

*Palamarchuk M.\**

## GLOBAL BUSINESS CYCLE: SYNCHRONIZATION IN THE CURRENT RECESSION

***Анотація.** У 2008-2009 роках світова економіка зіткнулась з найсильнішим фінансовим потрясінням з часів Великої депресії. В умовах скорочення частки позикових коштів глобальної фінансової системи і перебування економіки США в умовах серйозної кризи, світова економіка демонструє швидке падіння темпів зростання після кількох років бурхливого підйому. Незважаючи на підвищення інтенсивності торговельних і фінансових зв'язків у всьому світі, глобальний економічний цикл становить тільки близько 50% – 60% варіації зростання реального ВВП серед основних розвинених країн, і країн з ринком, що формується. Решта є результатом конкретних регіональних і країнових факторів. Економіка США як і раніше є основним прискорювачем зростання світової економіки, хоча економіки країн БРІК стали ще одним важливим гравцем.*

***Summary.** In 2008-2009 global economy was grappling with the most severe financial shock since the Great Depression. With the global financial system deleveraging and the U.S. economy in the midst of a severe recession, the global economy was decelerating quickly after years of heady growth. Despite more integrated trade and financial linkages around the world, the global business cycle accounts for only approximately 50%–60% of the variation in real GDP growth across the major developed and emerging market economies. The remaining economic volatility is a result of region-specific and country-specific factors. The U.S. economy remains the primary accelerator of world economic growth, even though the BRIC economies have clearly emerged as another important engine.*

**Keywords:** global business cycle; globalization; business cycle synchronization; Markov switching models.

World Economy in 2008-2009 experienced the deepest recession over the last 50 years. Many observers argue that this decline has all the signs of global recession. What is the global business cycle? In the 1960's for answers to this question was enough to consider the cyclical fluctuations in countries with developed economies, particularly the U.S. These countries produced the lion's share of world output, almost 70 percent of purchasing power parity (PPP), in addition, cyclic activity in much of the rest of the world is largely dependent on conditions in countries with developed economies. Today, as the share of countries with advanced economies in the global production volume decreased to approximately 55 percent of PPP, coincidence of the business cycles in time in these countries and global business cycles can no longer be taken for granted. Indeed, in 2007, when economic activity began to decline in the U.S. and other

---

\* Department of World Economy and International Economic Relations, Institute of International Relations, Kyiv National Taras Shevchenko University

countries with developed economies, there was a hope that the emerging markets and developing countries to some extent insulated from these events by the size and strength of domestic demand in their economies and by the increased importance of intraregional trade in Asia. At the same time countries in the world today are more integrated through trade and financial flows than in 1960, creating greater potential for secondary effects and spillover. As a result of enhanced feedback, in both directions, between the course of business cycles in countries with developed economies and in emerging markets, emerging and developing countries, which increases the probability of synchronous change and global business cycles.

While the gyrations were most evident in financial markets, global production and trade were also severely buffeted. For the first ten months following the start of the crisis (in April 2008), industrial production fell at the same rate as in the Great Depression and global trade fell much faster. Since then there has been some recovery, but 20 months into the crisis, industrial production and trade were, respectively, 6 percent and 20 percent below their previous peaks<sup>1</sup>. The economic contraction experienced by some countries could scarcely have been imagined. For example, the German economy, which grew at an average rate of 1½ percent a year in the last two decades (with a standard deviation of ¼ percent), contracted by 5 percent in 2009, a contraction not experienced in the last 70 years. Forecasters have been repeatedly humbled as new data releases have been associated with sizeable real time revisions of growth projections. The unusually high volatility since mid-2008 came as a complete surprise. It followed an extended period of declining output volatility—the so-called “Great Moderation”—that had embraced a large number of advanced industrialized nations.

The sense of the Great Moderation’s durability was reinforced by the investigation of its determinants. The possibility that “good luck” (milder “shocks” to the economic system) played a role has generally been discounted, with the moderation increasingly attributed to advances in the design and implementation of monetary policy, better inventory management, and financial have argued that the changing age distribution of the workforce has helped: the labor input of young workers tends to be particularly volatile and the declining share of young workers in the workforce has accounted for one-fifth to one-third of the decline in GDP volatility. An important feature of studies of the Great Moderation is that, even when considering multiple countries, they have typically dealt with individual country experiences. In contrast, the international dimension of the reduction in volatility received less attention. This is surprising in view of the rapid globalization in recent decades.

“Common international” shocks are defined as those experienced contemporaneously across countries and “spillovers” as country-specific idiosyncratic shocks that are transmitted to other countries with a lag. Their procedure allows the decomposition of a country’s GDP growth volatility into domestic, common international, and spillover components. And they trace the source of the great moderation to a fall in international shocks.

Despite its frequent use, however, synchronization as a formal concept has only recently been formally introduced into the business cycle literature, where comovements among cyclical time series have been the dominant object of analysis for many decades. Harding and Pagan (Harding, D. and A. Pagan (2003). A Comparison of Two Business Cycle Dating Methods. *Journal of Economic Dynamics and Control* 27 (3): 1681-90.) proposed a definition of cross-country cycle synchronization that is an offspring of the traditional concepts developed by the National Bureau of Economic Research (NBER) starting in the early 1920s. Specifically, they consider national business cycles to be synchronized if turning points in the corresponding ref-

---

<sup>1</sup> Eichengreen B., O’Rourke K. A tale of two depressions: What do the new data tell us? 8 March 2010, <http://www.voxeu.org/index.php?q=node/3421>

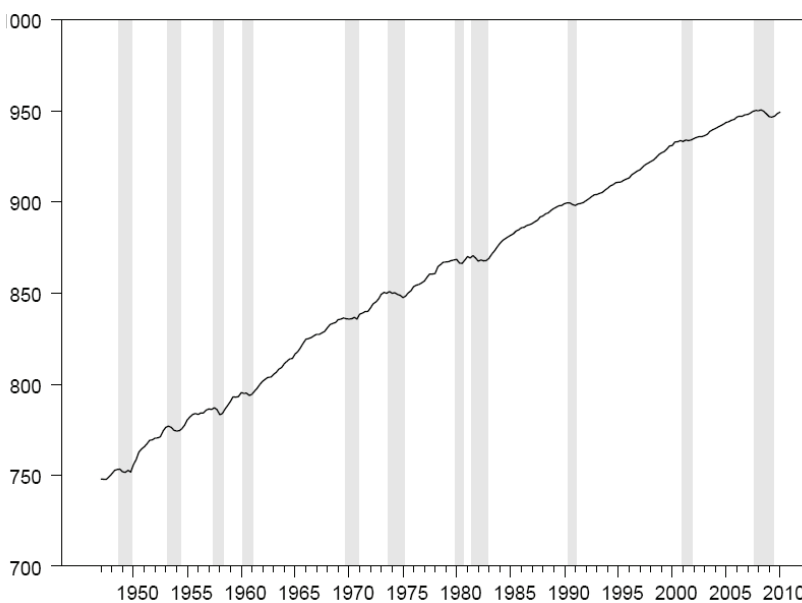
erence cycles occur roughly at the same points in time. On this basis, they have derived a statistical measure, the concordance correlation, that allows one to test whether national cycles are significantly synchronized or not. This approach to measuring synchronization boils down to national business cycles being in the same phase—expansions and recessions—at about the same time [2, 5].

