijk} = F(T_{ik}, F_{ik}, S_i),$$

⁷Even though the factors are uncorrelated, samples taken at each pass of the Markov chain will not be, purely because of sampling errors. To ensure adding up, we orthogonalized the sampled factors, ordering the global factor first, the regional factor second, and the country factor third. Our simulations suggest that the order of orthogonalization has little impact on the results. In particular, all of the results remain qualitatively similar under alternative orderings, and the quantitative differences are small.

where T_{ik} is the degree of trade integration of country i with other countries in group k and F_{ik} is the extent of financial integration of country i with other countries in group k .

Now, consider the scenario where the degree of trade integration among countries in a group, which can be denoted as $T_k = (1/k) \sum_i T_{ik}$, goes up. Can we isolate the effects of rising trade integration on business cycle synchronization? Different classes of theoretical models have highlighted two opposing effects. In standard macroeconomic models, international trade linkages generate both demand and supply-side spillovers across countries, which can increase the degree of business cycle synchronization. On the demand side, an investment or consumption boom in one country generates increased demand for imports, boosting other economies (Baxter and Kouparitsas, 2005). On the supply side, a positive tradable output shock leads to lower prices; hence, imported inputs for other countries become cheaper (Kose and Yi, 2001, 2006).

However, both classical and “new” trade theories imply that increased trade linkages lead to increased specialization. How this affects the degree of synchronization depends on the nature of specialization (intra- versus interindustry) and the types of shocks (common versus country-specific). If stronger trade linkages are associated with increased interindustry specialization across countries, then the impact of increased trade depends on the nature of shocks: If industry-specific shocks are more important in driving business cycles, then international business cycle comovement is expected to decrease (see Krugman, 1993). If common shocks, which might be associated with changes in demand and/or supply conditions, are more dominant, then this would lead to a higher degree of business cycle comovement (see Frankel and Rose, 1998).

There are similar contrasting effects of financial integration on within-group correlations. Financial linkages could result in greater business cycle synchronization by generating large demand side effects as correlated changes in equity prices affect wealth dynamics. Furthermore, contagion effects transmitted through financial linkages could also result in heightened cross-country spillovers of macroeconomic fluctuations (Claessens and Forbes, 2001; Imbs, 2006).

However, international financial linkages could decrease cross-country output correlations if they lead to greater specialization of production through the reallocation of capital in a manner consistent with countries’ comparative advantage in the production of different goods. Such specialization of production is stimulated by financial linkages that allow for more diversified portfolios, and hence, enable more efficient risk sharing in response to country-specific output fluctuations. For example, Kalemli-Ozcan et al. (2001) report a positive relationship between the degree of financial integration (risk sharing) and specialization of production, both across and within countries (using data on regions within countries). This would lead to less correlated cross-country fluctuations in output, as it could result in more exposure to industry- or country-specific shocks. In short, the overall net effect of rising within- and between-group trade and financial integration is hard to pin down in a theoretical model.

The level of development also influences the nature of the transmission mechanism. Trade and financial integration help low-income underdeveloped economies diversify their production bases by giving them access to foreign finance for investment projects and also access to larger foreign markets. It is only at higher per capita income levels that specialization dominates this diversification effect of greater integration (Imbs and Wacziarg, 2003).

This discussion implies that the net effect of trade and financial integration can only be resolved empirically. Even the availability of data on bilateral trade and financial flows would not be useful in disentangling the effects of different forms of integration on shock transmission. An additional implication is that the level of development may have a bearing on how integration affects a country’s business cycle synchronicity with the rest of the world, suggesting the need for a breakdown of country groups not by region but by level of development.

Our depiction of how within-group correlations can be affected by within-group trade and financial integration is, of course, equally relevant when we consider integration at the level of the world economy. This raises a question about the “right” level of aggregation that we should use for analyzing business cycle correlations. The overall trade integration of country i with the world can be decomposed as follows:

$$T_{iw} = T_{ik} * T_{k,w \notin k} + T_{i,w \notin k},$$

where $T_{k,w \notin k}$ is the degree of trade integration between the entire group of countries denoted by k and the rest of the world economy and $T_{i,w \notin k}$ represents country i 's "direct" integration with countries not in its group. In other words, a country's total trade integration with the world economy depends—conceptually, rather than strictly arithmetically—on (i) country i 's integration with other countries in its group times the entire group's integration with the rest of the world and (ii) country i 's direct trade integration with the countries not in its group. The same decomposition can be applied to the measure of financial integration.

The channels that we discussed earlier could operate at either the group or world level. If a country's level of integration with its group is greater than that with the rest of the world, the relevant level of disaggregation might be the group. Indeed, it is conceivable that a country's entire integration is with the group rather than directly with the rest of the world. In any event, it is clear that unless we simultaneously estimate the degree of business cycle synchronization within a group and with the world, we could end up statistically misattributing changes in within-group correlation to changes in worldwide correlations, or vice versa. Thus, our factor model that allows us to perform this simultaneous estimation is crucial to an accurate empirical characterization of changes in business cycle correlations across countries.

Our econometric model cannot distinguish truly "global" shocks from those that emanate in one country and spill over to all other countries. This is a common identification problem in the business cycle literature and can only be solved by imposing strong assumptions on the cross-country propagation mechanism of shocks. As our primary interest is in characterizing the commonality of fluctuations at different levels of disaggregation across the full set of countries, this is not a concern for us.⁸ Furthermore, our objective is to document the overall evolution of within- and between-group business cycle synchronization rather than to evaluate alternative transmission mechanisms. Hence, from here on, we limit our focus to outcomes in terms of cyclical comovement and do not attempt to disentangle the mechanisms driving the results.

2.5. Data. Our data set, primarily drawn from the World Bank's World Development Indicators, comprises annual data over the period 1960–2008 for 106 countries. Real GDP, real private consumption, and real fixed asset investment constitute the measures of national output, consumption, and investment, respectively. All variables are measured at constant national prices. We compute the growth rates and remove the mean from each series. We divide the countries into three groups: industrial countries (23 INCs), emerging market economies (24 EMEs), and other developing countries (59 ODCs). The Appendix shows the distribution of countries among the three groups. For our purposes, the key distinction among the EMEs and ODCs is that the former group has attained a much higher level of integration into global trade and finance. For instance, the average growth rate of total trade (exports plus imports) has been more than twice the growth rate of GDP in the former group since the mid-1980s, whereas the corresponding figure for the ODCs is much lower. EMEs have also received the bulk of private capital inflows going from industrial to nonindustrial countries. Over the last two decades, the total gross stocks of foreign assets and liabilities of all EMEs have risen more than fivefold and are now an order of magnitude larger than those of all ODCs.

To study how business cycles have evolved over time in response to trade and financial integration, we divide our sample into two distinct periods—the preglobalization period (1960–1984) and the globalization period (1985–2008). There are three reasons for this demarcation. First, global trade and financial flows have increased markedly since the mid-1980s. Countries have intensified their efforts to liberalize external trade and financial account regimes and

⁸The difficulty of such identification is illustrated by Boivin and Giannoni's (2010) use of a factor augmented vector autoregression to capture the impact of globalization on the U.S. monetary transmission mechanism. Reichlin (2010) notes that the interpretation of their estimated VARs and related Granger causality tests is confounded by the relationships and feedbacks among global and national forces that jointly determine national variables, making the transmission mechanism difficult to interpret.

the fraction of countries with a fully liberalized trade (financial) account in our sample has increased from 20% (30) to close to 70% (80) over the past two decades. These factors have led to a dramatic increase in global trade flows, both in absolute terms and relative to world income, during the globalization period. For example, the ratio of world trade to world GDP has surged from less than 30% in 1984 to more than 55% now. The increase in financial flows has also been remarkable as the volume of global assets and liabilities has risen more than 10-fold during the same period (see Lane and Milesi-Ferretti, 2007). In other words, global economic linkages clearly became much stronger during the second period.

Second, after a period of stable growth during the 1960s, the first period witnessed a set of common shocks associated with sharp fluctuations in the price of oil in the 1970s and a set of synchronized contractionary monetary policies in the major industrial economies in the early 1980s. This demarcation is essential for differentiating the impact of these common shocks from that of globalization on the degree of business cycle comovement. Third, the beginning of the globalization period coincides with a structural decline in the volatility of business cycles in both industrial and nonindustrial countries until the financial crisis of 2008–2009 (see McConnell and Perez-Quiros, 2000; Stock and Watson, 2005).

