CHAPTER 1

International Macroeconomic Comovement: The Role of Globalization in Goods and Asset Markets

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1. Introduction

The US Great Recession of 2007–2009 has been dubbed as the first truly “global recession” of recent times, in that the severe economic downturn starting in the US coincided with downturns in many other countries. As the world struggles to recover from the global recession, this is an opportune time to reflect on the nature and mechanisms of *International Macroeconomic Interdependence*. This episode provides new evidence, as well as new urgency, regarding a set of questions long debated in the macroeconomics literature. To what degree do national economies move together in their cycles of recession and recovery? Does the trend of greater international integration in goods and asset markets provide greater opportunity for transmission of shocks from one country to another? In terms of policy implications, does greater comovement imply greater benefit from countries coordinating together with their domestic macroeconomic policies?

This chapter brings to bear updated empirical evidence and novel model simulations to provide a new perspective on these fundamental questions.

Data indicate that the Great Recession was truly an unusual episode. Prior to it, business cycle comovement between the US and its major trading partners was moderately positive but far from perfect. During the Great Recession, the correlation of national gross domestic product (GDP) fluctuations was nearly complete, with recessions experienced by all the major trading partners. However, this does not appear to be a new norm, as the US recovery from the recession was not experienced universally, and the correlation of national GDP levels subsequently moved to low levels.

Can this episode of high international comovement be attributed to trends of globalization in goods and asset markets? I do document a long-run trend of rising integration, which appears to have accelerated in the decade prior to the crisis, both in terms of goods trade and asset trade. Both types of trade reversed trend and dropped significantly during the Great Recession, and even though both have since recovered their previous levels, the trends of rapid growth in both goods and asset trade of the pre-crisis period have not returned. To focus on how goods and asset trade affect business cycle comovement, rather than the reversed direction of causality, we look at the cross sectional experience of the US main trading partners in the year prior to the crisis, and see how this related to the varying degrees of GDP comovement with the US among these countries. One finds suggestive evidence that greater integration in both goods and asset markets promoted greater business cycle comovement during the particular episode of the Great Recession.

To understand better the mechanisms by which goods and asset trade can transmit shocks across countries, I construct a simple dynamic stochastic general equilibrium model with two countries, two goods, and two assets. Two countries are needed as a minimum, of course, to study transmission across a border. Two goods are needed if one wants to consider integration in goods markets separately from asset markets, so that a country trades one good for another good under the condition of balanced trade. Finally, two internationally tradable assets are needed to consider the hypothetical case of international integration in asset markets, where there is no trade in goods, but only trade of one asset exchanged for another asset. I believe this is the first paper of to study separate goods and asset market integration in this manner.

Stochastic simulations of the model indicate that the greatest transmission occurs when both goods and asset integration are operative, so that a

country may trade assets to finance a level of expenditure on goods different from domestic production. Financing of a trade imbalance thus allows for a large effect on the level of domestic demand for foreign goods, and hence induces the greatest spillover to the level of foreign production. This transmission typically takes place through changes in the world interest rate, which has direct effects on foreign consumption, investment, and production decisions. Transmission via the goods market alone, in isolation from asset market trade, can also be fairly large, but the transmission there takes place largely via the terms of trade, the relative price of the two country's export goods. Changes in the relative value of foreign exports also affects the consumption and production decision in the foreign country. Finally, we find that integration in asset markets alone, in isolation from goods trade, does not provide a transmission channel for the usual supply or demand shocks, but can provide a potent transmission channel for shocks hitting the financial market of one of the countries. This last result may offer insight into the mechanisms by which the financial crisis in the Great Recession in the US could be transmitted so strongly to other countries.

The model also makes clear that, even while greater international market integration can strengthen spillovers of shocks, these spillovers can make foreign output either move the same direction as home output or in the opposite direction. The sign of the spillovers depends on the shocks involved and the structure of the economies. In general, comovement will be positive in the case of demand shocks like government spending, or in a case where home and foreign goods are viewed by demanders as more complementary.