In 1997-1998, many countries with the emerging market, especially in Asia, suffered a sharp decline in economic activity, but in countries with developed economies growth rates were not declining. In 2001, on the contrary, many countries from developed economies have experienced a small decline, while in the main countries with the emerging market, including China and India, the growth rate remained stable.

Recession in 1975 was caused mainly by lower activity in developed countries, but countries with emerging market and developing countries played a significant role in three other episodes. In 1982, a recession in many countries of Latin America reduced global activity, whereas in 1991 an important factor was decline in countries with economies in transition. Recession in 1991 lasted several years: the U.S. recession in 1990-1991 followed by recessions in European countries during the European exchange rate mechanism (ERM) crisis of 1992-93. Period 2006-2007 is notable for a record low number of countries experiencing a recession. But then the situation changed dramatically. The 2009 recession affected almost all countries with developed economies. The current recession differs by the highest level of synchronization over the last 50 years. While it happened obviously due to lower activity in countries with developed economies, a recession in some emerging markets and developing countries contributes to its strengthening and improves synchronization degree.

The standard story of the present global recession and financial crisis emphasizes the centrality of developments in the United States—especially the expansion and subsequent collapse of the real estate and real estate financing bubble and its impact on an overleveraged US and global financial system. Others point more broadly to persistently easy monetary policies, very low interest rates and interest rate spreads, and general disregard of growing risks in the financial system as key causes. Some point to the “global savings glut,” particularly the part emanating from China’s massive current account surpluses and reserve accumulation, as a key underlying cause of present travails.

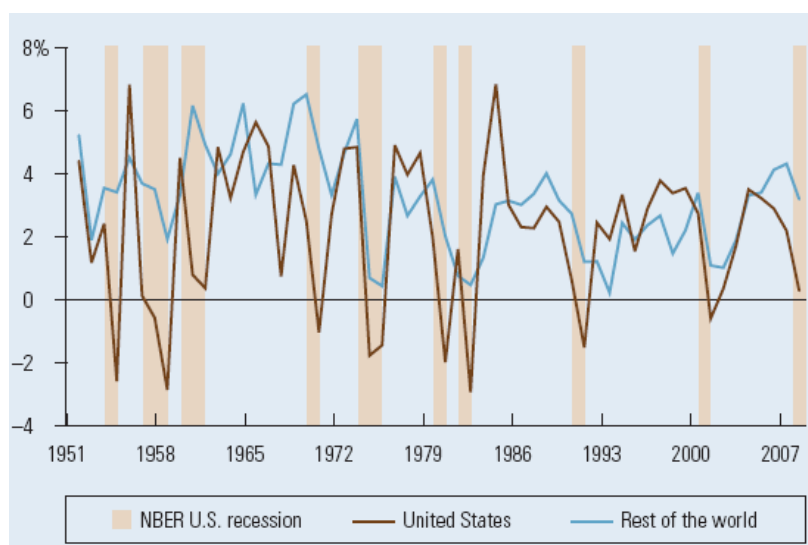
All of these explanations harbor a degree of truth, especially the first two. However, to understand both the sudden sharp deepening of the global recession and financial crisis last autumn and the reasons to anticipate recovery, it is important to look to a broader set of causes of present difficulties. While it seems like a distant memory, it is important to recall that from mid-2003 through early 2008, the world economy enjoyed a boom of broad scope and exceptional vigor, with average annual growth of global GDP ap-



**Figure 1.** One hundred times the natural logarithm of U.S. real GDP, 1947:Q1-2010:Q1. Last shaded region covers 2007:Q4-2009:Q2; other shaded regions correspond to NBER recession dates [Hamilton J. Calling Recessions in Real Time. NBER Working Paper 16162, July 2010. <http://www.nber.org/papers/w16162>, p.33].

proaching 5 percent and with virtually all countries participating in the boom. As reflected in a deteriorating balance of real net exports, through the end of 2005, growth of domestic demand in the US economy in excess of US real GDP growth (Figure 1) contributed to the boom in output in the rest of the world. The upsurge in residential investment in the United States and the impact of increasing household net worth from rising home and equity prices on US consumption contributed to this phenomenon. In 2006 residential investment turned downward, and growth of US domestic demand slowed. With the aid of a weakened dollar, US real net exports began to improve.

Indeed, from the end of 2005 through mid-2008, the improvement in US real net exports slightly more than offset a very large decline in real residential investment. This kept US real GDP growing, albeit at a reduced pace, despite a considerable slowdown in real domestic demand growth. Thus, the rest of the world helped to cushion the slowdown in the United States.



**Figure 2.** Real GDP per capita growth rates for the United States and the rest of the world, 1951–2008 [6, p. 4].

This was fortunate from the perspective of the rest of the world as well. Rising inflation, not weak output growth, was the key macroeconomic problem for the rest of the world. This is evident both in the actual rise of inflation and in the fact that many countries were tightening their policies in order to combat rising inflation. Indeed policy tightening was undertaken in virtually all industrial countries, except the United States, until the summer of 2008, and many emerging-market countries (notably China, India, and Brazil) were also tightening their policies. From their perspective, the slowdown of demand growth in the United States and the improving US real trade balance were helping in the battle against inflation. Most obviously, how sensitive is the global economy to the U.S. business cycle? As shown in Figure 2, past U.S. recessions have either coincided with— or led to—global slowdowns because the rest of the world’s trade and financial markets are linked with those of the United States. Should investors expect the U.S. economy to continue to act as the proverbial “locomotive” for world growth in the years ahead?

The stress and turbulence that began to develop in world financial markets in early 2007—linked to worries about US subprime mortgages and complex financial instruments based on such mortgages—was not such a mutually beneficial development. The deepening of these troubles in August 2007 was similarly unwelcome. The United States was clearly a key source of these difficulties, but it was not the exclusive source. The United Kingdom had its own problems related to mortgages as reflected in the need to nationalize Northern Rock. Difficulties with

mortgage finance in Ireland and Spain also had domestic origins. And, for those financial institutions whose problems stemmed largely from assets based on US mortgages, it is noteworthy that they purchased these assets of their own free will.

