Has Globalization Increased the Synchronicity of International Business Cycles?

By Travis J. Berge

From the business cycle peak at the end of 2007 to the trough in mid-2009, the U.S. economy shrank by 5 percent and lost nearly 9 million jobs, making the 2007-09 recession the most severe downturn of the post-World War II era. However, the United States was not alone; the downturn was global. Global output fell more than 5 percent during this period and most advanced economies simultaneously experienced a recession. Viewed from this perspective, the startling feature of the recent recession was not only its depth but its breadth—no event since the Great Depression has produced such wide-ranging consequences.

While the financial crisis in the United States in part sparked the global downturn, it is the slowdown in Europe that threatens the U.S. economy today. In his June 2012 testimony to Congress, Federal Reserve Chairman Ben Bernanke said, "The crisis in Europe has affected the U.S. economy by acting as a drag on our exports, weighing on business and consumer confidence and pressuring U.S. financial markets and institutions." Going further, Bernanke noted, "…the situation in

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Europe poses significant risks to the U.S. financial system and economy and must be monitored closely."

The global recession and continuing tremors in advanced economies suggest that the degree of synchronization among business cycles internationally has increased significantly. Lurking in the background of the increase in synchronization is the dramatic increase over the past 30 years in the volume of trade in goods and international financial holdings. The number of bilateral and regional free trade agreements has increased steadily over this period and the volume of trade in goods has followed suit. Financial connections have increased as countries liberalize financial markets.

This article shows that business cycles have become more synchronized over the past 20 years. After identifying the dates of expansions and recessions for a group of 32 industrialized countries since 1960, Section I shows that business cycles have become more synchronized over the past 20 years. Section II describes how increased global trade in goods and financial products have contributed to the increase in business cycle synchronicity. It then shows that there is little evidence that financial linkages have affected the synchronization of business cycles internationally. However, trade does affect the synchronization of business cycles. Countries with high trade volume have more synchronized business cycles.

I. THE SYNCHRONICITY OF INTERNATIONAL BUSINESS CYCLES

Determining what impact, if any, globalization has had on the synchronization of business cycles internationally requires clear definitions of business cycles and synchronization. This section estimates the dates of recessions and expansions for 32 countries. Countries were included based on their size and the availability of data. Table A1 of Appendix I provides the details. With the 32 countries in the sample representing nearly 70 percent of global output, this section also documents basic facts about international business cycles and creates a *global recession index* that measures the global business cycle since 1960. The index highlights the severity of the most recent downturn. Finally, the section measures business cycle synchronicity between each country-pair

in the sample. Since around 1990, business cycles have become much more synchronized internationally.

Dating international business cycles

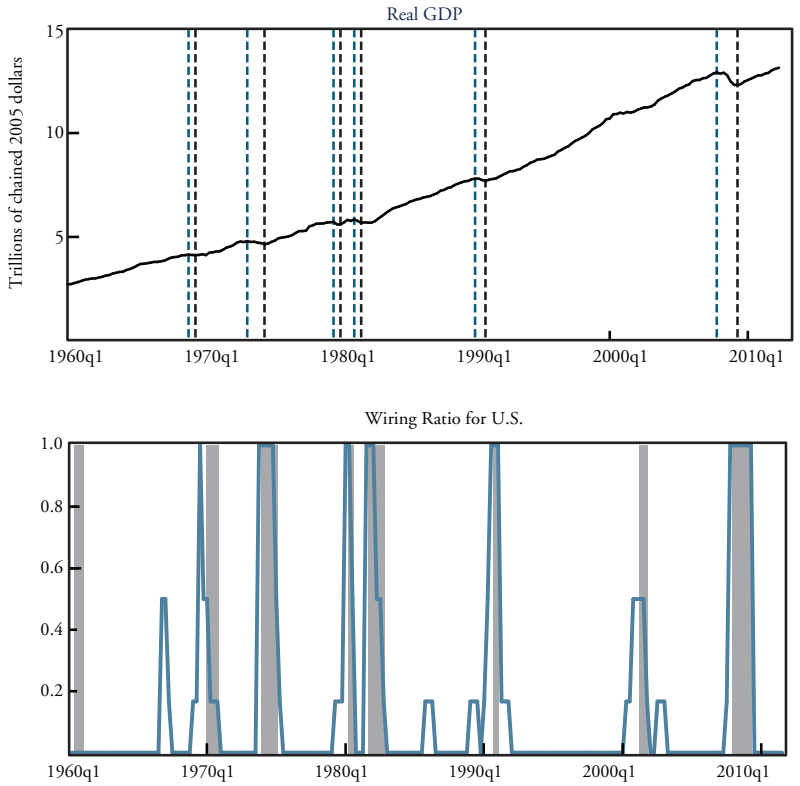
Economic activity tends to follow a cyclical pattern. Activity increases during an expansion until it reaches a peak, then declines during a recession until it reaches a trough. The cycle is then repeated. A common definition of recession is two consecutive quarters of declining real GDP. However, the Business Cycle Dating Committee of the National Bureau of Economic Research (NBER), the arbiter of U.S. business cycle peaks and troughs, takes a broader view: "A recession is a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in production, employment, real income, and other indicators" (NBER 2008). When the NBER announced the trough date for the most recent recession, it made clear that the decision rested on identifying the trough date for many different economic indicators, not just GDP.[1]

Following the NBER, this article uses a broad range of indicators to determine whether an economy is in recession or expansion. The indicators are real GDP, unemployment, industrial production and a retail sales index. Peaks and troughs are identified for each variable separately. Peaks are defined as quarters in which the variable is greater than in the two preceding quarters and the two following quarters. Similarly, troughs are quarters in which the variable is less than in the two preceding quarters and the two following quarters. Identifying turning points in this way is known as the Bry-Boschan algorithm (Bry and Boschan 1972; Harding and Pagan 2002).

The results of applying the Bry-Boschan algorithm to U.S. GDP are shown in Chart 1. The chart shows U.S. real GDP since 1960 with business cycle peaks in blue and troughs in gray. The algorithm identifies the majority of NBER-defined U.S. recessions since 1960. The only exception is the 2001 recession, during which GDP did not fall for two consecutive quarters. This omission highlights the need to look across many different indicators when dating business cycles. Although the Bry-Boschan algorithm applied to GDP data misses the 2001 recession, each of the other three indicators does show a peak-trough pattern around the 2001 recession.

Chart 1

CALCULATING PEAKS AND TROUGHS IN U.S. REAL GDP AND OVERALL U.S. ECONOMIC ACTIVITY USING THE BRY-BOSCHAN ALGORITHM



Notes: Gray bars indicate recessions as defined by the National Bureau of Economic Research.
Sources: U.S. Bureau of Economic Analysis, National Bureau of Economic Research and author calculations.

Applying the Bry-Boschan algorithm to each of the four indicators produces separate recession chronologies. These chronologies are combined using a "wiring ratio" that calculates the fraction of pairs of chronologies that indicate a recession.[2] The wiring ratio for the four indicators describing the U.S. economy is shown in the lower panel of Chart 1, where NBER-defined recessions are shaded in gray. The wiring ratio effectively replicates the NBER dates. The methodology produces one short-lived false positive recession in the fourth quarter of 1966 and the first quarter of 1967 that is not identified by the NBER. Otherwise

Table 1

SUMMARY STATISTICS OF INTERNATIONAL BUSINESS CYCLE CHRONOLOGIES

Country	Number of observations	Number of quarters in recession	Percentage of time in recession	Number of recessions	Average duration (quarters)	
					Recession	Expansion
Argentina	89	23	26%	5	4.6	11.0
Australia	208	44	21%	11	4.0	13.7
Austria	208	53	25%	14	3.8	11.1
Belgium	208	47	23%	10	4.7	16.1
Brazil	148	37	25%	12	3.1	9.3
Canada	208	22	11%	4	5.5	37.2
Chile	208	66	32%	12	5.5	11.8
Czech Republic	88	25	28%	5	5.0	10.5
Denmark	208	53	25%	12	4.4	12.9
Finland	208	40	19%	7	5.7	21.0
France	208	50	24%	8	6.3	17.6
Greece	200	52	26%	8	6.5	18.5
Germany	208	54	26%	10	5.4	14.0
Great Britain	208	41	20%	7	5.9	20.9
Iceland	128	40	31%	5	8.0	14.7
Ireland	208	39	19%	9	4.3	16.9
Israel	208	29	14%	6	4.8	25.6
Italy	208	54	26%	12	4.5	12.8
Japan	208	43	21%	9	4.8	16.5
Mexico	208	44	21%	10	4.4	14.9
Netherlands	208	32	15%	7	4.6	29.3
Norway	208	53	25%	7	7.6	22.1
New Zealand	196	59	30%	12	4.9	10.5
Portugal	208	39	19%	8	4.9	21.1
Russia	77	8	10%	2	4.0	23.0
South Africa	208	50	24%	9	5.6	15.8
South Korea	208	11	5%	3	3.7	49.3
Spain	204	27	13%	5	5.4	35.4
Sweden	208	40	19%	7	5.7	21.0
Switzerland	208	78	38%	11	7.1	11.8
Turkey	128	25	20%	7	3.6	12.9
United States	208	34	16%	8	4.3	19.3
Average	**189**	**41**	**22%**	**8**	**5.1**	**18.7**

Source: Author calculations.

the algorithm matches the NBER dates very well, picking up the 2001 recession that was missed by the measure that focused only on GDP.