3. DYNAMIC FACTORS AND EPISODES OF BUSINESS CYCLES

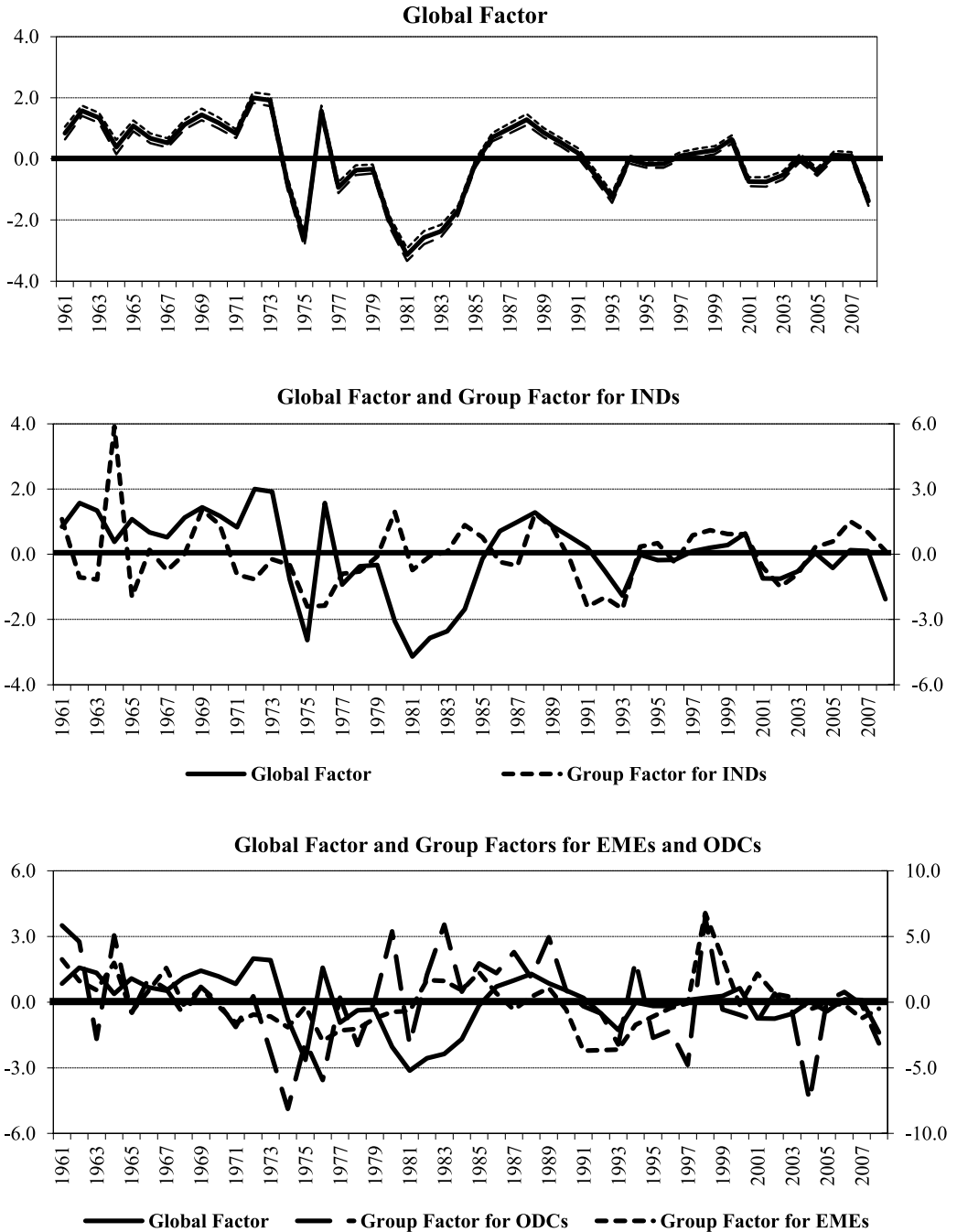
In this section, we examine the evolution of different factors and analyze their ability to track important business cycle episodes since 1960. Since conventional measures of business cycles have tended to focus on fluctuations in output, we restrict our analysis in this section to the decomposition of output growth fluctuations into different factors.

3.1. Evolution of the Global and Group-Specific Factors. Figure 1 (top panel) displays the posterior mean of the global factor, along with the 5% and 95% posterior quantile bands for the estimated factors. These bands form a 90% probability coverage interval for the factor—that is, the probability that the factor lies in this interval is 0.9. The tightness of this interval suggests that the global factor is estimated fairly precisely. This factor reflects the major economic events of the past four decades: the steady expansionary period of the 1960s; the boom of the early 1970s; the deep recession of the mid-1970s associated with the first oil price shock; the recession of the early 1980s stemming from a variety of forces including the debt crisis and the tight monetary policies of major industrialized nations; the mild recession of the early 1990s; the 2001 recession and the subsequent recovery; and the beginning of the global recession associated with the latest financial crisis.⁹

The behavior of the global factor is also consistent with several interesting stylized facts pertaining to the amplitude and sources of global business cycles. First, the global factor has become less volatile after the mid-1980s. The standard deviation of the global factor fell from 0.85% in the 1960–1984 period to 0.30% during 1985–2008. This is consistent with the structural decline in the volatility of business cycles in a number of countries. Second, consistent with other studies, fluctuations in oil prices appear to be related to the turning points of global business cycles (see Backus and Crucini, 2000). The largest troughs in the global factor coincide with sharp increases in the price of oil, as the major oil price increases of 1974 and 1980–1981 were associated with global recessions. However, the contemporaneous correlation between the global factor and the growth rate of the oil price is rather small, suggesting that there are other important factors besides oil prices that matter for global business cycles.¹⁰ Third, the worldwide recession in the early 1980s was deeper than the one in the mid-1970s.

⁹Since our data set ends in 2008, the global factor does not display the plunge in global output that took place in 2009. We extended the analysis to 2009 using a mix of actual data and IMF forecasts for those countries for which national income accounts data are not yet precisely available. The global factor declines sharply in 2009, but adding in this year's data made little difference to our headline results.

¹⁰The correlation between the global factor and the world price of oil, measured by the index of average spot prices (from the IMF's International Financial Statistics), is -0.04 . We reestimated the model with oil prices as an additional



NOTES: In the top panel, we estimate the model over the full sample period, and then plot the mean of the posterior distribution of the estimated global factor (the dark solid line). The dashed/dotted lines around the mean show 5% and 95% quantile bands of the distribution of estimates of the global factor. In the middle and bottom panels, we estimate the model over the full sample period, and then plot the mean of the posterior distribution of the estimated factors. INDs, EMEs, and ODCs refer to Industrial Countries, Emerging Market Economies, and Other Developing Countries, respectively.

FIGURE 1

GLOBAL AND GROUP-SPECIFIC FACTORS

The group-specific factors are orthogonal to the global factor by construction and, as we discussed earlier, any common shocks affecting all countries will be picked up by the global factor.¹¹ The group-specific factors capture any remaining comovement among countries within each group (Figure 1, lower panels).¹² Although the maintained assumption of the model is that the innovations to the group-specific factors are orthogonal to each other, this assumption is neither necessary nor imposed. In practice, we do find a moderate amount of correlation between the group-specific factors, with the cross correlations amounting to about 0.51.

One possibility is that there is a second global factor that we have not accounted for. We conducted additional simulations allowing for a second world factor, but the results suggest that this factor is not quantitatively important and does not explain the comovement between the group-specific factors. A visual inspection of the group-specific factors shows that they move at times in the same direction, but the factors remain distinct. For example, in the 1991–1993 recession period, both the INC and EME factors decline, giving rise to a positive correlation. However, the timing, depth, and breadth of the recession differ across these factors, so they remain separate and distinct from each other despite their apparently high correlation. The fluctuations in the group-specific factors also reflect important cyclical episodes specific to each group. For example, the INC factor captures the 2001 recession and subsequent recovery, whereas the factors for the EMEs and ODCs pick up the Asian crisis in 1997. The behavior of the group-specific factors is also consistent with the downturn in 2008 due to the global financial crisis.