During 2008, stress in world financial markets deepened and broadened, led by developments in the United States. The near failure and emergency rescue of Bear Stearns in mid-March increased concerns about wider classes of assets and financial institutions. Deteriorating conditions in markets for mortgages and related financial instruments induced the US government to take over Fannie Mae and Freddie Mac. In mid-September, the outright failure of Lehman Brothers and emergency rescue of AIG (or, more accurately, of AIG's counterparties) began an unprecedented disruption of world credit markets.

This extreme disruption of key credit markets in the United States and worldwide continued through October and into November and only partially abated by year-end. The negative impact on economic activity and on trade was severe and virtually immediate. This explains at least an important part of the sudden economic collapse in the final quarter of 2008 and the first quarter of 2009.

The source of the extreme stress in financial markets was not exclusively in the United States. Severe problems in the banks of Britain (especially the Royal Bank of Scotland and Lloyds), Ireland, Belgium, the Netherlands, and tiny Iceland were primarily of their own making. Despite their generally sound management, Spanish banks faced difficulties linked to the inevitable collapse of the domestic housing boom. Other Western European banks were vulnerable because of overleveraging and due to their excessive exposure to affiliates in Central and Eastern Europe.

Beyond the stress in financial markets, the world economy also suffered important negative shocks late last year from several other sources. The upsurge in world commodity prices, especially in world oil prices to \$147 per barrel in July 2008, was a significant negative shock to users of these commodities. This shock was clearly not the consequence of financial stress, in the United States or elsewhere; but allowing for a slight lag, its economic impact hit at the same time as extreme credit market turbulence. More recently, the collapse of many commodity prices has clearly begun to undermine growth in exporting countries. Policies to combat rising inflation undertaken through mid-2008 probably also operated with somewhat of a lag, reinforcing the downturn in the world economy in late 2008 and early 2009. The slowdown in China's growth late last year probably owes more to the earlier tightening of Chinese policies and the wind-down from the Beijing Olympics than to global financial turmoil, and the Chinese economic slowdown has affected its trading partners especially in Asia. Other emerging-market countries that earlier had tightened their policies, including India and Brazil, found the effects inconvenient by year-end. The slowdown in the euro area during the second and third quarters of last year was at least partly the consequence of policy tightening to combat inflation. By the fourth quarter, this effect was adding unexpectedly and undesirably to a precipitous decline in output. In the United States, the 2008 tax cuts provided a modest boost to demand in the second and third quarters, but the wearing off of this effect added to the pace of decline in the fourth quarter. In sum, the extremely sharp declines in global economic activity and world trade in late 2008 and early this year reflect several important negative shocks, with the stress and turbulence in world financial markets playing the leading role.

The relationship between economic integration and business cycle synchronization dates back to the study of Mundell (Mundell, R. (1961), "A Theory of Optimum Currency Areas," *American Economic Review*, 51(4): 509-517.) on the desirability of the optimal currency area, where the focus has been on trade. The main argument is that countries will be more willing to give up their autonomous monetary policy if their business cycles are more correlated with each

other. Frankel and Rose (Frankel, J. and Rose, A. (1998), "The Endogeneity of the Optimum Currency Area Criterion," *Economic Journal*, 108(6): 1009-1025.) point out that even if countries with asynchronous business cycles form a currency union, then the union may become endogenously optimal if trade increases output co-movement through demand spillovers. Theoretically however the impact of trade on output patterns can go either way. If lower barriers to trade induce countries to specialize then output fluctuations will become less, not more, symmetric as argued by Krugman (Krugman P. (1991) \ *Geography and Trade*, MIT Press, Cambridge, MA.). On the other hand, if most trade stays within sectors (intra-industry trade) in spite of specialization at the sectoral level then the cycle will become more synchronized. Starting with Frankel and Rose (1998) many studies, such as, Clark and van Wincoop (Clark, T. E. and van Wincoop, E. (2001), \ *Borders and Business Cycles*, *Journal of International Economics*, 55(1): 59-85.), Otto, Voss, and Willard (Otto, G., Voss, G. and Willard, L. (2001), \ *Understanding OECD Output Correlations*, Reserve Bank of Australia Research Discussion Paper No 2001/05.), Baxter and Kouparitsas (Baxter, M. and Kouparitsas, M. (2005), \ *Determinants of Business Cycle Co-movement: A Robust Analysis*, *Journal of Monetary Economics* 52(1): 113-157.), and Calderon, Chong and Stein (Calderon, C., Chong, A. and Stein, E. (2007), \ *Trade Intensity and Business Cycle Synchronization: Are Developing Countries Any Different?*, *Journal of International Economics* 71(1): 2-21.) show that trade integration leads to more correlated business cycles. Yet recent work finds a much weaker link between trade intensity and output co-movement (e.g. Inklaar, R., Jong-A-Pin, R. and de Haan, J. (2008), \ *Trade and Business Cycle Synchronization in OECD Countries - A Re-examination*, *European Economic Review*, 52(2): 646-665.).

The collapse of the financial and real-estate bubbles in the US rapidly triggered a global drop in production comparable to the economic crisis of 1929. Nearly all observers underestimated its future severity because of assumption that economic turmoil in the US would not spread into a global conflagration. Many economists thought that much of the emerging world would not be affected by America's homegrown problems—it was often claimed, for example, that emerging economies were undergoing a robust and independent form of development.

As a consequence, economists also assumed that a continued demand for imports in such developing nations would help to bolster the economies of industrialized nations and mitigate the effects of reduced demand from the US. Studies analyzing the increasing integration of trade and financial markets with a view to business cycles in industrialized and developing countries have suggested that globalization does not lead to significantly greater business-cycle synchronization (Kose, M.A., E.S. Prasad, M.E. Terrones: *How Does Globalization Affect the Synchronization of Business Cycles?* *American Economic Review* 93(2), 57–62).