This chapter contributes to a large body of research on international business cycle comovement. Backus, Kehoe, and Kydland (1992) first showed that comovement can be negative in theory, using a simple one good business cycle model. This chapter differs in modeling the asset trade explicitly, rather than assuming complete asset markets operating in the background, so as to be able to track the asset trades that underlie shock transmission. I also extend the analysis to study the possibility of asset trade in isolation of goods trade. Early theoretical work actually had difficulty demonstrating a strong linkage between trade and positive business cycle comovement (see Kose and Yi, 2006). Burstein, Kurz, and Tesar (2008) showed that international trade linkages can promote positive output comovement, depending on the complementarity of home and foreign goods. But they interpret their comovement in terms of production rather

than consumption, and again, they do not consider the separate role of asset market integration.¹

There is also mixed evidence regarding the relationship between financial integration and business cycle comovement. Among limited empirical evidence, some work has found financial market integration can either promote positive comovement (see Kose, Prasad, and Terrones, 2004), and other work finds negative comovement (see Kalemli-Ozcan, Papaioannou, and Peydró, 2013). In theoretical work, Heathcote and Perri (2002) find that a business cycle model with financial autarky does a better job matching certain features of the data than a model with complete asset markets. Recent business cycle research has focused on shocks to the financial market that can generate recession, which one might think is particularly relevant to the Great Recession. Perri and Quadrini (2016) find that in this context financial integration can potentially contribute to positive output comovement. One paper that focuses on the Great Recession episode is Imbs (2010), which finds empirical evidence that asset market integration promotes output comovement during this particular event. We differ, among other things, in that our more updated data covers both the recession period and the recovery afterward, which gives a very different perspective, as will be explained below.²

The next section of this paper presents empirical methodology and stylized facts regarding international output comovement. Section 3 constructs a novel theoretical framework, and Section 4 presents simulation results. Section 5 concludes, and summarizes the contribution of the other chapters in this volume to the constellation of questions raised in this chapter.

2. Empirical Motivation

This section will document several empirical regularities regarding international comovement in real GDP. Data come from the International Financial Statistics collected by the International Monetary Fund. As standard in

¹Recent research has extended the logic of Burstein, Kurz, and Tesar (2008) to model internationalized production more explicitly in terms of offshoring (see Zlate, 2016; and Arkolakis and Ramanarayanan, 2009).

²This allows me to use GDP data, which is more comprehensive than the industrial production data Imbs needed to use due to its higher reporting frequency and his short sample.

business cycle research, data are quarterly and HP-filtered to remove long run trends. Countries were chosen because they are the ten largest trading partners of the US, excluding India due to lack of data availability. In sum, the list consists of the G-7 countries plus three emerging markets, Mexico, China, and Korea.

Table 1 lists the correlation of each country's GDP with the US for the sample period 1980:1–2016:3, along with the standard deviation of that country's GDP. Note that all correlations are positive, indicating positive comovement in the business cycles of these countries with the US on average. But the value of comovement varies widely by country, with Canada the most correlated with the US, and Korea the lowest.

Comovement also varies over time. Figure 1 reports correlations computed over a five-year rolling window. Two averages are plotted, one for the G-7 countries and the other for the three emerging markets. While correlation with the US generally is positive, there are periods of negative correlation, notably during the middle of the sample in the 1990s. This seems to belie the perception of a growing trend of globalization, in which the world's economies are becoming ever more integrated. A singular event, however, is immediately obvious toward the end of the sample. The US Great Recession of 2007–2009 appears to have been mirrored in downturns in all of the trading partners. This is reflected in a near perfect correlation

Table 1. Real GDP moments

	Standard deviation	Correlation with US
US	0.94	—
Canada	1.03	0.79
France	0.82	0.58
Germany	1.53	0.33
Italy	1.16	0.53
Japan	1.27	0.50
UK	1.07	0.71
China	1.03	0.79
Mexico	1.66	0.57
Korea	1.10	0.18

Source: International Financial Statistics, IMF. Quarterly real GDP, 1980:1–2016:3. Seasonally adjusted, logged and HP-filtered.

Figure 1. Correlation of GDP with US in rolling five-year window

Note: Solid line represents average among G-7 countries (excluding US), which includes Canada, France, Germany, Italy, Japan, and United Kingdom. Dashed line represents average among emerging markets countries in our sample, which includes China, Korea, and Mexico.