3.2. Country Factors and Domestic Economic Activity. We now examine the evolutions of the global, group-specific, and country factors for a few selected countries and see how those factors match up with actual output growth in those countries. To make the scales of the factors and output growth comparable for each country, the factors are multiplied by their respective factor loadings. This implies that the sum of the three scaled factors and the idiosyncratic component is equal to the growth rate of output of each country. The results are presented in Figure 2.

The top left panel shows the median of the estimated U.S. country-specific factor along with the global factor, the industrial-country group-specific factor, and the growth rate of U.S. output. The U.S. country factor captures most of the peaks and troughs of the NBER reference dates for U.S. business cycles.¹³ Although the U.S. country factor and the global factor exhibit some common movements, there are some notable differences between the two factors in almost every decade. Despite these differences, the contemporaneous correlation between the fluctuations in the U.S. output and the global factor is positive (0.34).¹⁴

The top right panel of Figure 2 displays the global factor, the industrial country group-specific factor, the country-specific factor, and the actual output growth rate for Japan. The rapid growth of the Japanese economy during the 1960s is captured by the country factor, whereas the impact of the global factor during this period was rather minor. Nevertheless, there is a relatively high

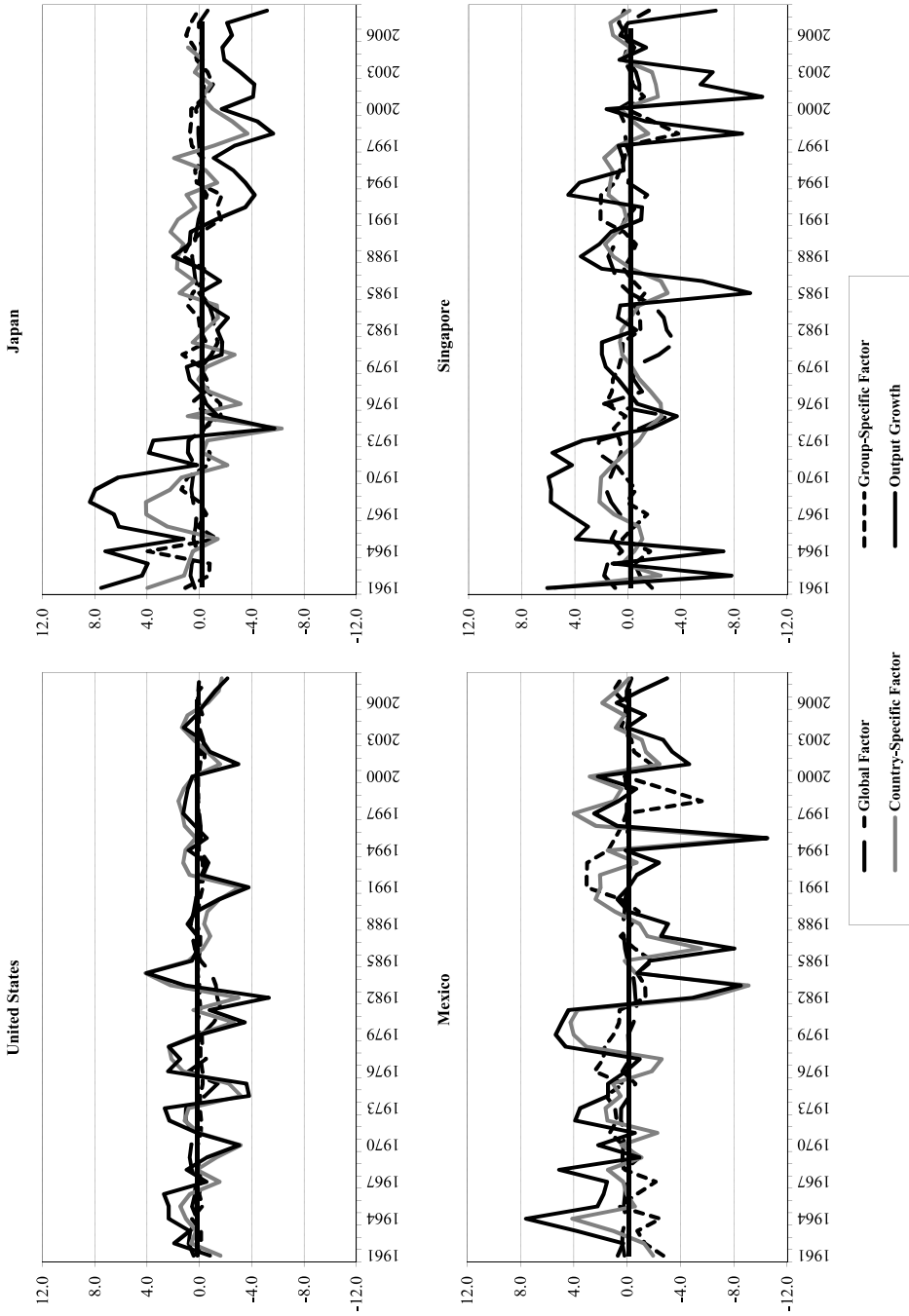
regressor. In principle, this “removes” the effect of oil on the world factor and separates out the effects of the world factor into oil and nonoil components. Our headline results with respect to the convergence and divergence of business cycles reported in subsequent sections did not change. The group-specific factors for the advanced and emerging regional factors were also unaffected.

¹¹In small samples, it is possible that the global and group-specific factors will appear correlated due to a spurious correlation. That is, two independent but serially correlated processes will often have a nonzero measured cross-correlation in small samples. In our estimates, the average correlation between the global factor and group-specific factors is less than 0.1. In all the results reported here, we impose orthogonality by regressing the group-specific factors on the global factor and retaining the residual.

¹²We calculated 5% and 95% quantile bands for all of the estimated factors, but leave them out of the plots to reduce clutter. Plots showing the quantile bands are available from the authors.

¹³Claessens et al. (2009) report reference business cycle dates for various countries.

¹⁴As noted earlier, the innovations to the factors are orthogonal by construction, not the factors themselves. The factors could comove for brief periods but, with a sufficiently long sample, they will be orthogonal as implied by construction.



NOTES: We estimate the model over the full sample period. For the relevant country in each plot, we then show the means of the posterior distributions for each of the factors, along with overall annual output growth for that country.

FIGURE 2
OUTPUT GROWTH AND ESTIMATED FACTORS FOR SELECTED COUNTRIES

TABLE 1
 VARIANCE DECOMPOSITIONS—ALL GROUPS (1960–2008)

Group	Factor	Output	Consumption	Investment
World	Global	11.82	8.86	5.73
	Group	4.55	2.30	5.02
	Global+Group	16.37	11.16	10.75
	Country	47.24	39.35	30.94
	Idiosyncratic	35.26	48.43	57.25
Industrial countries	Global	30.59	26.40	14.58
	Group	9.99	3.89	14.14
	Global+Group	40.58	30.29	28.72
	Country	38.78	34.78	40.27
	Idiosyncratic	20.05	34.20	30.36
Emerging market economies	Global	7.63	4.80	3.70
	Group	6.65	3.49	4.94
	Global+Group	14.28	8.30	8.64
	Country	60.56	40.34	46.96
	Idiosyncratic	24.23	50.53	43.54
Other developing countries	Global	6.21	3.68	3.10
	Group	1.57	1.19	1.49
	Global+Group	7.78	4.86	4.60
	Country	45.11	40.73	20.79
	Idiosyncratic	45.68	53.13	73.31

NOTES: We estimate the model over the full sample period (1960–2008) and compute the variance decompositions for each country and, within each country, for output, consumption, and investment. In each cell, we then report the cross-sectional mean of the variance share attributable to the relevant factor. The cross-sectional means are calculated for the relevant cluster of countries indicated in the first column. The rows marked (Global+Group) are just the sums of the average variance shares of the global and group-specific factors.

correlation between the global factor and the Japanese country factor (0.3) from 1960 to 1992. Since the early 1990s, this link has disappeared, as the country-specific factor plays a more significant role in driving business cycles in Japan and the correlation drops to -0.4 during the period 1993–2008. The lower panels of Figure 2, which plot the estimated factors for Mexico and Singapore, illustrate that the country-specific factors play a relatively larger role in explaining business cycles in the EMEs. These factors also reflect some important historical business cycle episodes. For instance, the Mexican country factor captures the Tequila crisis of 1994–1995.