The broadly synchronized recent downturn in the industrial countries has generally reinforced the notion of international business cycle synchronization. Paradoxically, however, the empirical evidence for the past three decades is so mixed that it remains difficult to make a strong case for the notion of increased or increasing business cycle linkages among industrial countries. Depending on the sample period, output correlations have even decreased in recent decades, largely on account of a remarkable cycle desynchronization among the major industrial countries in the late 1980s and early 1990s (Helbling and Bayoumi, 2003)<sup>2</sup>. The empirical case against increased synchronization is made forcefully by Doyle and Faust (2002)<sup>3</sup>, who analyze

<sup>2</sup> Helbling, Thomas and Bayoumi, Tamim, *Are They All in the Same Boat? The 2000-2001 Growth Slowdown and the G-7 Business Cycle Linkages* (March 2003). IMF Working Paper, Vol. , pp. 1-42, 2003. Available at SSRN: <http://ssrn.com/abstract=879121>

<sup>3</sup> Brian M. Doyle & Jon Faust, 2002. "An investigation of co-movements among the growth rates of the G-7 countries," *Federal Reserve Bulletin*, Board of Governors of the Federal Reserve System (U.S.), issue Oct, pages 427-437.

changes in the comovements among the growth rates of G-7 countries since 1971 and found no evidence for significant increases in output correlations over time, even for Canada and the United States or for the euro area member countries. On the other hand, studies using dynamic factor models find evidence of increased international business cycle linkages. For example, Kose, Otrok and Whiteman (Kose, M. A., C. Otrok, and C. Whiteman, 2003, International business cycles: World, region, and country specific factors, American Economic Review) report that a global factor explains larger shares of output variances in the G-7 countries during 1986-2001 than it does during the Bretton Woods period (1960-1972).

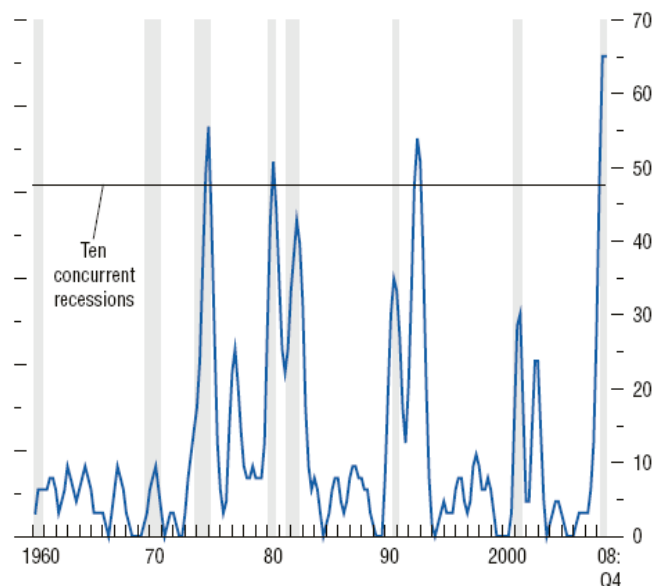
In another empirical study of interdependencies in international business cycles between 1960 and 2005 the results show that business cycles in industrialized nations have been convergent over the last twenty years (1985-2005). The same applies to developing nations. However, the divergence between industrialized and developing nations has tended to grow larger. Because of studies like this, the rapid global spread of the crisis was not expected (Kose, M.A., C. Otrok, E.S. Prasad: Global Business Cycles: Convergence or Decoupling? NBER Working Paper No. 14292). Because of studies like this, the rapid global spread of the crisis was not expected.

So, 2009 was the year of deepest recession for the world's postwar period. Most indexes fell more sharply than in previous episodes of global recession. In addition to severity, this global recession also qualifies as the most synchronized, as virtually all the advanced economies and many emerging and developing economies are in recession.

The financial crisis that first erupted in the U.S. subprime mortgage market in August 2007 has evolved into the largest financial shock since the Great Depression, inflicting heavy damage on markets and institutions around the world. Indicative of the magnitude of the shock, equity market volatility is at or near unprecedented levels, corporate bond yields are extremely high relative to U.S. Treasury yields, and commodity prices have plummeted. With the global financial system deleveraging and the U.S. economy in the midst of a severe recession, the global economy was decelerating quickly after years of heady growth.

As shown in Figure 3, past U.S. recessions have either coincided with — or led to — global slowdowns because the rest of the world's trade and financial markets are linked with those of the United States.

Some analysts believe that the world economy has become less sensitive to U.S. developments as a result of rapid growth in emerging markets. Indeed, Figure 4 highlights the growing and outsized contribution of emerging market economies to recent worldwide economic growth. In light of explosive growth in the so-called BRIC economies (Brazil, Russia, India, and China), many analysts wonder whether the emerging markets have “decoupled” from the rest of the world.



**Figure 3.** Highly Synchronized Recessions (Percent of countries in recession; shaded areas denote U.S. recession. The sample includes the following 21 country: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and United States.) [11, 119].

Over the past five decades, the average correlation among the world's major economic blocks has been positive, but far from perfect. On average, the global business cycle has accounted for approximately 50%–60% of the variation in real GDP growth across the major developed and emerging market economies since 1950 [6, p. 5]. The remaining 40%–50% of the economic variation observed across the four major economic regions has been associated with region specific and country-specific factors, such as whether a country is a commodity exporter or importer and its level of reliance on international capital flows.

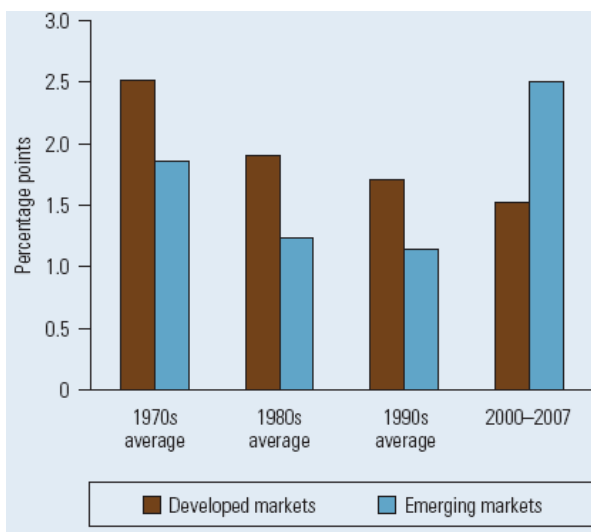
Business cycles in the developed markets have historically been the most highly correlated with the global business cycle by definition, since developed markets represent a large share of the world's total economic output. Between 1950 and 2007, the contemporaneous correlation in annual real GDP growth between the developed markets and the world economy has been 74%. Over that same time period, the collective emerging market economy has had a 39% contemporaneous correlation with the world economy. Generally speaking, the economic correlations between emerging markets and developed markets have tended to be lower than business-cycle correlations among industrialized countries.

Economies around the world have generally become more integrated through the linkages of trade, finance, and banking. Statistics from the International Monetary Fund (IMF) show that the ratio of world trade to world GDP has nearly doubled over the past three decades, while the gross external assets of developed and emerging markets have risen exponentially over the same period.