Using the wiring ratio, a single recession chronology for each country can be calculated. A threshold value of 0.15 is used to identify whether an economy is in recession; this threshold means that for a quarter in which all four indicators are available, a recession occurs when two of the four variables signal recession. Table 1 summarizes recessions in the 32 countries, with more detailed information provided in Table A2 in Appendix I. The average economy spends 20 percent of its time in a recession. A typical recession lasts slightly longer than a year while expansions last about four and a half years. Surprisingly, of the 32 countries, Switzerland has been in recession most often—nearly 40 percent of the time—including much of the 1990s. In contrast and reflecting its fast growth throughout this period, South Korea has experienced three recessions, the fewest of the 32 countries. Moreover, two of South Korea's recessions are associated with international events, with one coinciding with the Asian financial crisis of the 1990s and the other with the most recent global recession.

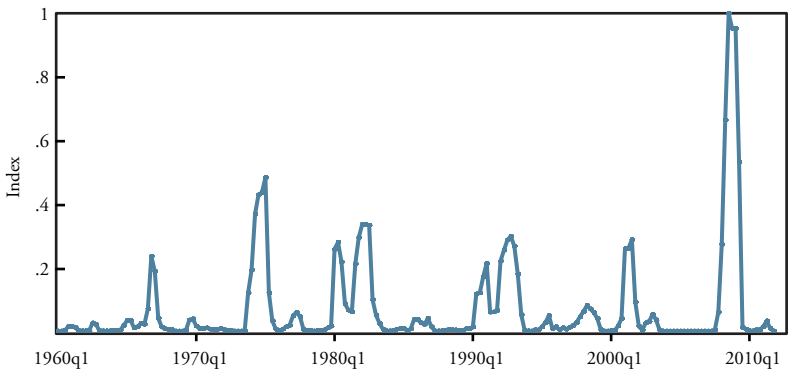
Calculating a global recession index

Each country in the sample experienced a recession beginning in either 2007 or 2008 (Table A2). Moreover, many of the European countries have experienced double-dip recessions since 2008. In any case, the uniformity of experience across countries since 2007 is striking. With the 32 business cycle chronologies in hand, an interesting extension is to calculate a recession index for the global economy. To do so, the wiring ratio is applied again, but now to the chronologies for the 32 countries in the sample. The wiring ratio calculated across the 496 country-pairs in the sample is plotted in Chart 2 and labeled the *Global Recession Index*. To ensure that the index is a global measure, each country is weighted by its Purchasing Power Parity-adjusted real GDP so that large economies receive more weight when falling into recession than small economies.

Chart 2 reveals several global recessions since 1960. As a frame of reference, if all of the countries were the same size, and if half of the countries are in a recession at the same time, then the index equals

Chart 2

GLOBAL RECESSION INDEX: WIRING RATIO FOR 32 ADVANCED ECONOMIES



Source: Author calculations.

0.25. The most recent recession stands out as a unique experience. All countries in the sample experienced a recession in 2007-09 so that the index equals 1.0, the only time this has occurred since 1960. However, other well-known global events are visible, which makes the most recent recession that much more impressive. Most notably, the oil crisis of 1973—the second highest spike in Chart 2—produced a wide-ranging recession. The global recession index spikes to nearly 0.50 in the first quarter of 1975 and 22 of the 32 countries were in a recession at that time. The double dip of the early 1980s for the United States and many European countries is also easily identified. There is a similar double-dip pattern at the start of the 1990s, reflecting recessions that followed several disparate sources of turmoil, such as the first Iraq War, banking crises in Scandinavia, and the reunification of Germany. Each event contributed separately but simultaneously to national recessions in many of the countries. A mild global recession follows the bursting of the 2001 technology bubble. One global event not shown in the index is the Asian financial crisis of the late 1990s. The index does not reflect this event because there are few Asian countries in the sample. However, Table A2 shows that many of the countries involved in the Asian financial crisis—Japan, South Korea, Russia, Argentina, and Brazil—experienced recessions during this period.

The synchronicity of global business cycles

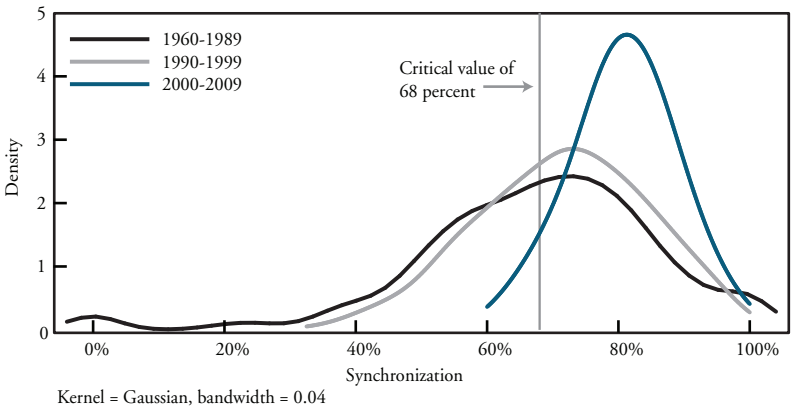
The next step in determining what affects the synchronicity of business cycles is to construct a measure of business cycle synchronicity. Here, the degree of synchronicity between two countries over a time period is measured by the fraction of time that both countries are in the same state of the business cycle; that is, the fraction of time the countries are both in recession or are both in expansion (Harding and Pagan 2002). Recall that the previous subsection found that economies tend to be in recession about 20 percent of the time. Therefore, statistically, if the occurrence of recession/expansion were completely independent across two countries, the countries would be in the same phase of the business cycle 68 percent of the time.[3] Sixty-eight percent thus serves as the critical value for the measure of synchronization. For example, consider the United States and the United Kingdom in the 1970s. They were in recession at the same time for four quarters, and they were in expansion together for 24 quarters. As a result, the U.S./U.K. pair in the 1970s was in the same phase of the business cycle 70 percent of the time (28 quarters/40 quarters)—very close to the critical value of 68 percent. By this measure, U.S. and U.K. business cycles were largely independent of each other during this period.

Of course, the fraction of time spent in the same business cycle can be calculated for all countries in the sample and for all the decades in the sample. Chart 3 provides one way of summarizing this information in one picture. The chart presents this same measure but calculates it across all 496 country-pairs in the sample separately for each decade. To construct the chart, the fraction of time that two countries are in the same phase of the business cycle is calculated for each decade, giving 496 data points for each decade. To summarize these data, a smoothed version of a histogram, called a density, is calculated. Chart 3 presents the density for each of the decades in the sample. Because the densities for the first three decades of the sample—the 1960s, 1970s and 1980s—lie almost completely on top of one another, Chart 3 pools these 30 years together and shows only one density for the entire period.

The density is read in the same way as a histogram. Higher values of the density indicate that a larger proportion of the 496 observations for that decade correspond to the value on the horizontal axis.[4] In this way, Chart 3 shows business cycles have become more synchronized

Chart 3

DENSITY OF BUSINESS CYCLE SYNCHRONIZATION FOR THREE SAMPLE PERIODS



Kernel = Gaussian, bandwidth = 0.04

Source: Author calculations.

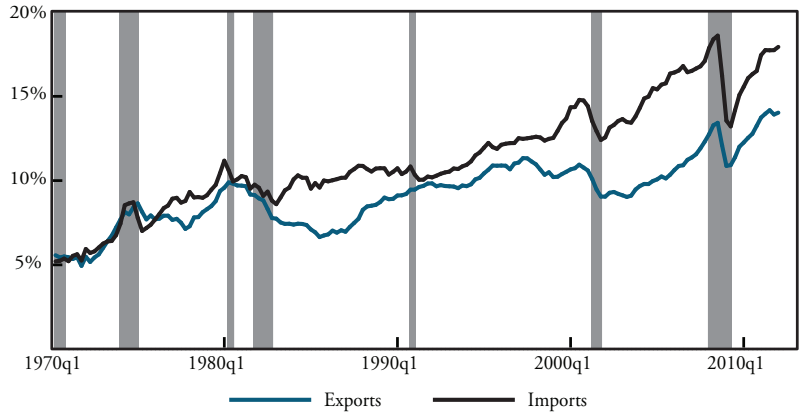
in recent decades. For example, the peak of the density for the 1960s-1980s is close to the critical value of 68 percent, which indicates that the synchronization during this period is close to what one would expect if business cycles were completely independent. The density is also quite wide, indicating that different country-pairs were in the same phase of the business cycle for different fractions of time. Business cycles in the 1990s exhibit more synchronization, indicated by the shift in the density to the right. The density for the 2000s is even further to the right. The movements in the densities are not due to chance—each shift is meaningful in a statistical sense.[5] The appearance of the shift in the 1990s hints at a fundamental change in the global economy—over the past 20 years, the business cycles of different countries have become more synchronized.