4. SOURCES OF BUSINESS CYCLE FLUCTUATIONS: 1960–2008

We now examine the sources of fluctuations using variance decompositions over the full sample period. As a summary measure of the importance of the factors, we present the average variance shares (within the relevant groups of countries) attributable to each factor for the world and the three groups of countries defined earlier. We do not report standard errors for these cross-country averages, but will do so when we look at individual country results.¹⁵

4.1. *Common Cycles: Global and Country-Specific Factors.* Table 1 shows that the global factor accounts for a significant fraction of business cycle fluctuations in all three macroeconomic variables over the period 1960–2008, implying that there is a “world business cycle.” The global factor, on average, explains 12% of output growth variation among all countries in the sample. It also accounts for 9% and 6% of the volatility of growth rates of consumption and investment, respectively. Although these numbers may seem small, note that the common factor across the

¹⁵We also calculated the median (rather than mean) variance shares attributable to each factor for the full sample and each group of countries. These were generally close to the average shares reported in Tables 1–6. As there are no obvious outlier countries driving our results, we only report results using means.

three variables is for a large and diverse set of countries. The factor loadings associated with output and consumption growth on the global factor are positive for most countries (i.e., the posterior distributions of the factor loadings have little mass in symmetric intervals about zero).¹⁶ Since the global factor is identified by a positive factor loading for U.S. output growth, these findings also imply that positive developments in the U.S. economy are generally associated with positive developments in the rest of the world.

Although the global factor is important in each group of countries, on average, it plays a more dominant role in explaining business cycles in industrial countries. The average variance share of output growth attributable to the global factor in industrial countries is around 31%, about four to five times as much as in the two groups of nonindustrial countries. The global factor is also associated with a substantial share of the variance in consumption and investment growth among industrial countries, accounting, on average, for 26% and 15% of the total variance of these variables, respectively. These shares are also much larger than the corresponding shares for EMEs or ODCs.

Once we account for the world business cycle, are there common cycles across any of the remaining groups of countries? Table 1 shows that the group-specific factor accounts for about 5% of output growth fluctuations in the full sample. This factor, like the global factor, is also more important for industrial countries than for EMEs or ODCs. On average, it accounts for 10% of output growth fluctuations in industrial countries, compared to 7% and 2%, respectively, for EMEs and ODCs. A more comprehensive measure of how much a country's cyclical fluctuations are tied in to those of other countries is to look at the sum of the variance contributions of the global and group-specific factors. The rankings of the different groups remain much the same. Among industrial countries, the total contribution of these two factors averages 41% for output and nearly 30% for consumption and investment. For EMEs, the corresponding averages are 14% and 8%, respectively.

4.2. National Cycles: Country and Idiosyncratic Factors. The country and idiosyncratic factors play important roles in driving business cycles around the world (Table 1). The country factor is, on average, more important than the idiosyncratic factor in explaining output variation (47% versus 35%), but the reverse is true for fluctuations in consumption and investment. Looking across the three groups of countries, it is evident that as countries become more developed (and, as an empirical corollary to development, also become more exposed to global trade and financial flows), the global and group-specific factors appear to become more relevant in explaining national business cycles at the expense of the country and idiosyncratic factors.

A striking result is that, among EMEs, country-specific factors account for 61% of the variation in output, much higher than in industrial countries (39%) or ODCs (45%). This means that the degree of comovement across the three main macroeconomic aggregates is much greater within countries in this group, once we have stripped out the part of the comovement attributable to factors that are common across all countries in the sample or across all EMEs. Interestingly, the pattern is reversed for consumption fluctuations in EMEs. In this case, the contribution of the idiosyncratic factor is highest (51%) and the combined share of the global and group-specific factors is only 8%. This pattern holds for ODCs as well, with the total contribution of common factors to consumption fluctuations amounting to only 5%. Taken together, these results tie in well with a recent literature, showing that developing countries have not been able to achieve much international risk sharing, as measured by correlations of domestic consumption with world consumption (or income). Their consumption fluctuations are closely correlated with their own output fluctuations and, in addition, their consumption fluctuations are not correlated with those of other countries.

For the sample as a whole and also for each group of countries, the total contribution of the global and group-specific factors is greater for output than for consumption. This implies that, on average, country-specific and idiosyncratic factors play a more important role in explaining

¹⁶To conserve space, we do not report the factor loadings here; they are available from us upon request.

TABLE 2
 VARIANCE DECOMPOSITIONS—INDUSTRIAL COUNTRY SUBSAMPLES (1960–2008)

Group	Factor	Output	Consumption	Investment
Industrial countries	Global	30.59	26.40	14.58
	Group	9.99	3.89	14.14
	Global+Group	40.58	30.29	28.72
	Country	38.78	34.78	40.27
	Idiosyncratic	20.05	34.20	30.36
G-7	Global	39.71	35.35	20.18
	Group	6.98	2.82	14.03
	Global+Group	46.69	38.17	34.22
	Country	37.88	36.58	45.62
	Idiosyncratic	14.81	24.56	19.51
United States–Canada	Global	24.31	24.51	6.65
	Group	3.34	1.17	2.18
	Global+Group	27.65	25.68	8.83
	Country	52.20	51.21	68.97
	Idiosyncratic	19.39	22.38	21.47
EU 12	Global	40.82	33.78	19.77
	Group	10.44	3.50	15.90
	Global+Group	51.26	37.28	35.67
	Country	29.67	24.88	35.06
	Idiosyncratic	18.47	37.05	28.56

NOTES: We estimate the model over the full sample period (1960–2008) and compute the variance decompositions for each country and, within each country, for output, consumption, and investment. In each cell, we then report the cross-sectional mean of the variance share attributable to the relevant factor. The cross-sectional means are calculated for the relevant cluster of countries indicated in the first column. The rows marked (Global+Group) are just the sums of the average variance shares of the global and group-specific factors.

consumption fluctuations than in the case for output fluctuations. This result echoes a well-known stylized fact in the literature that, contrary to the predictions of conventional theoretical models of international business cycles, output is more highly correlated across countries than consumption (Backus et al., 1995, refer to this as the “quantity anomaly”).

Another notable result from Table 1 is that among ODCs, the contribution of the idiosyncratic factor is greater than that of any other factor. This is true for all variables, but especially so for investment, where, on average, the idiosyncratic factor accounts for 73% of fluctuations. This finding suggests that investment fluctuations in these countries do not seem to be closely tied to either domestic or world business cycles.

Although the results in Table 1 reveal interesting contrasts across different groups of countries, they also mask large differences in the relative importance of different factors among individual countries. This becomes evident even when we use a finer breakdown of the three coarse country groups. Table 2 is a counterpart of Table 1 but shows the results for smaller groups of industrial countries. These results are based on the estimation of the full model, and the group-specific factor here refers to that for all industrial countries. On average, the global factor is more important for the G-7 and EU-12 countries than for other groups. The United States and Canada, in particular, seem to march to their own beat compared to other groups of industrial countries.¹⁷

4.3. *Summary.* Our analysis of variance decompositions for the period 1960–2008 has yielded three major results. First, there exists a global business cycle. The global factor accounts for a modest but significant share of macroeconomic fluctuations across all country groups, although it is more important for explaining business cycles in industrial countries than

¹⁷The differences are starker when we look at results for individual countries. Detailed variance decompositions for each country in our sample are available upon request.