At the same time, the process of globalization has been accompanied by several structural changes in the world economy that have contributed to a less U.S.-centric global economy. Most importantly, intraregional trade has grown relative to traditional trade links between emerging economies and the developed world. The impressive performance of some emerging countries has led to a greater diversification of trade destinations, as emerging economies have begun to trade more often with each other.

Some analysts argue that the developments in the emerging markets have been so drastic that the emerging markets have decoupled from the rest of the world. According to the decoupling hypothesis, the emerging market business cycle is now unaffected by U.S. economic growth. However, Table 1 delineates a number of arguments that would run counter to the emerging-market decoupling hypothesis. The relative decline in trade linkages of emerging markets with the United States, for instance, must be weighed against increased financial linkages with developed markets.

Mentioning the role of emerging markets nowadays, most visibly, Mexico, China, and emerging Europe became key nodal points in the global supply chain in the 1990s. Given their bilateral export and import relationships with key advanced industrialized economies, they served to transmit and amplify international shocks. Moreover, most emerging economies have not yet achieved the structural maturity necessary for dampening domestic volatility. Included



**Figure 4.** The emerging markets as a rising global economic force. Contribution to world real GDP growth (Note: GDP data in this figure are defined on a purchasing power parity basis) [6, p. 4].



in countries with continuing high levels of volatility are Ireland and Iceland, both of which have also long been part of the global vertical specialization process. All of these countries thus contribute to the pool of international spillovers through their own national shocks and the transmission of external shocks to which they are subject.

**Table 1** Are emerging markets coupled to developed markets? [6, p.5]

Arguments in favor of decoupling	Arguments against decoupling
Decline in relative reliance on U.S. export market.	Increase in total trade with developed markets.
Increased share of trade within regions.	Emerging markets are very export-oriented.
High BRIC economic growth rates.	United States remains the largest import market.
Emerging markets financial market depth less than that of developed markets.	Reliance on foreign investment and capital flows.
General improvement in fiscal balances.	Global financial integration.
	Financial market spillovers/contagion.
	High commodity-price exposure or dependence.

Correlations among global business cycles also rise significantly when financial shocks severely impair the world's largest economies through the secondary "spillover" channel. Past U.S. recessions have most adversely affected the broader global economy through two primary links:

- trade (the United States is the largest importer of foreign goods in the world) and
- finance (U.S. financial markets are the core of the global financial system).

The degree of business cycle synchronization can provide information on the necessity of independent fiscal and monetary policy, on the impact of regional union and the benefits of agreements. Among association agreement between countries the business cycles become more similar and internal and external shocks are common. On the other hand, if shocks are country-specific, then the ability to conduct independent monetary and fiscal policy is usually seen as important in helping an economy adjust to a new equilibrium.

Various studies have been presented in the literature concerning the issue of business cycle synchronization in different regions in the world, especially for the developing countries. Different conclusions were obtained. Part of these differences can be related to differences in variables used, diverging business cycle measures and methods to assess synchronization. For example, Artis M., Kontolemis Z. G. and Osborn D. R. ("Business cycles for G7 and European countries", *Journal of Business*, 1997, #70, pp. 249-270) found that the degree of concordance between business cycle dates for industrial production for the G7 and some European countries is high (near one) implying that the cycles are synchronous and that the evidence of the existence of regional cycles is found to be the strongest amongst North American and European economies.

#### Concordance index

Concordance index is the fraction of time that both countries in the comparison were in the same cycle phase (contraction or expansion). This index is clearly between 0 and 1. A high degree of concordance (value close to 1) indicates that business cycles of both countries are synchronized, while a value near 0 indicates non synchronous cycles. According to Harding and Pagan (Harding D. and A. Pagan, "Synchronisation of cycles", *Journal of Econometrics*, 2006, Vol 132 (1), pp. 59-79.) we use the following formula to calculate the concordance index between two countries *i* and *j*:

$$C_{ij} = \frac{1}{T} \sum_{t=1}^T S_{it} S_{jt} + (1 - S_{it})(1 - S_{jt}) \quad (1)$$

**Where,**

$S_t = 0$  when the economy is in recession phase and 1 when it is in expansion phase.

$S_t$  is a binary latent method which can be determined following several methods. In the literature review we can use parametric or non parametric methods to construct the variable  $S_t$ .

As the correlations are related to the so-called concordance statistic (the sum of the products of the binary cycle indicators), which determines the number of periods during which national cycles are in the same phase (as a fraction of the total number of periods in the sample), we will refer to them as concordance correlations. If two cycles are perfectly synchronized, in the sense of being in the same state in every period, the concordance correlation coefficient  $\tilde{n}S$  is 1. If the two cycles are exactly in the opposite state in every period ( $S_{it}=1-S_{jt}$ ,  $t=1\dots T$ ), the correlation is -1. Finally, if the two cycles are uncorrelated, the correlation is 0.

Figure 5 shows the binary business cycle state indicator variable  $S_{it}$  for a panel of 16 industrial countries, for which GDP data are available from 1880. Real GDP is a measure of aggregate economic activity. With annual data, the determination of expansions and recessions is straightforward. A recession is defined as one or more consecutive years of negative real GDP growth, while an expansion consists of a year or more of positive growth. The resulting business cycle turning points broadly match the dates in the National Bureau of Economic Research (NBER) chronologies for the United States, the United Kingdom, France, and Germany. The differences reflect the use by the NBER of higher frequency (monthly) data and a broader variety of indicators, such as employment and department store sales. On this basis, correlation coefficients between all country pairs and their significance were estimated.