II. THE EFFECT OF GLOBALIZATION ON INTERNATIONAL BUSINESS CYCLES

The previous section showed that business cycles have become more synchronized over the previous two decades. This section relates increased synchronicity to greater trade and financial linkages. Because economic theory does not clearly answer whether globalization will produce more highly synchronized business cycles, the issue is examined empirically. Specifically, after documenting the increase in globalization of trade in goods and services and the increase in international

Chart 4

U.S. IMPORTS AND EXPORTS AS A PERCENTAGE OF GDP



Notes: Gray bars indicate recessions as defined by the National Bureau of Economic Research.
Sources: U.S. Bureau of Economic Analysis and National Bureau of Economic Research.

holdings of financial instruments, the article discusses what economic theory and empirical evidence says about the effect of trade and financial linkages on business cycle synchronicity.

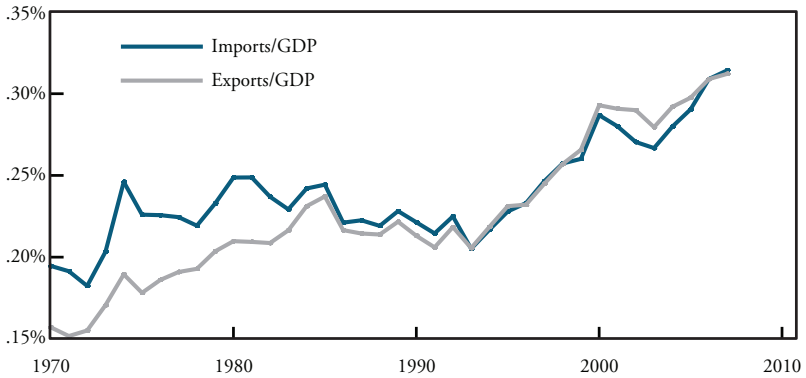
Globalization of international trade

International trade has grown dramatically over the last several decades. The annual growth of the real dollar value of the imports and exports of the countries in the dataset has averaged about 10 percent since 1970. Because real GDP in these countries grew by less than 10 percent annually, international trade as a share of output is now larger than it was 40 years ago. The situation in the United States illustrates this point (Chart 4). The chart plots real imports as a percentage of real GDP and real exports as a percentage of real GDP. In 1970, imports and exports were both about 5 percent of GDP. Since 1970, imports and exports have grown faster than GDP so that imports are now nearly 20 percent of GDP and exports are about 14 percent of GDP. The effect of the recent recession on international trade is also clear in the chart: imports and exports as a share of GDP both fell dramatically between 2007 and 2009.

International trade in all 32 countries shows a similar increase (Chart 5). To combine data from all 32 countries, the chart plots an unweighted average of imports-to-GDP and exports-to-GDP. As in the United States, imports and exports as a share of GDP have increased

Chart 5

GLOBAL IMPORTS AND EXPORTS AS A SHARE OF GDP: 1970-2007



Notes: The chart plots an unweighted average of the ratios imports-to-GDP and exports-to-GDP.
Source: Barbieri and Keshk (2012).

for the countries as a whole. Since 1970, exports as a share of GDP have doubled while imports as a share of GDP have increased by about 50 percent. Importantly for the discussion of business cycle synchronicity, there has been a dramatic increase in trade during the 1990s.

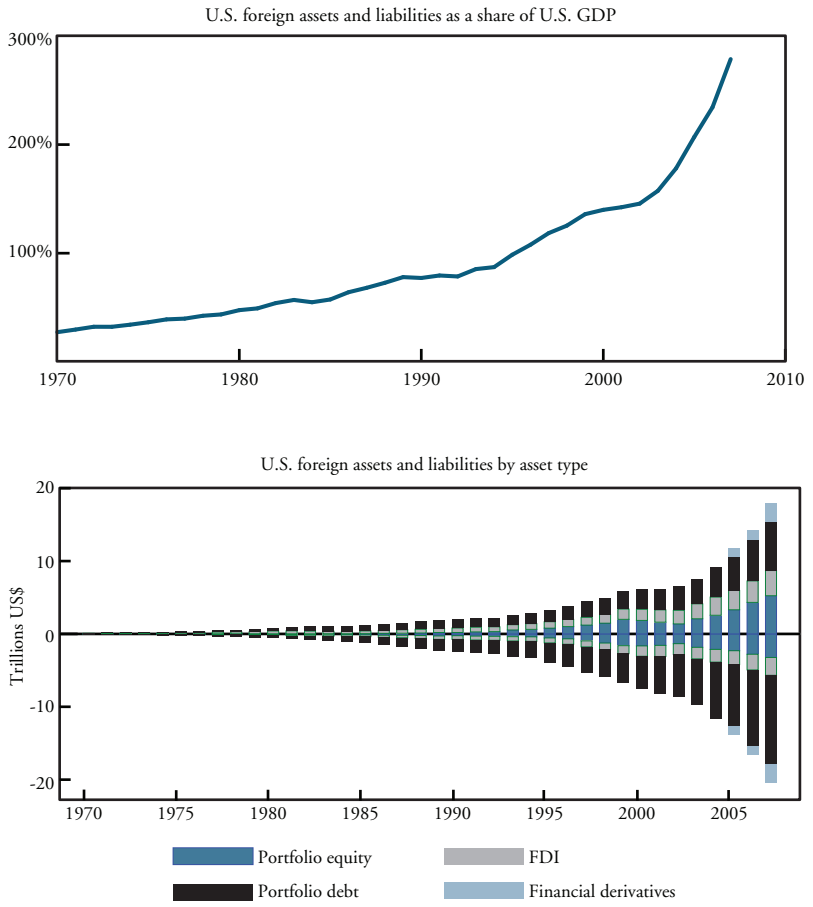
Globalization of international finance

Although trade in goods and services has become a larger share of global output, the growth in the cross-border holdings of financial assets dwarfs this increase in trade. The dataset compiled by Lane and Milesi-Ferretti (2007) shows the degree to which countries have become financially linked by providing values for the external assets and liabilities of a large number of countries. Each country's external assets and liabilities are further broken down by asset type: equity, debt and foreign direct investment (FDI). While the data only provide aggregate stocks of international holdings of financial assets, the analysis uses the data to construct proxies for bilateral asset holdings (see Appendix II for more details).

The growing importance of foreign assets held by U.S. residents and foreign liabilities owed by U.S. residents is shown in Chart 6. The United States has run a trade deficit for most of the past 40 years. The flip side of this trade deficit is the purchase of U.S. assets by foreigners. To measure the increased globalization of international financial

Chart 6

INTERNATIONAL ASSETS AND LIABILITIES OF THE UNITED STATES

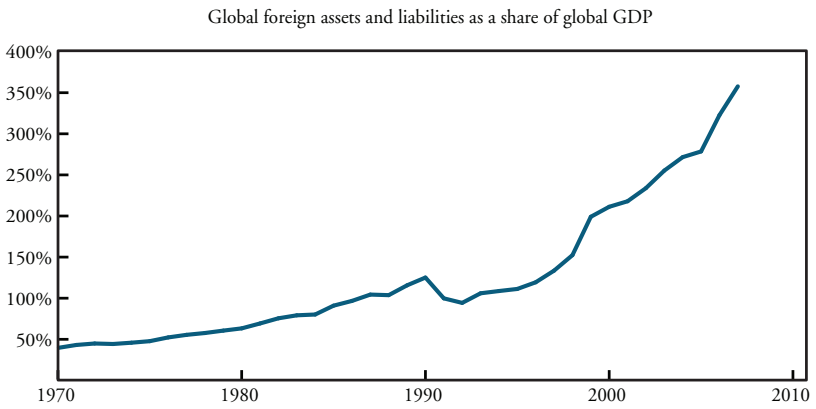


Source: Lane and Milesi-Feretti (2007).

markets for the United States, the upper panel of Chart 6 shows the sum of foreign assets and foreign liabilities as a share of GDP. This ratio has grown seven-fold over the last 40 years. The lower panel of Chart 6 shows the stock of U.S. assets (upper half of the chart) and liabilities (lower half of the chart) by asset type, this time in total dollar value to highlight the absolute value of the assets and liabilities of the U.S. economy. The growth in the stock of foreign assets and liabilities is broad-based, with assets and liabilities of all asset types growing over

Chart 7

FOREIGN ASSETS AND LIABILITIES AS A SHARE OF GDP



Source: Lane and Milesi-Ferretti (2007).