TABLE 3
VARIANCE DECOMPOSITIONS—ALL GROUPS

Group	Factor	1960–1984			1985–2008		
		Output	Consumption	Investment	Output	Consumption	Investment
World	Global	14.67	10.94	7.14	7.80	5.77	7.38
	Group	5.66	4.33	5.62	9.04	7.78	8.85
	Global+Group	20.33	15.27	12.76	16.84	13.55	16.23
	Country	43.99	39.14	28.60	41.48	35.04	32.12
	Idiosyncratic	33.31	43.09	56.21	37.67	47.93	48.26
Industrial countries	Global	27.68	25.27	12.06	14.04	13.52	14.37
	Group	17.16	9.39	15.29	30.03	23.67	24.68
	Global+Group	44.84	34.66	27.35	44.07	37.19	39.05
	Country	33.34	32.13	39.25	27.78	22.20	30.09
	Idiosyncratic	20.66	31.72	31.88	25.18	37.36	28.39
Emerging market economies	Global	13.28	7.22	6.38	4.53	3.19	3.72
	Group	2.65	3.84	3.13	7.09	4.91	7.92
	Global+Group	15.93	11.06	9.52	11.62	8.11	11.63
	Country	53.40	36.38	39.57	62.02	47.07	50.12
	Idiosyncratic	28.56	50.50	48.63	22.43	40.91	34.67
Other developing countries	Global	10.16	6.86	5.53	6.69	3.80	6.14
	Group	2.40	2.56	2.86	1.66	2.76	3.06
	Global+Group	12.56	9.42	8.40	8.35	6.55	9.20
	Country	44.32	43.00	19.99	38.47	35.16	25.59
	Idiosyncratic	40.17	44.50	68.79	48.74	54.91	61.54

NOTES: We estimate the model separately over the two periods 1960–1984 and 1985–2008. We then compute the variance decompositions for each country and, within each country, for output, consumption, and investment in each of these two periods. In each cell, we then report the cross-sectional mean of the variance share attributable to the relevant factor. The cross-sectional means are calculated for the relevant cluster of countries indicated in the first column. The rows marked (Global+Group) are just the sums of the average variance shares of the global and group-specific factors.

in EMEs or ODCs. Second, there are cycles specific to each group of countries, but even the group-specific factor plays a significantly more important role among industrial countries than between the other two groups. This is consistent with other evidence that industrial country business cycles are more closely aligned with each other and with the global business cycle. Since we do not weight countries by their GDP weights, this is not a mechanical result. Third, the contributions of global and group-specific factors together to the variance of output growth are higher—across country groups, time periods, etc.—than their contributions to the variance of consumption growth, suggesting that there are unexploited opportunities for international risk sharing. This differential is greater for EMEs and ODCs than for industrial countries, implying that the potential benefits of efficient international risk sharing are larger for these two groups (see Prasad et al., 2003).

5. GLOBALIZATION AND THE EVOLUTION OF INTERNATIONAL BUSINESS CYCLES

In light of our earlier discussion of the effects of global trade and financial integration, a logical (and intrinsically interesting) question is whether—and, if so, how—the patterns of international business cycle synchronicity have evolved in response to rising globalization. In this section, we first analyze this question. Next, we consider the evolution of the extent of risk sharing around the world based on cross-country comovement of consumption. We then briefly analyze how the contributions of different factors to investment fluctuations have evolved.

5.1. Convergence or Decoupling? The convergence hypothesis suggests that with closer economic integration, business cycles should become more synchronized across countries over time. Table 3 shows the variance decompositions in a manner analogous to Table 1 but based on

models estimated separately for the preglobalization (1960–1984) and globalization (1985–2008) periods.¹⁸ Contrary to the convergence hypothesis, the average contribution of the global factor to output fluctuations *falls* in half, from 15% to 8% for the full sample. The same pattern holds for consumption fluctuations and, to a much lesser degree, for fluctuations in investment. These patterns also hold up and are, in fact, stronger when we look at output fluctuations by country group. For industrial countries, the average contribution of the global factor falls sharply from 28% to 14%. The decline is also large for EMEs—from 13% to 5%—whereas it is somewhat smaller for ODCs—from 10% to 7%.

In contrast to the declining importance of the global factor, the group-specific factor has, on average, become more important in explaining business cycles. The average share of the variance of output and consumption attributed to the group-specific factor has risen from 6% to 9% during the globalization period. These patterns are particularly strong, for all three macroaggregates, among the industrial countries and EMEs. Our long sample, which covers a substantial period of the recent era of globalization, is essential for identifying the emergence of group-specific cycles in the industrial countries and EMEs during the period of globalization. In the next section, we also study the significance of the temporal changes in the importance of global and group-specific factors at the country level and show that these changes are indeed statistically significant.

As we noted earlier, a useful metric of the extent of business cycle synchronization around the world is the sum of the variance shares of the global and group-specific factors. Interestingly, when we look at the total contributions of these two common factors, there is much greater stability in their contributions to fluctuations in each of the macroaggregates and for each of the country groups (Table 3). This is, of course, the consequence of a substantial increase in the relative importance of the group-specific factor. For instance, looking at the variance decompositions for output fluctuations, the relative contributions of the group-specific factor rise from 17% to 30% for industrial countries and from 3% to 7% for EMEs. This largely offsets the decline in the variance contributions of the global factor, so the sum of the contributions of the two factors is only slightly smaller in the globalization period relative to the preglobalization period. These results show that, contrary to the convergence hypothesis, national business cycles have not, in general, become more synchronized at the global level.

Our findings suggest the need for a nuanced approach to the hypotheses of convergence and decoupling. Although there is little support for the hypothesis of global convergence of business cycles, there is a higher degree of synchronization in business cycles within the groups of industrial countries and EMEs during the globalization period, implying that the convergence hypothesis is valid at least for these groups of countries. At the same time, the emergence of group-specific cycles provides partial support for the decoupling hypothesis as it suggests that business cycles in EMEs are now influenced more by their own group-specific dynamics than they were in the preglobalization period.

How can we explain these results? There were large common disturbances during the preglobalization period—the two oil price shocks—and some correlated shocks in the major industrial countries, notably the tight monetary policy stance in the early 1980s and the associated increase in real interest rates. From the mid-1980s onward (globalization period), however, common global disturbances have become less important in explaining international business cycle fluctuations until the crisis of 2007–2009. Even during this crisis, on average, emerging markets were much less affected (in relative terms) and returned to high growth much more rapidly than advanced economies. These developments have led to an overall decline in the importance of the global factor in explaining business cycles during the globalization period.

¹⁸By estimating the model over two subsamples, we allow the model parameters, such as the factor loadings and those that determine the structure of propagation of shocks, to vary across subsamples. This yields a different variance decomposition. However, the estimate of the factor itself is similar whether estimated over the full sample or over subsamples, which is not surprising as the index of common activity in a period should not be affected by data many periods away. This is in line with Stock and Watson (2009), who show that latent factors can be estimated consistently despite parametric instability.

At the same time, intragroup trade and financial linkages among industrial countries and EMEs have risen rapidly, especially after the mid-1980s. Although there has been a sharp increase in intragroup financial linkages among industrial countries, intragroup trade linkages have become particularly strong among EMEs. The share of intragroup trade in the total international trade of EMEs rose from 20% in 1984 to 43% in 2008. During this period, EMEs' trade with the group of industrial countries as a share of the EMEs' total trade declined from 66% to 48%. Moreover, during the globalization period, the countries in these two groups have increased the pace of diversification of their industrial (and trade) bases. This has been accompanied by a greater degree of sectoral similarity across countries within each group (see Akin and Kose, 2008). With these changes, intragroup spillovers have begun to contribute more to concurrent cyclical fluctuations than common disturbances. These changes have been associated with a notable increase in the roles played by group-specific factors for the groups where such intragroup linkages have become much stronger. Not surprisingly, the importance of the global and group-specific factors in explaining business cycles in ODCs, the group least exposed to the forces of globalization, has barely changed between the two periods.

How do our findings compare with the results in the literature? Earlier studies have typically focused on just output fluctuations and limited their analysis to groupings of countries within the same geographic region. However, these studies often report conflicting results. For example, some recent papers document that there is a distinct European business cycle, whereas others argue the opposite.¹⁹ Other authors find regional cycles specific to East Asia and North America (see Helbling et al., 2007). Kose et al. (2008b) find that a common G-7 factor, on average, explains a larger share of business cycle variation in the G-7 countries since the mid-1980s compared with 1960–1972.²⁰ This finding is consistent with our results since we also report that the group-specific factor has become more important in accounting for business cycles in industrial countries since the mid-1980s. As we discuss in the next section, the increase in the share of variance due to the group-specific factor is quite large for the G-7 countries.

Some recent studies, which use results from the earlier version of our article as a baseline reference, examine the decoupling argument. Some of these studies use simple correlations (over much shorter time periods and smaller samples than ours) and report that business cycles have become more correlated (Walti, 2009; Flood and Rose, 2010).²¹ These studies mostly rely on bilateral correlations, which are fraught with problems. Mumtaz et al. (2010), on the other hand, employ a dynamic factor model and report findings similar to ours using data for a group of 36 countries but over a 75-year period. However, their article, like earlier studies in the literature, focuses on specific geographical regions and employs only output series.

Our analysis provides a global perspective on the evolution of business cycles. First, the statistical model we employ simultaneously estimates a global factor and factors specific to particular groups of countries. This avoids the problem that while countries in groups (regional or otherwise) could display comovement, the source of this comovement may not be distinctly group-specific, but rather, worldwide. Our analysis also shows that the relevant grouping for detecting common cycles is based not necessarily on geographic proximity but on levels of

¹⁹For evidence of a European business cycle, see Artis et al. (2004). Canova et al. (2007) argue that, since the 1990s, there is no evidence of a specific European cycle.