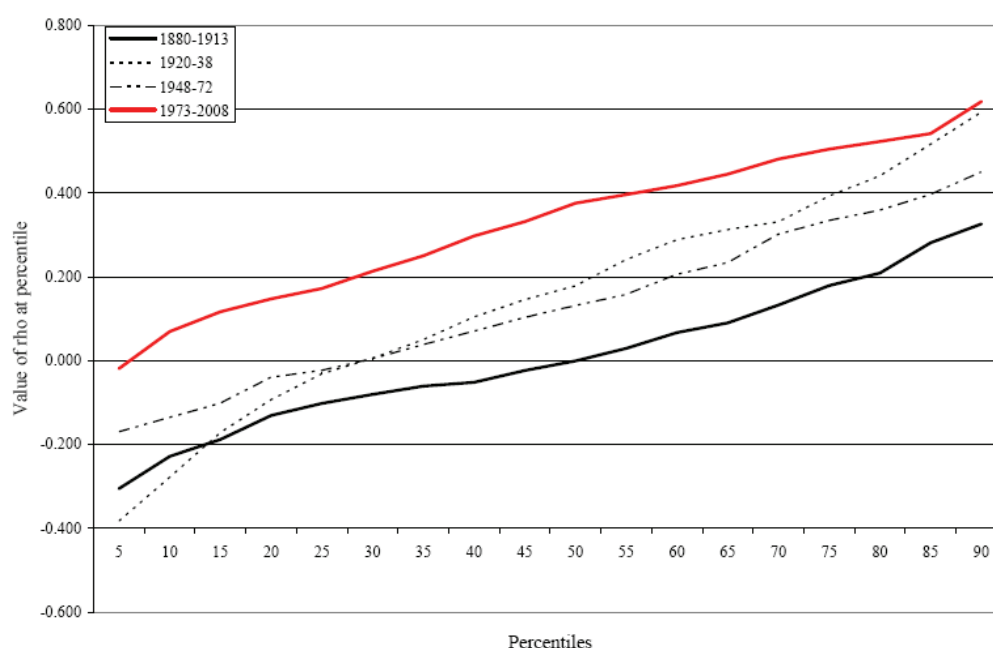
Figure 5 shows the concordance correlation coefficients by percentile for the four eras. The distribution of the correlation coefficients differs substantially from era to era. In particular, there has been a tendency toward higher, positive output correlations, not just a one-time level increase in synchronization. During the Gold Standard, about one half of all country pairs were characterized by negative output correlations and the average output correlation coefficient is about 0. A first important step toward synchronization occurred during the interwar period, when the share of negative correlations fell below 30 percent while the average correlation increased to about 0.15. A subsequent reversal during the Bretton Woods era was small, and correlations remained, on average, above those found for the Gold Standard era. A second important increase then occurred during 1973-2008, when less than 10 percent of all correlations were negative and the average correlation was 0.33.

Comparing the distribution of the correlation coefficients by era suggests the following.

- In the Gold Standard era, the average of the correlation coefficients was just about zero, as about half of all the pairs of national business cycles were negatively related to each other while the other half was positively related to each other. Hence, on average, business cycles were not synchronized according to this measure.

- In the interwar and the post-Bretton Wood periods, more than half of all pairs of national business cycles were positively related to each other. On average, the correlation is about 0.2, suggesting generally synchronized business cycles during these eras. Nevertheless, more than one fourth of all cycles remained negatively related, which explains why the average “synchronization” remains relatively weak.

Comparing the distributions of the two periods suggests no significant difference.



**Figure 5.** Bilateral Output Concordance Correlations By Percentiles [2, 9]

Overall, synchronization was most pronounced in the Bretton Woods era, when many economies enjoyed uninterrupted expansions. As shown below, the finding is misleading because output comovements were not stronger in that era than in either the preceding or the subsequent era. The relevant key finding is that synchronization patterns appear to have systematically changed once the world went off the classical Gold Standard. During the latter era, cycles were, on average, uncorrelated while, beginning with the interwar period, they started to become synchronized on average.

Output correlations have been the perhaps most frequently used measures of business cycle synchronization. According to this measure, national cycles are synchronized if they are positively and significantly correlated with each other. The higher are the positive correlations, the more synchronized are the cycles. Compared with concordance correlations, measuring synchronization with standard contemporaneous correlations is more stringent, as the latter require similarities in both the direction and magnitudes of output changes.

So far, we have looked at business cycle synchronization through a global lens, noting the increased synchronization without consideration for other factors. However, one would expect that synchronization patterns differ considerably across groups of countries, depending on factors such as “gravity” or country size. The extent to which gravity has shaped the synchronization trends depends on the region. For core European countries (the old “EEC”) and Continental European countries, the increase in business cycle synchronization was clearly much sharper than the general increase. At the other end of gravitas, business cycle synchronization between Japan and the other countries in the panel has increased by less.

The fact that the increase for all Continental European countries was smaller than that for the Core European countries suggests that the forces of gravity are affected by common policies, preferential trading agreements, and specific currency arrangements. The increase in correlations among the Anglo-Saxon countries is also remarkable even though it seems more difficult to attribute this to forces of gravity. While we do not believe that common institutions and heritage among the Anglo-Saxon countries account directly for the increased synchronization, they likely have fostered similar patterns.

While the regional perspective reinforces the notion of a trend increase, it should be noted that stark regional differences have only really emerged during the modern floating rate period. Forces of gravity were not a factor behind business cycle synchronization during the classical Gold Standard, as differences in correlations among regions were minor, with the high correlation between Canada and the United States and, to a much lesser extent, among the Scandinavian countries, being the main exceptions. During the Bretton Woods period, increased regional synchronization began to emerge in the core European countries. Interestingly, the increased synchronization during the interwar period was primarily on account of an increased synchronization between the cycles in the United States and other countries, which in turn seems to reflect the equity boom bust cycle and its effects from the mid-1920s to the mid-1930s.

Another measure of business cycle synchronization is related to the notion of common factors. Many macroeconomists would probably agree that international business cycle linkages are best understood as a small set of factors that are common to all countries and that explain a substantial fraction of fluctuations in major macroeconomic aggregates. The common factors themselves reflect a combination of global shocks affecting all countries and country-specific disturbances with significant spillover effects.

For the non parametric method we can consider the algorithm which tent to localize the different phases of the series and then we determine the variable  $S_t$ . We can also use the Markov switching models, which is considered as parametric method, to construct the variable  $S_t$ .

### Markov switching models

A great panoply of techniques concerning the non linear time series have been used for the modelisation of the different economic cycle characteristics as the linear models cannot capture the cyclical asymmetries. A great stress has recently been attached to the non linear specifications in which we have introduced a significant distinction between the expansion and the recession phases. These models are so flexible that they allow to take into consideration the different specifications and relations corresponding to each phase and many extensions have been proposed in the literature. Among these non-linear models, there exists the autoregressive threshold models<sup>4</sup>, the SETAR models<sup>5</sup> and the regime switching models<sup>6</sup>. We will devote the focus of our study just to the Markov switching models. However, Markov switching models have been applied in many domains (economics, finance, biology, medicine, forecasting ...). It have been applied in economics and finance for analyzing the business cycle of United States, the business cycle characteristics of the Euro-zone, explaining the different features of the foreign exchange rates, stock market volatility, etc.

Hamilton (1989) was first to develop the Markov switching model in order to capture business cycles in real GNP. He was considered that the mean GNP growth rate switches between two states: the recession phase and the expansion phase.