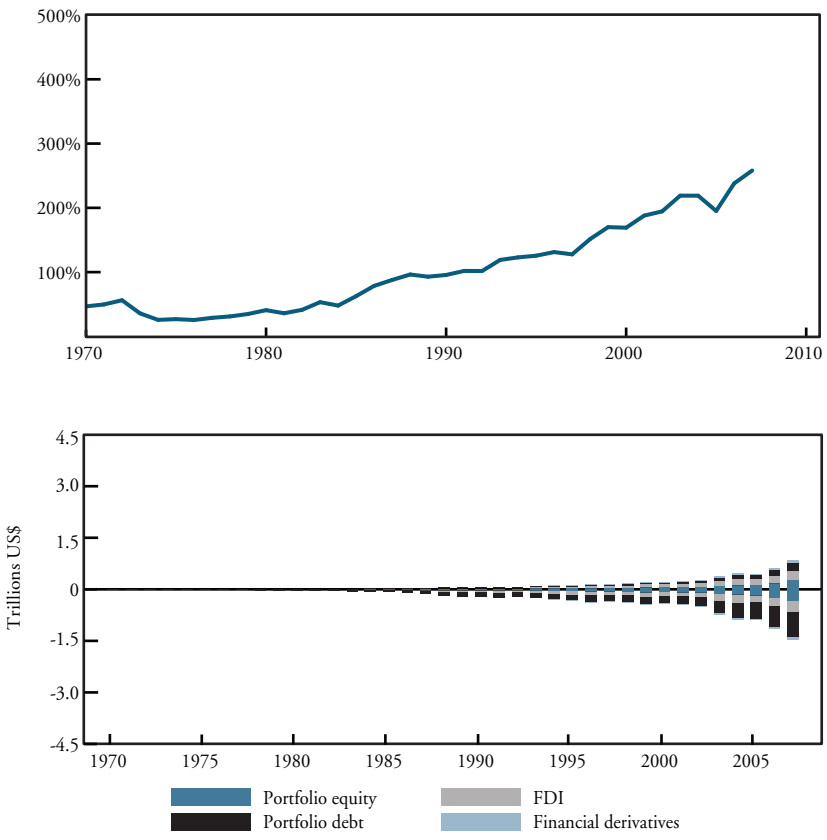
the previous 20 years in particular. The well-known asymmetry in U.S. foreign asset holdings is visible: U.S. foreign assets tend to be equity or FDI, whereas the bulk of U.S. liabilities are debt instruments.

Chart 7 illustrates the increase in globalization of international finance markets for all the countries in the Lane and Milesi-Fertetti dataset. The chart shows the global sum of the dollar value of foreign assets and foreign liabilities as a ratio to the dollar value of global GDP. Similar to the United States, total world foreign assets and liabilities have grown from about 50 percent of global GDP in 1970 to more than 300 percent of global output today.

Chart 8 displays the total value of foreign assets and liabilities for a group of countries—Australia, Canada, Japan and Norway—again presented as a ratio to that country's GDP. The increase in the international financial linkages is broad-based for each country. All four have a foreign assets and liabilities to GDP ratio of at least 200 percent. Norway in particular has used the income from its oil wealth to purchase large quantities of foreign assets—its foreign assets and liabilities to GDP ratio is more than 500 percent. The right panel of Chart 8 shows the dollar value of each country's international asset position. Note that scales of the four countries are the same so they are comparable, although the scales are different from those in Chart 6 for the United States. The

Chart 8a

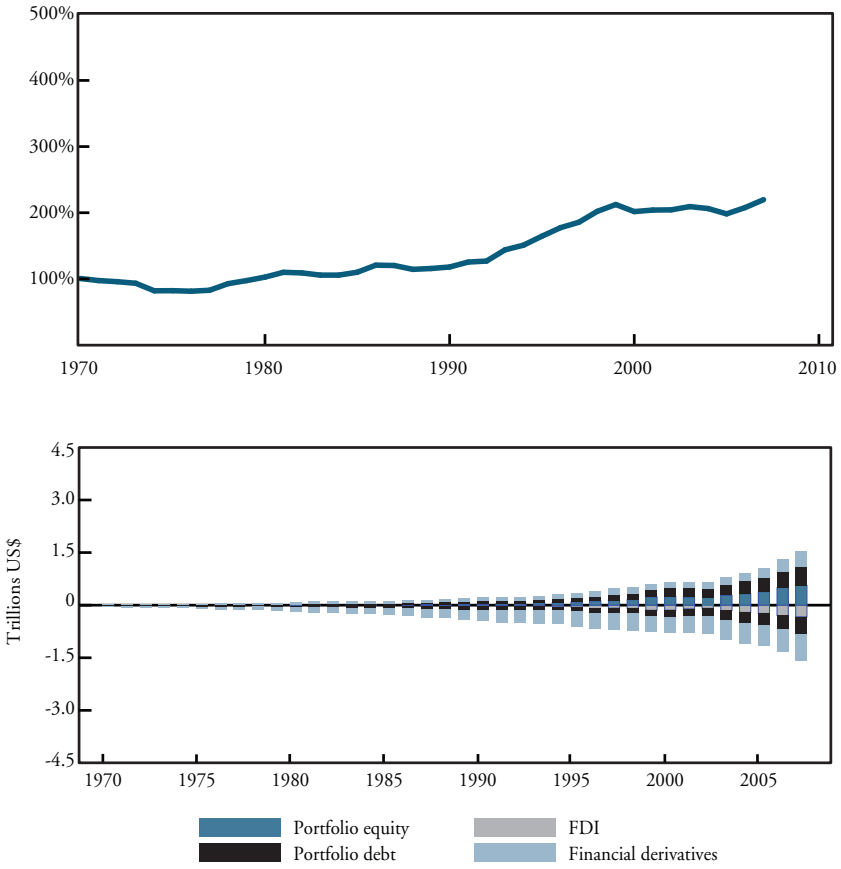
AUSTRALIA: FOREIGN ASSETS AND LIABILITIES AS A SHARE OF GDP



Notes: The upper panel shows the ratio of the sum of foreign assets and liabilities to GDP. The lower panel shows the dollar value of foreign assets and liabilities, broken into asset type.
Source: Lane and Milesi-Ferretti (2007).

Chart 8b

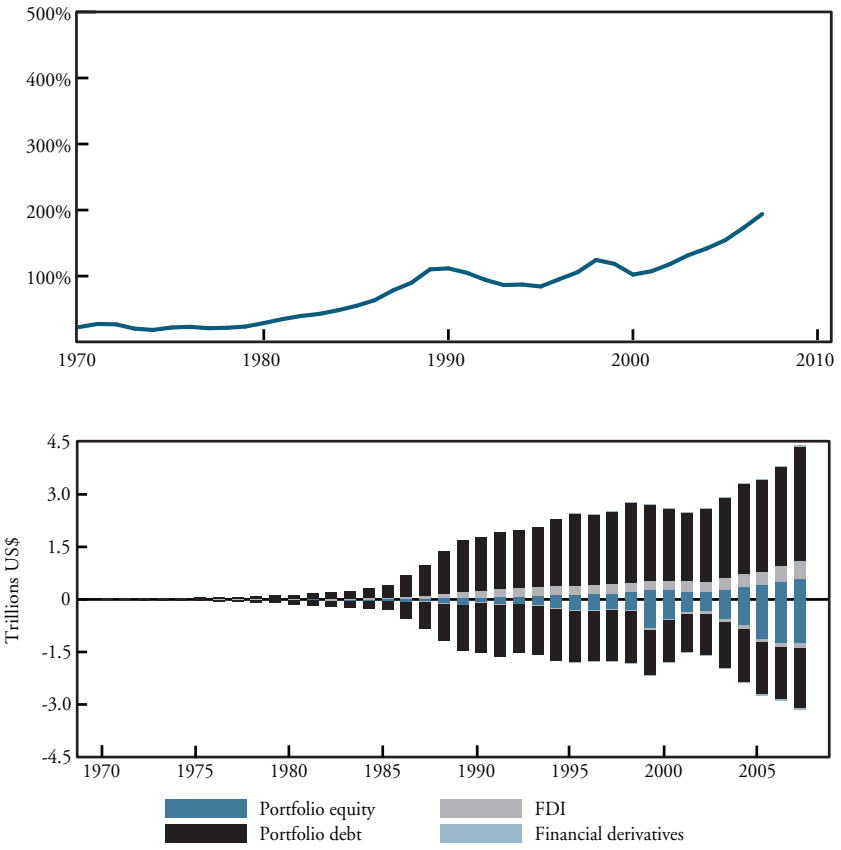
CANADA: FOREIGN ASSETS AND LIABILITIES AS A SHARE OF GDP



Notes: The upper panel shows the ratio of the sum of foreign assets and liabilities to GDP. The lower panel shows the dollar value of foreign assets and liabilities, broken into asset type.
Source: Lane and Milesi-Ferretti (2007).