²⁰The decline in the common factor's importance reflects decreased synchronization with Japan and, to a lesser extent, Germany. Stock and Watson (2005) report that the share of output fluctuations in the other five G-7 countries that can be attributed to common factors increased from 1960–1983 to 1984–2002.

²¹Some of these papers argue that due to convergence effects, the impact of INC business cycles on EMEs will mechanically decline over time. Convergence, however, is largely about first moments, and our specific interest is about the comovement in growth rates rather than the averages. Convergence effects on average growth rates will be captured by the constant terms in our empirical model; it is not obvious why convergence should affect cyclical growth fluctuations or by itself limit cyclical spillovers. Moreover, differences in average growth rates do not affect the variance decomposition calculations.

economic development and integration into global trade and financial markets. Moreover, our sample is more comprehensive than those used in earlier studies.²²

5.2. Consumption Comovement. For industrial countries, the increase in the variance contribution of group-specific factors to consumption fluctuations is particularly large—from 9% to 24% (Table 3)—but the joint share of the global and group-specific factors has increased marginally. For EMEs and ODCs, the two common factors jointly account for a slightly lower share of consumption fluctuations in the globalization period. One interpretation of these results is that industrial countries have been able to use financial globalization to effectively share risk among themselves, a result found by various other authors as well (Sorensen et al., 2007). On the other hand, EMEs and ODCs have yet to attain this benefit of globalization, as their consumption fluctuations are still closely tied to domestic cycles (see Kose et al., 2009). Consumption comovement measured in this manner is, of course, not a decisive test of risk sharing, although a broad class of open economy models does yield this interpretation.

5.3. Dynamics of Investment. The share of investment variance attributable to the global and group-specific factors goes up in the globalization period. This is a curious result for which conventional theoretical models do not yield a convincing explanation. Although one can easily rationalize the increase in the importance of the global and group-specific factors in explaining output and consumption variation over time, it is not clear what drives the increase in the investment variance explained by these common factors. In standard stochastic dynamic business cycle models, stronger trade and financial linkages generally lead to lower investment correlations across countries. Reduced restrictions on capital and current account transactions should induce more “resource shifting,” through which capital and other resources rapidly move to countries with more favorable technology shocks (see Backus et al., 1995; Heathcote and Perri, 2002).²³

6. SENSITIVITY EXPERIMENTS

We now examine our key results through different lenses in order to verify their robustness and understand their implications.²⁴

6.1. Results for Subgroups of Countries. First, we look at smaller groups of countries to check if a particular set of them may be driving the results. For instance, there has been a sharp increase in trade and financial flows among EU countries, especially since EMU took hold. Among the EMEs, the level of trade and financial integration among Asian economies has increased quite sharply over the last decade. Perhaps the result we have uncovered is specific to such smaller groups of countries.

Table 4 shows cross-country means from the decompositions for selected subgroups within the larger group of industrial countries. As before, the decompositions are based on estimates of the full model and the group-specific factor refers to the factor common across all industrial countries. The top panel replicates the relevant panel from Table 3 as a benchmark. The key patterns we identified for industrial countries—in particular, an increase in the contribution of the group-specific factor, a decline in the contribution of the global factor, and a small decline

²²For instance, Kose et al. (2003) use data from 60 countries, but their sample period is limited to 1960–1990. Gregory et al. (1997) and Kose et al. (2008b) consider only G-7 countries. The use of recent data is important since globalization really picked up only in the mid-1980s. Moreover, our use of a larger sample (and larger subsamples within each group) allows us to draw a sharper contrast across country groups in terms of their exposure to the global economy.

²³Some recent theoretical papers produce results consistent with the dynamics of investment we report here. In Head's (2002) model, cross-country correlations of investment are positive because of increasing returns to the worldwide variety of intermediate goods. Also, see Heathcote and Perri (2004).

²⁴Detailed results on sensitivity experiments are at <http://people.virginia.edu/~cmo3h/research2.html>.

TABLE 4
VARIANCE DECOMPOSITIONS—INDUSTRIAL COUNTRY SUBSAMPLES

Group	Factor	1960–1984			1985–2008		
		Output	Consumption	Investment	Output	Consumption	Investment
Industrial Countries	Global	27.68	25.27	12.06	14.04	13.52	14.37
	Group	17.16	9.39	15.29	30.03	23.67	24.68
	Global+Group	44.84	34.66	27.35	44.07	37.19	39.05
	Country	33.34	32.13	39.25	27.78	22.20	30.09
	Idiosyncratic	20.66	31.72	31.88	25.18	37.36	28.39
G-7	Global	36.87	36.20	16.14	18.36	19.56	16.92
	Group	14.42	9.27	17.03	31.61	22.14	30.25
	Global+Group	51.29	45.47	33.17	49.97	41.70	47.17
	Country	32.02	30.05	42.78	27.80	27.36	33.38
	Idiosyncratic	15.57	23.01	22.43	19.33	27.45	17.15
US–Canada	Global	35.17	39.99	12.90	26.14	33.93	22.00
	Group	1.93	1.20	0.97	6.99	4.03	4.26
	Global+Group	37.10	41.19	13.87	33.12	37.96	26.26
	Country	43.50	37.15	65.85	40.63	33.15	55.69
	Idiosyncratic	18.42	20.18	18.63	23.44	26.29	15.41
EU 12	Global	34.81	30.56	15.48	9.59	9.75	11.80
	Group	18.46	7.41	18.31	45.44	35.93	33.12
	Global+Group	53.27	37.98	33.79	55.03	45.68	44.92
	Country	26.50	26.71	34.55	20.33	14.18	23.70
	Idiosyncratic	19.13	33.78	30.15	21.93	37.03	29.53

NOTES: We estimate the model separately over the two periods, 1960–1984 and 1985–2008. We then compute the variance decompositions for each country and, within each country, for output, consumption, and investment in each of these two periods. In each cell, we then report the cross-sectional mean of the variance share attributable to the relevant factor. The cross-sectional means are calculated for the relevant cluster of countries indicated in the first column. The rows marked (Global+Group) are just the sums of the average variance shares of the global and group-specific factors.

in the sum of the two—come through very strongly for the G-7 and the EU-12. The patterns are similar, although less strong, when we consider the United States and Canada by themselves.

Table 5 shows the results of a similar exercise for EMEs, using regional groupings. Our main result comes through very strongly for emerging markets in both Asia and Latin America, indicating that our key result is not an Asia-centric phenomenon. For instance, among the emerging markets in Latin America, the contribution of the global factor to the variance in output growth fluctuations falls from 23% in the preglobalization period to 4% in the globalization period. The contribution of the group-specific factor, by contrast, goes from 1% to 8%. The results for Africa are mixed and do not show any clear patterns.

6.2. Changes in the Importance of Global and Group Factors: Country-Specific Results. The next issue is whether the averages presented in the tables so far are representative of patterns at the country level. For each country, we now break down the relative contributions of the different factors to each of the variables. Figures 3 and 4 show the relative contributions of the global and group-specific factors to output fluctuations in individual industrial countries and emerging markets, with the contributions shown separately for the preglobalization and globalization periods. We also show the posterior coverage intervals (of length two standard deviations) around the posterior means of the estimated variance contributions. Nonoverlapping posterior coverage intervals indicate statistically significant changes between the two periods.