In a Markov switching model, it is assumed that the process generating the observed data—in our case, growth in real GDP—is dependant on a qualitatively unobservable variable. In its

---

<sup>4</sup> Usefulness of Linear Transformations in Multivariate Time-Series Analysis. George C. Tiao, Ruey S. Tsay and Taychang Wang; *Empirical Economics*, 1993, 18(4), pp. 567-93.

<http://search.epnet.com/login.aspx?direct=true&db=bth&an=5821790>

<sup>5</sup> Teräsvirta, T. and H.M. Anderson (1992). Characterizing nonlinearities in business cycles using smooth transition autoregressive models' *Journal of Applied Econometrics* 7, S119-S136. Reprinted in: M.H. Pesaran and S. Potter, eds. (1993). *Nonlinearity and chaos in econometrics*, 111-128. New York: Wiley.

<sup>6</sup> Hamilton, James D, 1989. "A New Approach to the Economic Analysis of Nonstationary Time Series and the Business Cycle," *Econometrica*, Econometric Society, vol. 57(2), pages 357-84, March 1989.

behavior, this variable is subject to certain systematic rules—in the literature known as “Markov chains.” The concrete values that this variable takes on are described as “states.” In the investigation of business-cycle fluctuations, the Markov chain has two states: “expansion” and “contraction.” The state of “expansion” is generally associated with positive real GDP growth, and “contraction” with negative growth. In a statistical estimation procedure, the goal is to link assumptions about these states with the actually existing dynamic structure in the real GDP time series and to provide an estimation of probabilities for the states of “expansion” or “contraction” at each point in time. An example for an empirical application of the model is performed based on real GDP growth in the US: We take growth rates from Q1 of 1947 to Q1 of 2009 and calculate a Markov switching model with two states based on this data. For the purpose of illustration the estimated recession probabilities are displayed for the US at left. The recession probabilities clearly correspond with the official NBER dates for recessionary periods.  $K$  stands for the number of different states and  $p$  for the number of autoregressive lags that go into the formula. For all countries, only two states are possible—“expansion” or “contraction.” However, the number of autoregressive lags is determined by the dynamic characteristics of each time-series. Formally, the formula is expressed as

$$x_t = \alpha(st) + \phi_1 x_{t-1} + \dots + \phi_p x_{t-p} + u_t, \quad (2)$$

where  $\phi_i x_{t-i}$  represents the lags with the corresponding parameters—the autoregressive element (AR)—and  $u_t$  unsystematic white noise.  $st$  stands for the unobserved Markov chain and takes the values of “expansion” or “contraction.” In the “expansion” state, the parameter  $\alpha(\cdot)$  has a positive value. This value is negative, by contrast, in the “contraction” state. In this way,  $\alpha(\cdot)$  is the only state-dependent parameter, and is decisive for the characterization of the business cycle. If one ignores the fact that  $\alpha(\cdot)$  is dependent on a unobserved discrete process, then the formula corresponds with the calculation of a linear autoregressive process of the order  $p$ . This fact is exploited in the data-driven selection of the lag order  $p$ , which is first determined based on a linear autoregressive process with the Schwarz

Information Criteria (SIC) and then used in the estimation of the Markov switching model.

If one has estimated the model by the maximum likelihood method, it is necessary in the next step to obtain information about the (unobserved) states of  $st$ . Two algorithms which represent the actual core of the method are used for this purpose: A filter algorithm, and a smoothing algorithm. With the filter algorithm it is possible to calculate the probability of a specific state based on the estimated model and depending on the data provided up to a given point in time  $t$ —for example, the probability of “contraction.”

$$P(st = \text{“Contraction”} \mid x_1, x_2, \dots, x_t) \quad (3).$$

By contrast, the smoothing algorithm determines the probability of a given state based on all available data (up to the last point in time  $T$ ), thus providing more precise inference

$$P(st = \text{“Contraction”} \mid x_1, x_2, \dots, x_T) \quad (4).$$

If one views the last available data point  $T$ , the results of the filter and smoothing algorithms correspond. Probabilities calculated using the smoothing algorithm are often described as “smoothed” probabilities. They represent time series that correspond with the dimension of the original GDP time-series data. These time series can then be interpreted in several ways—for example, by comparing them with official dates concerning recessionary periods.

Clements and Krolzig (2003), has proved that the two regime switching model cannot capture the steepness business cycle asymmetry. For this reason, the three regime switching model was developed.

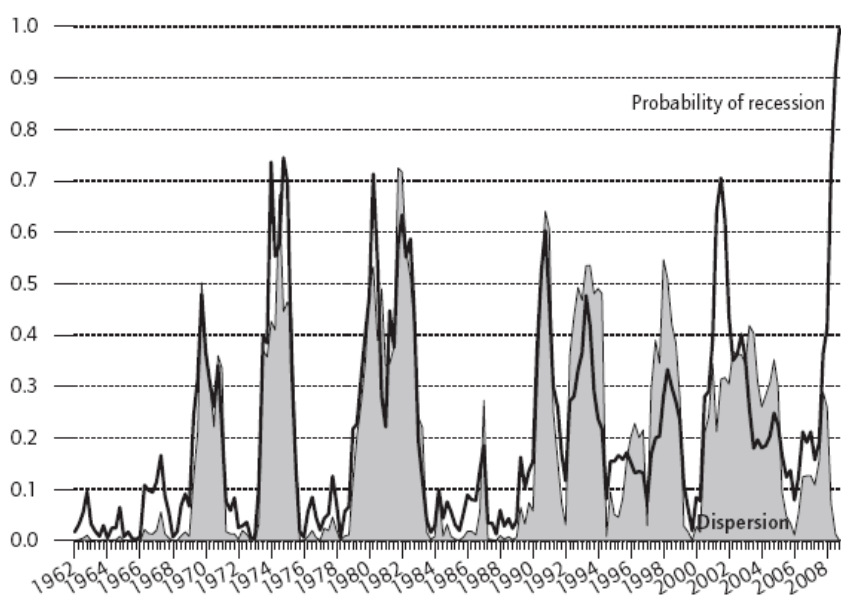
The economic interpretation of these three regimes is as follows:

- A low growth regime: this regime is characterized by a negative growth rate, and is therefore associated to the classic recession phases.
- An intermediate growth regime or a regime of moderate expansion: for this phase, we suppose that the economic growth rate is below the trend associated to the growth rate (a growth cycle weak phase) without recession.
- A high growth or high expansion regime: for this regime, we suppose that the economic growth rate is above the trend associated to the growth rate (a strong phase of the growth cycles).