Chart 8c

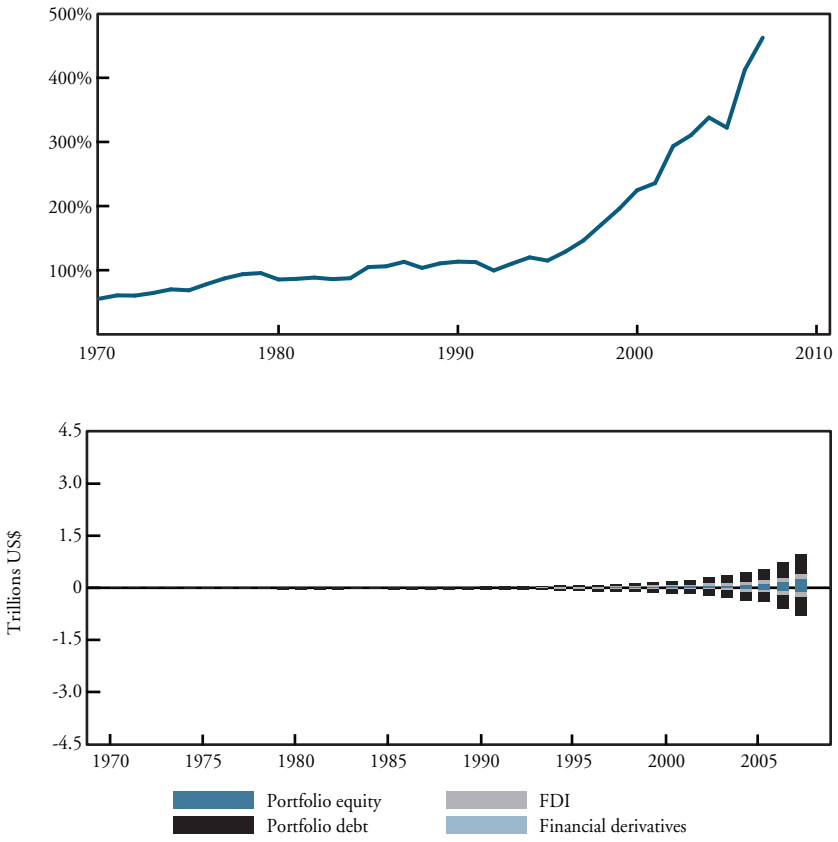
JAPAN: FOREIGN ASSETS AND LIABILITIES AS A SHARE OF GDP



Notes: The upper panel shows the ratio of the sum of foreign assets and liabilities to GDP. The lower panel shows the dollar value of foreign assets and liabilities, broken into asset type.
Source: Lane and Milesi-Ferretti (2007).

Chart 8d

NORWAY: FOREIGN ASSETS AND LIABILITIES AS A SHARE OF GDP



Notes: The upper panel shows the ratio of the sum of foreign assets and liabilities to GDP. The lower panel shows the dollar value of foreign assets and liabilities, broken into asset type.
Source: Lane and Milesi-Ferretti (2007).

composition of these foreign asset holdings varies dramatically across countries. For example, the net foreign asset position of Australia and Canada is in some ways similar to the United States: liabilities are primarily dominated in debt while foreign assets are more likely to be equity or FDI. Japan is very different: its foreign liabilities are largely equity and debt instruments, while the country's assets are dominated by debt.

After having documented the increase in globalization, this section now turns to the effect of globalization on business cycle synchronicity—first theoretically and then empirically.

The effect of globalization on international business cycles: theory

Economic theory is unclear about the effect of increased trade and financial integration on business cycle synchronization. While both trade and financial linkages provide a channel through which demand shocks can be transmitted across economies—possibly leading to greater business cycle synchronicity—both types of connections can also produce offsetting effects that reduce business cycle synchronicity. In theory, it is difficult to tell which effects will dominate.

Trade linkages provide a direct channel through which increased demand in one country is transmitted to increased production in another country. For example, suppose that there are only two countries in the world, country A and country B. Consumers in both countries consume a basket of goods that consists of products produced in both countries. Imagine what happens if the demand for final goods by consumers in country A increases. This demand shock raises the demand for all goods, including imports from country B. Country B will react by producing more goods to meet the extra demand from country A. Trade has transmitted this demand shock from A to B, leading to more synchronous business cycles because both countries produce both goods in response to the increased demand.

Another way that trade may lead to synchronous business cycles is through intra-industry trade. Hummels, Ishii, and Yi (2001) have documented the growing importance of intra-industry trade to the global economy. When one country imports intermediate goods—that is, goods that will be used to produce some other good—industry-specific shocks can be transmitted internationally. Continuing the example, suppose country A produces intermediate goods—wheat and

steel—while country B produces final goods, bread and cars. In order to produce bread and cars, country B imports wheat and steel from country A. If country A experiences a drought such that wheat production (and therefore wheat exports) declines, then country B will produce less bread. As a result, the drought in country A affects output in country B in the same direction so business cycles will be more synchronized.

However, it is also possible that trade linkages could actually decrease the synchronization of business cycles between countries. Consider the case where two countries specialize and trade different types of products. Instead of the example above, suppose that country A produces cars while country B produces and exports wheat. Again, suppose that a drought significantly reduces country B's wheat production. Clearly both countries will consume less bread, but country A's car production will remain relatively unharmed by the drought. Thus, even though both countries are adversely affected by the drought, it is clear that country A is less affected than country B. In this way, if countries specialize and trade very different types of goods, and if industry-specific shocks are important, then trade may actually reduce the synchronicity of business cycle movements.

The impact of financial linkages on business cycle synchronization is also ambiguous in theory. On the one hand, standard international business cycle theory (Backus, Kehoe, and Kydland 1992) would predict that the free-flow of capital internationally would decrease business cycle synchronization. To understand the mechanism, suppose that one country experiences a positive shock to its productivity while the other does not. Global investors will move their investments away from the relatively less productive economy to the more productive economy. As a result, the country with the positive productivity shock sees an increase in output for two reasons: directly from the positive productivity shock and indirectly from the inflow of funds from the foreign country. Unfortunately, the country without the productivity shock sees a decline in output because funds flow out of the country and into the now more productive country. Thus financial linkages can lead to asynchronous business cycles. To further complicate matters, Heathcote and Perri (2004) point out that it is difficult to determine if financial linkages cause asynchronous business cycle fluctuations, or if the reverse

is true, since asynchronous business cycle fluctuations also provide investors with good hedging opportunities.

Access to international financial markets means that investors can hold the assets of many different countries. Such diversification implies that shocks to the financial system of one country can affect the wealth of consumers in other countries, which in turn can affect consumption in that country. If consumers in one country hold a large portion of their equity assets in a foreign country, and the country's stock market falls, then consumption in both countries will fall because consumers of both countries will be less wealthy. In a similar way, suppose that the value of an international bank's assets in one country declines. In response, the bank may withdraw funds from many different countries simultaneously, leading to more highly correlated business cycles (see, e.g., Krugman 2008; Kollmann, Enders, and Muller 2011). Finally, as the European sovereign debt crisis has shown, financial market contagion can reduce growth internationally.

The effect of globalization on international business cycles: empirical evidence

Theory is mixed on whether trade and financial linkages lead to more or less synchronous business cycles. Therefore, this section examines the issue empirically using the measure of synchronization observed across country-pairs produced earlier. Many empirical studies have attempted to sort the contradictory predictions of economic theory.[6] Prior studies generally measure business cycle synchronicity by calculating the statistical correlation between the detrended output of economies. In contrast, this article focuses on the business cycle by looking at whether countries tend to experience expansions or recessions at the same time.