Among industrial countries, the variance contribution of the global factor drops from the first period to the second for 14 countries, remains unchanged for 5 others, and increases for only 4 countries. The picture is reversed for the relative importance of the group-specific factor, which goes up for 10 countries and declines for 3. These patterns are quite similar when we look at emerging markets as well, with the relative importance of the global factor going up for only 4

TABLE 5
 VARIANCE DECOMPOSITIONS—EMERGING ECONOMY SUBSAMPLES

Group	Factor	1960–1984			1985–2008		
		Output	Consumption	Investment	Output	Consumption	Investment
Emerging market economies	Global	13.28	7.22	6.38	4.53	3.19	3.72
	Group	2.65	3.84	3.13	7.09	4.91	7.92
	Global+Group	15.93	11.06	9.52	11.62	8.11	11.63
	Country	53.40	36.38	39.57	62.02	47.07	50.12
	Idiosyncratic	28.56	50.50	48.63	22.43	40.91	34.67
Emerging Asia	Global	11.29	7.05	6.13	3.94	3.29	4.58
	Group	3.69	3.76	4.41	7.43	4.87	6.98
	Global+Group	14.97	10.81	10.53	11.37	8.16	11.56
	Country	49.90	29.75	37.49	61.96	45.20	52.54
	Idiosyncratic	32.94	57.41	49.50	23.04	42.90	32.37
Emerging Asia 10	Global	12.31	9.05	6.41	4.55	3.28	3.75
	Group	3.88	3.95	4.46	8.70	5.61	7.65
	Global+Group	16.19	13.00	10.87	13.24	8.89	11.40
	Country	53.48	31.90	39.91	62.97	48.13	54.93
	Idiosyncratic	28.24	53.08	46.74	19.81	38.89	29.95
Emerging Latin America	Global	22.97	11.11	9.15	4.16	2.70	2.38
	Group	1.24	4.52	1.43	7.80	7.08	9.78
	Global+Group	24.21	15.63	10.58	11.95	9.78	12.16
	Country	57.68	42.10	50.09	72.97	52.51	61.70
	Idiosyncratic	16.18	40.33	37.29	11.87	34.71	24.10
Emerging Africa	Global	2.84	1.01	2.39	7.11	3.75	3.28
	Group	1.73	2.89	1.96	4.71	1.25	7.68
	Global+Group	4.56	3.90	4.35	11.82	5.00	10.96
	Country	57.27	47.90	27.95	43.07	43.59	21.99
	Idiosyncratic	35.99	45.85	65.67	38.97	45.29	60.66

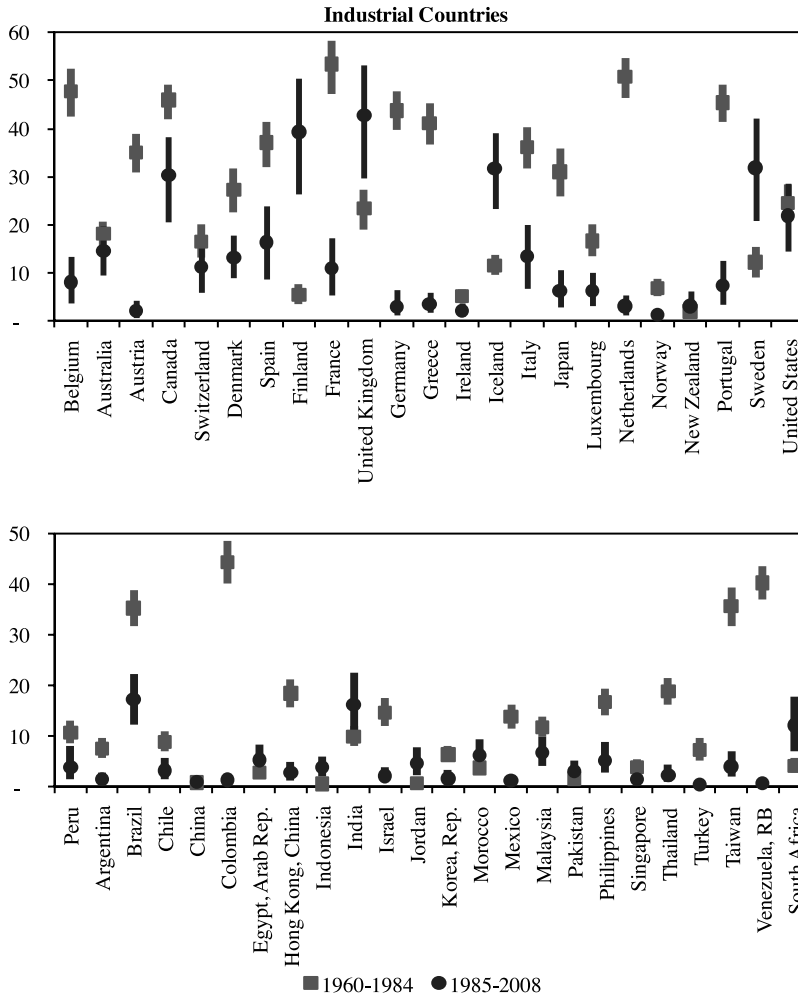
NOTES: We estimate the model separately over the two periods, 1960–1984 and 1985–2008. We then compute the variance decompositions for each country and, within each country, for output, consumption, and investment in each of these two periods. In each cell, we then report the cross-sectional mean of the variance share attributable to the relevant factor. The cross-sectional means are calculated for the relevant cluster of countries indicated in the first column. The rows marked (Global+Group) are just the sums of the average variance shares of the global and group-specific factors.

countries but declining for 14. The relative importance of the group-specific factor, by contrast, rises for 10 emerging markets and declines for none of them.

Thus, the individual country results confirm that the relative contribution of the global factor to industrial country and emerging market business cycles has fallen significantly in the globalization period, whereas the contribution of the respective group-specific factors has risen.

6.3. Implications of Crises. Another important question is whether our results are driven entirely by crises. This is a concern mainly for emerging markets, some of which experienced simultaneous crises. During the globalization period, the most prominent widespread crises have, of course, been the Asian financial crisis of 1997–1998, which directly affected a handful of countries in our sample, and the global crisis of 2007–2009. We cannot just exclude the crisis years since they are an integral part of the analysis of fluctuations; from a mechanical perspective, that would also distort the lag-lead patterns in the data. The global crisis biases the results *against* our main hypothesis that the global factor declined in importance, so we do not address it. The Asian crisis could potentially bias the results in *favor* of our main hypothesis that the group factor became more important.

To account for the Asian crisis, we first reestimated the models including dummies for the crisis years (the models already include country fixed effects) and interactions of those dummies with the countries that were hardest hit by the Asian crisis (Korea, Malaysia, Philippines, and Thailand). Second, we used the original model estimates and then calculated the mean



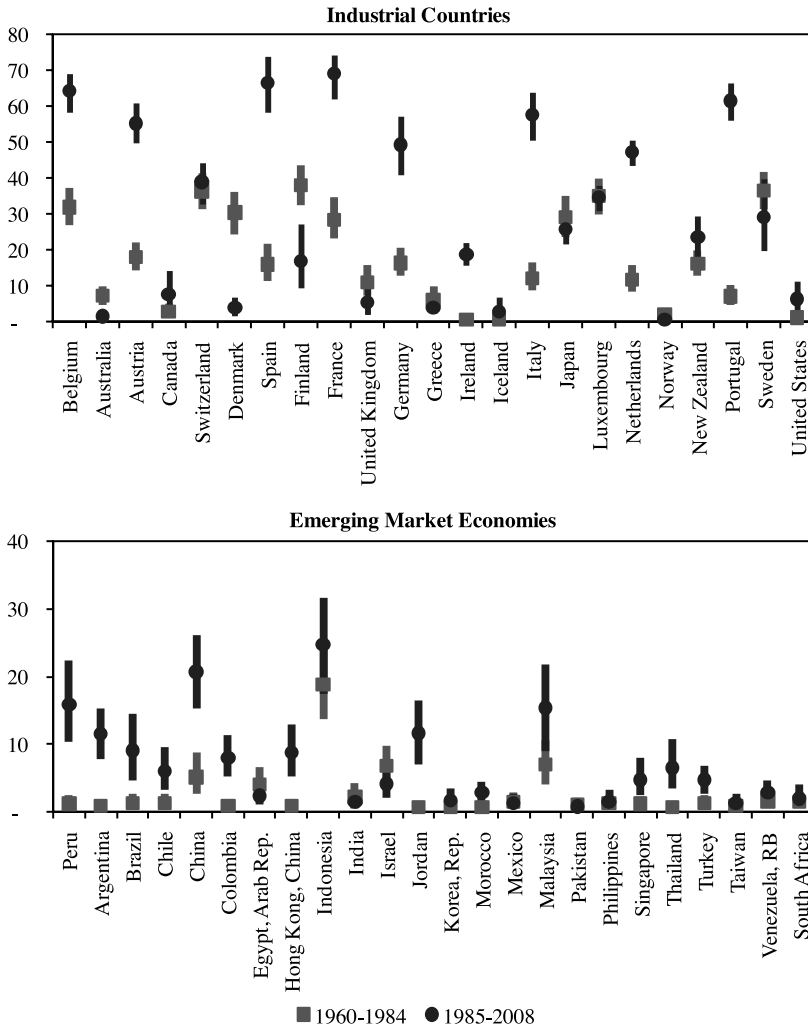
NOTES: We estimate the model separately over the two periods 1960–1984 and 1985–2008. For each country, we then show the posterior means of the share of the variance of output growth fluctuations accounted for by the relevant factor in each panel. We also show the corresponding posterior coverage intervals of length two standard deviations (%).