A method to determine the degree of business cycle synchronization between individual countries and within economic blocks is based on Markov switching models. In the investigation of business-cycle fluctuations, the Markov chain has two states: “expansion” and “contraction.” The state of “expansion” is generally associated with positive real GDP growth, and “contraction” with negative growth. In a statistical estimation procedure, the goal is to link assumptions about these states with the actually existing dynamic structure in the real GDP time series and to provide an estimation of probabilities for the states of “expansion” or “contraction” at each point in time.

The analysis presented evaluates the degree of business cycle synchronization in the most important industrialized nations (the G7, consisting of the US, Germany, Japan, Britain, France, Canada, and Italy). In order to measure the synchronization of business cycle fluctuations, the probability that each country is in a recession is first calculated for each quarter. This probability can have a value between 0 (expansion) and 1 (contraction). Next, the mean probability of recession for all countries is determined for each quarter. If the mean is near 0 or 1, this means that the majority of countries are in an expansionary or recessionary phase.

In the current crisis, the weighted mean probability of recession for the G7 is nearly 1. Since Q1 of 1956 this value has never been as high in any other recession. The highest previous values during the first (1973) and second (1979) oil crises and the recessions that followed are under 0.8. A much



**Figure 6.** Average Recession Probabilities in the G7 Nations (“Expansion” = 0 to “Contraction” = 1) [10, p. 189].

higher degree of dispersion between the business cycles of the G7 is also apparent in comparison to the current recession. Based on this it can be concluded that the oil crises had a much more varied impact from country to country than the current recession.

In past expansionary periods things looked a bit different, however. The countries underwent expansionary phases largely in paral-

lel, with very little divergence between business cycles, as demonstrated by the very low dispersion. This is likely attributable to the very close integration of Western Europe's national economies.

While the extreme volatility that the world has recently witnessed could not have been anticipated, it should not have come as a complete surprise. The Great Moderation was a robustly-established trend. The factors identified as underlying the Great Moderation, in turn, were durable. Domestic volatility was declining as a consequence of improved policy management and innovations in the private sector. But these analyses did not factor into the ongoing integration of the global economy. The international transmission of a country's volatility was emerging as a latent source of volatility amplification. In a benign global environment, the international transmission also worked in a relatively benign manner. However, with the convergence of several large shocks—to the financial sectors and to the real economies of several countries—the transmission process added to the rapidity with which the crisis crossed borders and the sense of panic it generated in the past couple of years.

Improved domestic policies and structural changes drove down the size of domestic shocks and hence aggregate volatility. But potent though these forces were, the increasingly-interconnected nature of the global economy introduced countervailing tendencies. As the global economy became more integrated, shocks from one country were transmitted more rapidly and to more countries. In the long expansion between 2001 and 2007, these linkages reinforced global growth. However, the intensity of the recent crisis was in no small measure due to the speed at which domestic shocks traveled across borders, amplifying the original shocks. Countries most reliant on global financial and trade links were hardest hit.

The policy lessons are simple in principle but complex to implement. Imbalances in or shocks experienced by one country have increasingly important implications for other countries. While this observation is widely accepted, the magnitude of the effects underlying global integration is increasing and large. Vertical specialization is a benign force for global growth and welfare but can turn rapidly to amplify downturns. Countries responded *ex post* to the urgency of the recent crisis by coordinating (to varying degrees) financial, monetary, and fiscal policies. Looking ahead, all countries have a stake in the policy stance and approaches of other countries. Recent efforts to achieve greater transparency and coordination of policy on a much larger scale than in the past under the auspices of the G-7 and within the European Union augur well in this regard. But ultimately, the best *ex ante* coordination is likely to be sensible economic policies followed in a country's self interest. On the outcome of these efforts may depend whether the next crisis threatens another upheaval.

**Conclusions.** The business cycles of industrialized nations have exhibited an unprecedented degree of synchronization since the start of the crisis. In the worst economic downturn since the end of the Second World War, the most important national economies have been drawn one after another into the maelstrom of global recession.

Despite more integrated trade and financial linkages around the world, the global business cycle accounts for only approximately 50%–60% of the variation in real GDP growth across the major developed and emerging market economies. The remaining economic volatility is a result of region-specific and country-specific factors. Of course, the correlation among international business cycles varies over time, by country, and by the source and magnitude of financial shocks. Broadly speaking, cross-country correlations in real GDP growth rise whenever (1) asset-price shocks are systemic (e.g., the 1970s oil-price shock) and (2) the world's largest economies are severely impaired in the process (e.g., the situation in the United States today).

The U.S. economy remains the primary accelerator of world economic growth, even though the BRIC economies (Brazil, Russia, India, and China) have clearly emerged as another important engine. Based on this and other factors, emerging market economies remain fully coupled to severe U.S. recessions and global financial crises. In more normalized conditions, the economic correlations between emerging markets and developed markets tend to be lower than business cycle correlations among industrialized countries.

### References

1. Artis M., Kontolemis Z. G. and Osborn D. R. "Business cycles for G7 and European countries", *Journal of Business*, 1997, #70, pp. 249-270.
2. Bordo M., Helbling T. Have national cycles become more synchronized? / NBER Working paper 10130, December 2003. <http://www.nber.org/papers/w10130>
3. Crucini M., Kose A., Ortok C. What are the driving forces of international business cycles? NBER Working Paper 14380, October 2008. <http://www.nber.org/papers/w14380>
4. Global prospects and policies. *World Economic Outlook*, Ch. I, April 2009, p. 11-14.
5. Harding D. and A. Pagan, "Synchronisation of cycles", *Journal of Econometrics*, 2006, Vol 132 (1), pp. 59-79.
6. Joseph H. Davis J., Aliaga-Díaz R. The global recession and international investing. / Vanguard Investment Counseling and Research. 2009. [www.vanguard.com](http://www.vanguard.com)
7. Kalemli-Ozcan S., Papaioannou E., Peydró J. Financial integration and business cycle synchronization. NBER Working Paper 14887, April 2009. <http://www.nber.org/papers/w14887>
8. Kose A., Otrok C., Prasad E. Global Business Cycles: Convergence or Decoupling? IMF Working Paper, June 2008.
9. Kose A., Otrok C., Whiteman C. Understanding the Evolution of World Business Cycles. IMF Working Paper # 211, November 2005.
10. Kuzin V., Hillebrand M. Global Business Cycles: Degree of Synchronization in the Current Downturn is Unprecedented. / German Institute for Economic Research. No. 27/2009, Volume 5, September 30, 2009.
11. *World Economic Outlook*. IMF, April 2009. From recession to recovery: how soon and how strong? (Chapter III).