The regression analysis used in this analysis examines whether countries with close trade and financial relationships have business cycles that move together. Specifically, let $Synchronization_{ijt}$ denote the fraction of time country i and country j are in the same state of the business cycle during decade t. This measure is plotted for all country-pairs in Chart 3. Further, let $Trade\ linkages_{ijt}$ measure the degree of trade linkages between the two countries and $Financial\ linkages_{ijt}$ measure the degree of financial linkages between the two countries, both measured at the start of decade t. Then the empirical effect of trade and financial

linkages on business cycle synchronization can be estimated using the following regression:

$$Synchronization_{ijt} = \beta_0 + \beta_1 \times Trade\ Linkages_{ijt} + \beta_2 \times Financial\ linkages_{ijt} + \Gamma \times Controls \quad (1)$$

The control variables take into account other characteristics that may be important for business cycle synchronization. The effect of trade and financial linkages on the synchronicity of business cycles is captured by the parameters β_1 and β_2.

The composition of countries' international assets and liabilities can vary dramatically, and different asset types may transmit shocks internationally in different ways. For this reason, an expanded regression is also estimated:

$$Synchronization_{ijt} = \beta_0 + \beta_1 \times Trade\ Linkages_{ijt} + \beta_2 \times Equity\ linkages_{ijt} + \beta_3 \times Debt\ Linkages_{ijt} + \beta_4 \times FDI\ linkages_{ijt} + \Gamma \times Controls \quad (2)$$

A finding that the parameters β_1 to β_4 are positive and statistically significant would mean that trade and financial linkages are important determinants of business cycle synchronicity. And because the previous section showed that trade and financial linkages have increased, this finding would explain in part why business cycles have become more synchronized in the last two decades.

Two different definitions of the variable *trade linkages* are used in estimating equations (1) and (2). While both definitions measure the volume of bilateral trade between the two countries, one definition looks at bilateral trade relative to the total volume of trade between the two countries and all other countries; the other definition looks at bilateral trade relative to total GDP for the two countries.

In addition, the statistical procedure used in estimating equations (1) and (2) must account for the fact that the key variables in the equations are simultaneously determined. The box "Dealing with Simultaneity between Business Cycle Synchronicity, Trade Linkages, and Financial Linkages" describes two ways for dealing with this problem.

Finally, two different sets of control variables are used when estimating the equations. Although the control variables are not directly of interest, estimating different specifications are one way to test the robustness of the results. Appendix II discusses in detail the construction of the variables *trade linkages* and *financial linkages* as well as the different regression specifications.

The primary finding of the analysis is that a greater level of bilateral trade between two countries is associated with those two countries having more highly synchronized business cycles (Table 2). The results indicate that spillover effects are important—demand shocks that are transmitted through trade linkages are more important than any offsetting effects due to specialization. The result is consistent with the previous literature and is robust. Of the eight regression specifications, five are positive and statistically significant, two are positive but statistically insignificant and one is negative and statistically insignificant.

In economic terms, the magnitude of the effect is modest. The coefficient on trade linkages hovers around 0.02. Because the trade-to-total trade and trade-to-GDP variables in the regression have been transformed by the log function (see Appendix II), this value means that a 10 percent increase in the trade intensity between two countries will increase the fraction of quarters that the countries spend in the same phase of the business cycle by 0.2. For example, consider that the trade-to-GDP ratio for U.S.-Mexico trade doubled between 1990 and 2000. According to the estimate above, synchronization can be expected to increase by 2.0. Because there are 40 quarters in a decade, this means that during the 2000s, Mexico and the United States spent one additional quarter in the same phase of the business cycle than they otherwise would have had their trade-to-GDP ratio not changed.

Financial connections as measured here do not appear to have an analogous impact on business cycle synchronization. Total financial linkages have a negative and often significant, effect on synchronization. While a negative result is not inconsistent with economic theory, it is somewhat surprising because the majority of empirical work has found a positive effect. Moreover, when financial connections are measured by asset type instead, the results are not consistent enough to draw strong conclusions about the impact that these connections have on business cycle synchronization. Countries with equity linkages

DEALING WITH SIMULTANEITY IN BUSINESS CYCLE SYNCHRONICITY, TRADE LINKAGES AND FINANCIAL LINKAGES

The key variables in the two regression equations are determined simultaneously and are therefore said to be endogenous. While the regression equations are written so that it looks as though trade and financial linkages *cause* business cycle synchronization, it could be the other way around: a high degree of trade or financial linkages could *be caused by* business cycles that are highly synchronized. Moreover, rather than trade and financial linkages causing business cycle synchronicity, or business cycle synchronicity causing trade and financial linkages, it could be that some other factor—for example, increased cooperation between policymakers around the world—is causing both greater trade and financial linkages *and* greater business cycle synchronicity.

One way to reduce the simultaneity problem is to estimate the two regression equations using instrumental variables rather than ordinary least squares. An instrument is a variable that is correlated with the endogenous explanatory variable (trade and financial connectedness in this application) but is not correlated with the outcome (business cycle synchronization). Because the instrument is not correlated with the outcome, it can be used to "sterilize" the endogenous variable and produce proper estimates of the coefficients of interest. If the instruments are valid, then the regression results can be interpreted as causal relationships and not simply correlations. In the present application, variables from the so-called gravity model of international trade are used to instrument trade and financial linkages.[7] These variables are essentially descriptions of a country's specific characteristics, such as language, legal system and the distance from its trading partners. A country's specific characteristics are not correlated with its' comovement with other economies around the world. Moreover, standard tests indicate that these instruments are strongly correlated with the endogenous regressors. The instruments are

therefore valid: they are exogenous to business cycle synchronization yet correlated to the endogenous regressors.

Another way to further reduce the problem of endogeneity is to calculate the measures of trade and financial interconnectedness at the first quarter of each decade from 1970 to 2000 (see Appendix II). In this way, the trade and financial linkages for each country-pair *at the start of the decade* are used to explain that country-pair's degree of business cycle synchronization *during that same decade*, thereby reducing the likelihood that business cycle synchronization during the decade and linkages at the start of the decade are simultaneously determined.

Table 2

THE EFFECT OF TRADE AND FINANCIAL LINKAGES ON BUSINESS CYCLE SYNCHRONICITY

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Trade/total trade	0.023**	0.031**	0.026	0.184**				
	(0.009)	(0.005)	(0.019)	(0.083)				
Trade/GDP					0.023**	0.023**	-0.067	0.232
					(0.009)	(0.005)	(0.129)	(0.187)
Total financial linkages	-0.032**		-0.285		-0.032**		-0.268**	
	(0.015)		(0.180)		(0.014)		(0.121)	
Equity linkages		0.039**		-0.185		0.050**		-0.322
		(0.010)		(0.227)		(0.011)		(0.478)
Debt linkages		-0.027**		-0.13		-0.032**		0.196
		(0.013)		(0.825)		(0.013)		(1.061)
FDI linkages		-0.019		0.084		-0.031		-0.163
		(0.021)		(0.174)		(0.021)		(1.025)
N	1685	1589	1685	1589	1685	1589	1685	1589
Fixed effects	Period	Period	Country-pair, period	Country-pair, period	Period	Period	Country-pair, period	Country-pair, period

**Indicates statistical significance at the 95 percent confidence level.
Notes: Standard errors are clustered at the country-pair level and are in parentheses.
Source: Author calculations.

appear to have more highly synchronized business cycles, although again the economic magnitude of the coefficient is relatively small. Debt and, perhaps surprisingly, FDI linkages do not appear to have a robust impact on business cycle synchronization.

III. CONCLUSION

The degree to which business cycles are now internationally synchronized has increased significantly over the past 20 years, due in part to closer economic ties between countries. Regression analysis that exploits the cross-country differences in the intensity in which countries trade goods and hold external financial assets reveals that economies that trade with each other have more synchronized business cycles. Perhaps surprisingly, financial linkages are not associated with more synchronized business cycles. However, the proxies for bilateral financial connections used in the analysis are aggregate in nature. A study with more detailed data on the nature of financial linkages may well lead to different conclusions. This is an interesting and important area for future work.

Although this article doesn't address the shocks that catalyzed the initial downturn in the U.S. and world economies, others have pointed to some combination of high oil prices, shocks to the financial system, constrained demand due to overleveraged households, and high levels of uncertainty (see Stock and Watson 2012, Davig and Haakio 2010, Mian and Sufi 2010 and Bloom 2009, among others). No matter the ultimate cause, the evolution of the global economy over the previous several decades—particularly the dramatic increase in the flow of international trade in goods—has helped to set the stage for the global transmission of these shocks. Given that globalization continues unabated, U.S. policymakers need to remain vigilant to events occurring outside the United States, especially in areas to which the United States has close economic ties.