FIGURE 3

OUTPUT VARIANCE EXPLAINED BY GLOBAL FACTOR

preglobalization and postglobalization contributions of different factors for the emerging markets group excluding the crisis countries. Neither of these experiments yielded results very different from the ones that we have reported so far (results are available from the authors).

6.4. *Alternative Breakpoints.* Another issue relates to the choice of breakpoint. In Section 2, we discussed a variety of reasons why 1985 is a logical cutoff point for identifying the beginning of the globalization period. We ran some formal tests to examine whether there is a structural break in the sample. In particular, we perform univariate break tests for a variance break following Stock and Watson (2005). We use the Andrews (1993) test for a break in either the unconditional variance or the persistence of each time series at an unknown date (for details, see Appendix B of Kose et al., 2008a). Searching over the middle two thirds of the full time span of the sample, we find that 80% of those time series that have a break in their unconditional variance experience that break in or before 1984. A similar test for a break in the autoregressive parameter of a univariate AR(1) model indicates that roughly 80% of the series that have a



NOTES: See notes to Figure 3.

FIGURE 4

OUTPUT VARIANCE EXPLAINED BY GROUP FACTOR

break have it by 1984. By choosing the 80% threshold, we get a relatively “clean” look at the globalization period. These univariate tests indicate that our break date of 1985 is reasonable. A break test on the entire multivariate factor model would be difficult to apply and beyond the scope of this article.

As a further robustness test related to the choice of sample period, we estimated the full factor model for alternative sample periods. The first is from 1960–1983 (1984–2008) and the second is from 1960–1987 (1988–2008). These results were nearly identical. Most importantly, the individual variance decomposition patterns documented in Figures 3 and 4 remain essentially the same, confirming that our results are not crucially dependent on the exact break date.

6.5. *Lagged Effects of the World Factor.* Our current model structure allows for variables to depend on the factors only contemporaneously. It is plausible that we have understated the role of the world factor if those effects are lagged. In principle, one could allow for a lag structure directly in the factor loadings. However, this is difficult in practice because it leads to identification problems. We believe that these effects are likely to be small since our factor

structure is, in fact, dynamic. Additionally, since we use annual data, the lagged effect would have to be fairly slow moving to have an impact on the results. Nevertheless, we address the potential for lagged effects by regressing each observable variable on the factor and two lags of the factor.²⁵ The coefficients on the first lag were significant for only 16 out of the 318 time series (or 5%). Focusing on the advanced and emerging economies, the first lag is significant in 8 out of 141 time series. The second lag is of similar importance, with a significant coefficient in 8% of the time series. We conclude that lagged responses are of minor importance and would not affect our main conclusion about the relative importance of the world and group factors.

Given our derivation of the distribution of the dynamic factor model, it is difficult for us to directly add a lagged factor to the model. However, if lagged affects are important, one would expect that when we estimate a multiple world factor model, the second factor would end up looking like a lag of the first one. However, when we estimate such a model, we find that the second factor is generally not quantitatively important, consistent with our baseline results here.

6.6. Factor Structure. Our parametric approach to factor analysis may mean that the results are sensitive to model specification. One potential concern is that if the true underlying model is driven by multiple shocks, then our single world factor will not allow for the heterogeneous responses of each observable to these shocks. Giannone et al. (2006) show that the solution to this problem is to add additional factors. We have experimented with this and found that an additional world factor is not quantitatively important.

The results we report here are not sensitive to potentially omitted factors among subgroups of countries. Given the hierarchy of the model, by construction, if there are omitted factors among countries, then we may overstate the role of the country factor but will not misstate the role of group and world factors. As shown in Forni et al. (2000) and Doz et al. (2008), the large N and T dimensions of our model imply that our results are robust to potential misspecifications of this nature.

7. CONCLUSION

We have provided a comprehensive examination of the evolution of global business cycle linkages. We find that the global factor has become less important for macroeconomic fluctuations in both industrial economies and EMEs during the globalization period (1985–2008) relative to the preglobalization period (1960–1984). By contrast, for both industrial countries and EMEs, the importance of group-specific factors has increased markedly. There is little change in the overall degree of international synchronization of business cycles as measured by the joint contribution of the global and group-specific factors to business cycle fluctuations.

What are the implications of these results for the recent debate about whether there has been a global convergence or decoupling of national business cycles? Our findings suggest the need for a nuanced approach to this debate. Contrary to the convergence hypothesis, rising trade and financial integration are not associated with global convergence of business cycles, as evidenced by the decline in the importance of the global factor. But there is indeed some evidence of convergence at a different level. The increase in trade and financial linkages among industrial countries and among EMEs has been associated with the emergence of group-specific cycles. In other words, there has been a substantial convergence of business cycles among industrial economies and among EMEs, but there has also been a concomitant divergence or decoupling of business cycles between these two groups of countries.

Our results have a broader interpretation than just in terms of short-term shifts in patterns of business cycle correlations of macroeconomic variables. Although emerging market economies have per capita incomes well below those of the industrial countries, the growing size of emerging

²⁵The calculation is done using the posterior mean of the factor. Accounting for uncertainty in the factor will lead to even fewer variables responding to the factor at lags.

market economies and their rapidly rising income levels are expanding the size of their domestic markets, making them less reliant on demand in advanced economies. Since the emerging markets have high saving rates, they are also becoming less dependent on foreign finance, especially from advanced economies. Thus, our results could be portending a structural shift in business cycle comovement between these two groups of economies.

Our findings should not be interpreted as an endorsement of the decoupling hypothesis in the context of financial market spillovers. Our study focuses on macroeconomic variables representing the real side of the economy, but leaves out financial ones. Our results suggest that even the existence of large spillover effects across financial markets need not necessarily imply real spillovers of similar magnitude.

Our results point to exciting avenues for further research. First, our findings indicate the importance of improving our understanding of linkages among emerging markets and their implications for international transmission of shocks. Second, changes in the relative importance of global and group-specific factors in driving national business cycles may be relevant for assessing the likely spillover effects of domestic shocks and the design of stabilization policies to counter them. However, existing theories have yet to provide clear guidance on these issues.

APPENDIX: LIST OF COUNTRIES

Groups of Countries			
Industrial	Emerging Markets	Other Developing Countries	
Australia	Argentina	Burundi	Sri Lanka
Austria	Brazil	Benin	Lesotho
Belgium	Chile	Burkina Faso	Madagascar
Canada	China	Bangladesh	Mali
Switzerland	Colombia	Bolivia	Mozambique
Denmark	Egypt, Arab Rep.	Barbados	Mauritania
Spain	Hong Kong, China	Botswana	Mauritius
Finland	Indonesia	Cote d'Ivoire	Malawi
France	India	Cameroon	Niger
United Kingdom	Israel	Congo, Rep.	Nigeria
Germany	Jordan	Comoros	Nicaragua
Greece	Korea, Rep.	Cape Verde	Nepal
Ireland	Morocco	Costa Rica	Panama
Iceland	Mexico	Dominican Republic	Paraguay
Italy	Malaysia	Algeria	Rwanda
Japan	Pakistan	Ecuador	Senegal
Luxembourg	Peru	Ethiopia	El Salvador
Netherlands	Philippines	Gabon	Seychelles
Norway	Singapore	Ghana	Syrian Arab Republic
New Zealand	Thailand	Guinea	Chad
Portugal	Turkey	Gambia, The	Togo
Sweden	Taiwan	Guinea-Bissau	Trinidad and Tobago
United States	Venezuela, RB	Equatorial Guinea	Tunisia
	South Africa	Guatemala	Tanzania
		Guyana	Uganda
		Honduras	Uruguay
		Haiti	Congo, Dem. Rep.
		Iran, Islamic Rep.	Zambia
		Jamaica	Zimbabwe
		Kenya	

DATA SOURCES: Primarily from the World Bank's World Development Indicators (WDI), supplemented with the International Monetary Fund's World Economic Outlook (WEO) database.

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