APPENDIX I

Table A1

DATES FOR WHICH BUSINESS CYCLE DATA IS AVAILABLE

	Real GDP	Industrial Production	Unemployment	Retail Trade
Argentina	1990Q1-2011Q3	1994Q1-2011Q4	2002Q4-2011Q2	--
Australia	1960Q1-2011Q4	1960Q1-2011Q4	1966Q3-2011Q4	1983Q3-2011Q4
Austria	1964Q1-2011Q3	1960Q1-2011Q4	1960Q1-2011Q4	1973Q1-2011Q3
Belgium	1980Q1-2011Q3	1960Q1-2011Q4	1970Q1-2011Q4	1969Q1-2011Q4
Brazil	1995Q1-2011Q3	1975Q1-2011Q4	1981Q1-2011Q4	2000Q1-2011Q3
Canada	1960Q1-2011Q3	1960Q1-2011Q4	1960Q1-2011Q4	1970Q1-2011Q4
Chile	1980Q1-2011Q3	1960Q1-2011Q4	1986Q1-2011Q4	2005Q1-2011Q4
Czech Republic	1994Q1-2011Q3	1990Q1-2011Q4	1990Q1-2011Q4	1996Q1-2011Q4
Denmark	1977Q1-2011Q3	1960Q1-2011Q4	1970Q1-2011Q4	1968Q1-2011Q4
Finland	1970Q1-2011Q3	1960Q1-2011Q4	1960Q1-2011Q4	1960Q1-2011Q4
France	1960Q1-2011Q4	1960Q1-2011Q4	1967Q4-2011Q4	1975Q1-2011Q4
Germany	1960Q1-2011Q3	1960Q1-2011Q4	1962Q1-2011Q3	1960Q1-2011Q4
Great Britain	1960Q1-2011Q3	1960Q1-2011Q4	1971Q1-2011Q3	1960Q1-2011Q4
Greece	1977Q1-2011Q1	1962Q1-2011Q4	1998Q2-2011Q3	1963Q1-2010Q4
Iceland	1997Q1-2011Q4	1998Q1-2011Q3	1980Q1-2011Q4	1990Q1-2011Q3
Ireland	1997Q1-2011Q4	1960Q1-2011Q3	1982Q1-2011Q4	1968Q1-2011Q4
Israel	1968Q1-2011Q4	1960Q1-2011Q4	1992Q1-2011Q3	1995Q1-2011Q4
Italy	1980Q1-2011Q3	1960Q1-2011Q4	1960Q1-2011Q3	1990Q1-2011Q4
Japan	1960Q1-2011Q3	1960Q1-2011Q4	1960Q1-2011Q4	1970Q1-2011Q2
Mexico	1980Q1-2011Q3	1960Q1-2011Q4	1987Q1-2011Q4	1986Q1-2011Q4
Netherlands	1977Q1-2011Q3	1960Q1-2011Q4	1970Q1-2011Q4	1960Q2-2011Q4
New Zealand	1982Q2-2011Q3	1977Q2-2011Q3	1986Q1-2011Q4	1963Q1-2011Q4
Norway	1966Q1-2011Q4	1960Q1-2011Q4	1972Q1-2011Q3	1960Q1-2011Q4
Portugal	1977Q1-2011Q3	1960Q1-2011Q4	1983Q1-2011Q4	1990Q1-2011Q4
Russia	1995Q1-2011Q3	1993Q1-2011Q4	1992Q4-2011Q4	1995Q1-2011Q4
S. Korea	1960Q1-2011Q3	1960Q1-2011Q4	1989Q1-2011Q4	1990Q1-2011Q4
South Africa	1960Q1-2011Q3	1963Q1-2011Q4	2000Q1-2011Q3	1977Q1-2011Q4
Spain	1970Q1-2011Q3	1961Q1-2011Q4	1972Q4-2011Q4	1995Q1-2011Q3
Sweden	1969Q1-2011Q3	1960Q1-2011Q4	1970Q1-2011Q4	1960Q1-2011Q4
Switzerland	1965Q1-2011Q3	1960Q1-2011Q4	1970Q1-2011Q4	2002Q1-2011Q3
Turkey	1987Q1-2011Q3	1989Q1-2011Q3	2000Q1-2011Q4	--
United States	1960Q1-2011Q4	1960Q1-2011Q4	1960Q1-2011Q4	1960Q1-2011Q4

Sources: Data on real GDP, industrial production indices and unemployment rates all from the International Monetary Fund's International Financial Statistics database. Retail sales index from OECD.

Table A2

COUNTRY-SPECIFIC BUSINESS CYCLE CHRONOLOGIES*

Argentina		Australia		Austria		Belgium	
1989q4-2011q4		1960q1-2011q4		1960q1-2011q4		1960q1-2011q4	
Peak	**Trough**	**Peak**	**Trough**	**Peak**	**Trough**	**Peak**	**Trough**
1994q3	1995q3	1960q3	1961q2	1961q3	1963q1	1960q1	1961q1
1998q2	1999q2	1965q3	1966q1	1964q4	1965q2	1965q4	1966q2
1999q4	2000q3	1971q3	1972q1	1966q1	1967q3	1974q2	1975q2
2001q1	2002q1	1974q2	1975q4	1974q3	1975q2	1977q1	1978q1
2008q3	2009q2	1976q2	1976q4	1977q4	1978q2	1980q1	1980q4
		1977q2	1978q1	1980q4	1981q2	1982q1	1983q2
		1980q1	1980q2	1982q1	1982q3	1992q1	1993q4
		1981q2	1983q2	1983q4	1984q2	2001q1	2001q4
		1990q4	1991q2	1986q2	1986q4	2003q1	2003q3
		1996q1	1996q4	1992q2	1993q2	2008q2	2009q1
		2008q2	2008q3	2001q1	2001q3		
				2003q1	2003q3		
				2008q2	2009q2		

Brazil		Canada		Chile		Czech Republic	
1975q1-2011q4		1960q1-2011q4		1960q1-2011q4		1990q1-2011q4	
Peak	**Trough**	**Peak**	**Trough**	**Peak**	**Trough**	**Peak**	**Trough**
1980q3	1980q4	1979q3	1980q2	1960q1	1960q3	1990q4	1992q1
1982q4	1983q1	1981q2	1982q4	1966q3	1969q1	1992q3	1993q1
1987q1	1987q3	1989q3	1991q1	1970q2	1970q4	1996q4	1998q4
1988q2	1988q4	2008q3	2009q2	1971q4	1973q2	2003q3	2004q1
1989q4	1990q2			1974q1	1975q3	2008q3	2009q2
1991q3	1992q3			1981q1	1982q4		
1995q1	1995q3			1984q2	1985q1		
1997q3	1999q1			1990q1	1991q1		
2001q1	2001q3			1998q1	1999q1		
2003q1	2003q2			2000q1	2000q3		
2008q3	2009q1			2002q4	2003q3		
				2008q2	2009q3		

*As determined by the Bry-Boschan algorithm and the procedure described in Section I.

Table A2 continued

Denmark		Finland		France		Greece	
1960q1-2011q4		1960q1-2011q4		1960q1-2011q4		1962q1-2011q4	
Peak	**Trough**	**Peak**	**Trough**	**Peak**	**Trough**	**Peak**	**Trough**
1962q3	1963q1	1966q4	1967q2	1966q3	1968q2	1973q3	1974q3
1970q4	1971q2	1967q4	1968q2	1969q4	1972q3	1980q1	1980q4
1973q3	1975q1	1975q1	1975q4	1974q2	1975q2	1981q3	1983q1
1976q2	1976q3	1976q2	1977q3	1977q1	1977q3	1984q3	1985q1
1977q3	1977q4	1981q3	1981q4	1979q3	1980q4	1985q4	1987q2
1979q4	1981q1	1990q1	1993q3	1991q4	1993q1	1989q4	1990q3
1986q3	1987q1	2008q1	2009q3	1995q3	1996q3	1991q3	1993q1
1987q4	1989q3			2008q1	2009q1	2008q2	2011q4
1992q1	1993q2						
1995q1	1995q3						
2008q2	2009q4						
2011q2	2011q4						

Germany		Great Britain		Iceland		Ireland	
1960q1-2011q4		1960q1-2011q4		1980q1-2011q4		1960q1-2011q4	
Peak	**Trough**	**Peak**	**Trough**	**Peak**	**Trough**	**Peak**	**Trough**
1960q4	1961q2	1965q1	1966q4	1981q3	1984q1	1965q1	1966q2
1966q3	1967q2	1969q2	1969q4	1987q3	1989q4	1974q1	1975q1
1973q4	1975q2	1973q4	1975q3	2000q3	2001q1	1980q1	1980q3
1980q1	1982q3	1977q1	1977q2	2001q4	2003q1	1981q3	1982q1
1986q4	1987q1	1979q2	1981q1	2007q4	2010q1	1987q4	1988q1
1991q1	1993q2	1990q2	1991q3			1990q3	1991q2
1995q2	1996q1	2008q1	2009q2			1992q3	1993q1
2001q1	2002q1					2002q2	2002q4
2002q3	2003q2					2007q3	2009q4
2008q3	2009q2						

Table A2 continued

Israel		Italy		Japan		Mexico	
1960q1-2011q4		1960q1-2011q4		1960q1-2011q4		1960q1-2011q4	
Peak	**Trough**	**Peak**	**Trough**	**Peak**	**Trough**	**Peak**	**Trough**
1966q1	1967q2	1964q1	1964q3	1962q3	1962q4	1962q1	1962q3
1976q2	1977q4	1974q2	1975q3	1964q4	1965q2	1969q2	1969q3
1988q2	1989q2	1976q4	1977q3	1973q4	1975q1	1970q2	1970q4
2001q2	2001q4	1978q4	1979q2	1985q4	1986q2	1981q4	1983q3
2002q2	2003q1	1981q1	1983q2	1992q1	1993q3	1985q3	1986q4
2008q2	2009q1	1984q3	1985q1	1997q1	1999q1	1992q4	1993q3
		1992q1	1993q3	2001q1	2001q4	1994q3	1995q3
		1996q3	1996q4	2008q1	2009q1	2000q3	2001q4
		2001q1	2001q3	2010q3	2011q2	2006q2	2006q3
		2002q3	2003q2			2008q2	2009q2
		2007q3	2009q2				

Netherlands		New Zealand		Norway		Portugal	
1960q1-2011q4		1963q1-2011q4		1960q1-2011q4		1960q1-2011q4	
Peak	**Trough**	**Peak**	**Trough**	**Peak**	**Trough**	**Peak**	**Trough**
	1960q1	1966q3	1967q3	1960q1	1967q4	1966q2	1967q1
1980q1	1982q4	1970q2	1971q4	1980q2	1980q3	1970q2	1971q1
1992q1	1993q2	1974q3	1975q1	1981q4	1982q3	1974q1	1975q3
2001q3	2002q1	1975q4	1976q3	1988q1	1988q4	1983q1	1983q3
2003q1	2003q2	1982q2	1983q1	2003q1	2003q3	1992q2	1994q1
2008q2	2009q2	1984q4	1986q1	2008q2	2009q2	2002q3	2003q1
2011q2	2011q4	1986q3	1988q2	2009q4	2010q2	2008q1	2009q2
		1989q2	1990q2			2011q1	2011q4
		1990q4	1991q3				
		1992q2	1992q3				
		1997q2	1998q2				
		2007q4	2009q1				

Table A2 continued

Russia		South Africa		South Korea		Spain	
1992q4-2011q4		1960q1-2011q4		1960q1-2011q4		1961q1-2011q4	
Peak	**Trough**	**Peak**	**Trough**	**Peak**	**Trough**	**Peak**	**Trough**
1997q4	1998q3	1976q3	1977q3	1980q1	1980q2	1974q4	1975q2
2008q3	2009q2	1981q4	1983q1	1997q3	1998q2	1980q4	1981q2
		1984q2	1986q1	2008q1	2009q1	1991q4	1993q2
		1986q3	1986q4			2007q3	2009q4
		1989q3	1989q4			2011q1	2011q4
		1990q3	1993q2				
		1997q4	1999q2				
		2002q2	2002q4				
		2008q2	2009q2				

Sweden		Switzerland		Turkey		United States	
1960q1-2011q4		1960q1-2011q4		1980q1-2011q4		1960q1-2011q4	
Peak	**Trough**	**Peak**	**Trough**	**Peak**	**Trough**	**Peak**	**Trough**
1966q1	1966q3	1960q1	1964q4	1988q1	1988q4	1966q4	1967q1
1976q3	1978q2	1967q2	1967q3	1993q4	1994q2	1969q3	1970q1
1980q1	1981q3	1974q2	1976q1	1998q3	1999q2	1973q4	1975q1
1982q1	1982q4	1978q2	1979q1	2000q3	2001q3	1980q1	1980q3
1990q4	1992q4	1981q1	1982q4	2004q4	2005q1	1981q3	1982q3
1995q3	1996q1	1986q3	1987q1	2008q1	2009q1	1990q2	1991q1
2008q1	2009q2	1990q1	1993q2	2011q2	2011q3	2000q4	2001q3
		1996q2	1997q2			2007q4	2009q2
		1998q1	1998q4				
		2001q1	2002q1				
		2008q2	2009q2				

Source: Author calculations.

APPENDIX II

Bilateral measures of trade intensity follow Frankel and Rose (1998) and Baxter and Kouparitsas (2005). Specifically, bilateral trade data is collected from the Correlates of War database.[1] With the data, two different measures of trade intensity are produced for each country-pair. The first measures the intensity of bilateral trade of the two countries relative to the total amount that those two countries trade, while the second measures the intensity of bilateral trade for two countries relative to their national outputs. Specifically,

$$Trade/total\ trade_{ij} = (EX_{ij} + EX_{ji})/(EX_i + IM_i + EX_j + IM_j)$$

$$Trade/GDP_{ij} = (EX_{ij} + EX_{ji})/(NGDP_i + NGDP_j)$$

Measuring financial connections bilaterally is more difficult. The data of Lane and Milesi-Ferretti (2007) do not contain bilateral holdings of financial asset, only aggregate assets and liabilities by asset type for a large group of countries. However, proxies for bilateral holdings can be constructed by following Imbs (2004):

$$BF_{ij}^{total} = \left| \frac{NFA_i^{total}}{NGDP_i} - \frac{NFA_j^{total}}{NGDP_j} \right|$$

$$BF_{ij}^{equity} = \left| \frac{NFA_i^{equity}}{NGDP_i} - \frac{NFA_j^{equity}}{NGDP_j} \right|$$

$$BF_{ij}^{debt} = \left| \frac{NFA_i^{debt}}{NGDP_i} - \frac{NFA_j^{debt}}{NGDP_j} \right|$$

$$BF_{ij}^{fdi} = \left| \frac{NFA_i^{fdi}}{NGDP_i} - \frac{NFA_j^{fdi}}{NGDP_j} \right|$$

All proxies for bilateral trade and financial holdings are expressed in logs within the regressions.

Two different sets of fixed-effects are used. One set of fixed effects control for decade-specific effects that may not be captured by the gravity equation instruments. The other set of fixed effects control for both period-specific and country-pair-specific effects not captured by the gravity equation instruments.

[1]See: *http://correlates ofwar.org/COW2%20Data/Trade/Trade.html.*

ENDNOTES

[1]See the spreadsheet found at *http://nber.org/cycles/recessions.html.*

[2]For example, with four variables there are six different pairs: GDP-employment, GDP-industrial production, GDP-retail sales, employment-industrial production, employment-retail sales and industrial production-retail sales. Suppose that GDP, employment and industrial production all indicate recession, whereas retail sales do not. Among all six pairs, three have both variables indicating a recession so that the wiring ratio equals 0.50. In general, if n_t denotes the number of available indicators at date t, and k_t denotes the number of indicators that signal recession at time t, then the wiring ratio is calculated as: $w_t = \frac{k_t(k_t-1)}{n_t(n_t-1)}$.

[3]Assuming that the two events are independent means that the probability of both countries being in recession at any given point in time is $0.2 \times 0.2 = 0.04$ and the probability of both being in an expansion is $0.8 \times 0.8 = 0.64$. Then the probability of either both being in recession or both being in expansion is 0.64 + 0.04 = 0.68, or 68 percent.

[4]The values for the index are normalized so that the density is well defined, i.e., that it integrates to one.

[5]A Kolmogorov-Smirnov test statistic rejects the null hypothesis that the densities are the same at standard confidence intervals.

[6]Frankel and Rose (1998) were the first to test for these effects. They found that trade tends to increase the synchronicity of business cycles. A relatively large empirical literature has confirmed these findings. Baxter and Kouparitsas (2005) consider a large number of potential explanations for bilateral business cycle correlations and find that trade is the most robust explanatory variable. Rose and Engel (2002) study the impact of currency unions on synchronization. Imbs (2004, 2006) studies many links that may effect business cycle synchronization, including trade, specialization and financial integration. Finally, Claessens, Kose and Terrones (2011) study the interaction between financial cycles and business cycles. They find that recessions that correspond with financial downturns tend to be deeper and longer lasting than business cycle downturns that do not.

[7]The gravity model of international trade explains bilateral trade as a function of country characteristics. See Anderson and van Wincoop (2003). Feenstra and Taylor (2008) provide textbook discussions of the gravity model. The specific variables used as instruments include country size (log of the sum of the two countries' GDP) and the distance between capital cities. In addition, several dummy variables are included: do the countries share a common border? Do they share a common language? Do they have a regional trade agreement? Is the country land-locked? Is the country an island?

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