Source: International Financial Statistics, IMF. Quarterly real GDP, 1980:1–2016:3. Seasonally adjusted, logged and HP-filtered.

in GDP movements during this sample window. Correlations appear to be high both in developed and emerging market trading partners of the US. While the correlation in the early part of the crisis was somewhat lower than that in the G-7, we do not see strong evidence of the “decoupling” hypothesis of Kose, Otrok, and Prasad (2012), in which recessions in developed economies have smaller spillovers to emerging markets than in past decades. Nonetheless, the very high international correlation during the Great Recession appears to have been a one-off event, rather than indicating a new status quo of increased globalization and comovement, as in the aftermath of the Great Recession the correlations fall to near zero. This reflects recovery in the US, while there was new weakness in the economies of Europe and other trading partners.

Whether one takes the extremely high correlation of GDPs during the Great Recession as evidence of international integration, one readily can point to other indicators. While later chapters in this volume will discuss various ways of measuring goods market integration in terms of international convergence of prices, one crude but simple way to gauge integration is in terms of goods flows. Figure 2 plots trade volume (exports plus

Figure 2. US goods trade volume (exports plus imports) as a share of US GDP

Source: Comtrade.

imports) of the US as a share of GDP. Data are taken from Comtrade from the United Nations. One observes a steady rise in trade share in the first half of the sample, with a rapid rise in the early 2000s. This often is taken as indication of progressive integration of the goods markets among countries. But one notes a sudden drop-off during the Great Recession, indicating that as real GDP fell in the period, trade volume fell even more rapidly. This “trade collapse” often is attributed to the fact that a disproportionate share of trade consists of durable and investment goods, which comprise a particularly volatile component of GDP (see Alessandria, Kaboski, and Midrigan, 2010; Engel and Wang, 2011; Eaton *et al.*, 2016). What is less well understood is the fact that in the aftermath of the Great Recession, while trade volume recovered to its pre-recession level, the rapid rate of growth in trade did not resume.

Asset markets also show signs of growing international integration. Figure 3 plots the volume of US cross-border trade in portfolio investment assets. Data come from the Coordinated Portfolio Investment Survey (CPIS) of the International Monetary Fund (IMF), for which data begin in 2001. As with goods trade, one observes a rapid rise in the first decade of the 2000s, and a sudden drop-off during the Great Recession. The level of asset trade recovered afterward, but again showed a slower rate of growth.

It has been conjectured that the progression toward greater international integration in both goods and asset markets provides channels of cross-border transmission of shocks, hence engendering greater macroeconomic

Figure 3. US bilateral portfolio investment with the world (mill. \$)

Source: Coordinated Investment Portfolio Survey, IMF. Quarterly real GDP, 1980:1–2016:3.

Figure 4. Bilateral GDP correlation with US in 2009 plotted against bilateral trade volume with US in 2006 as a share of country's GDP

interdependence. As measured by correlations in Fig. 1, we see that the one period of significantly higher international comovement was during the Great Recession. We here briefly use this episode to investigate if there is any relationship between GDP comovement and the degree of integration in asset or goods markets, using the cross-sectional variation among the nine countries. Given the small sample, we do not conduct formal econometric analysis, but present some simple plots.

Figure 4 plots a measure of GDP correlation against a measure of trade integration. For the vertical axis, I use the correlation of GDP with the US

computed over the five-year window centered on 2009:1 for each of the nine countries. For the horizontal axis, I compute the volume of bilateral trade with the US in 2006 as a share of that country's GDP. Trade from a year prior to the onset of the crisis is used, in order to reduce problems of endogeneity. Recall that countries experienced a significant drop-off in trade volume with the US, ostensibly resulting from the onset of the Great Recession starting in 2007. I measure bilateral trade relative to GDP, rather than relative to total trade, in order to gauge not only the bilateral relationship with the US compared to other trading partners, but also the overall importance of trade for GDP in a country. The smattering of points seems to indicate a weak positive correlation between trade volume in 2006 and the correlation of GDPs in 2009. For example, note that the two countries far to the right on the graph with the greatest trade shares, Mexico and Canada, had GDP correlations above the average for the sample.

Similarly, Fig. 5 plots the GDP correlation centered on 2009:1 for each of the nine countries, against the volume of bilateral investment asset trade with the US in 2006 as a share of that country's GDP. Again there is substantial randomness, but one can see some support for a positive relationship, in that the country with the greatest investment trade, the United Kingdom, also happens to be the country with the highest GDP correlation during this period.

Overall, one concludes that there is on average positive comovement in business cycles across countries in our sample, but that this varies greatly

Figure 5. GDP correlation with US in 2009 plotted against bilateral trade volume in investment assets with US in 2006 as a share of country's GDP

over time and by country. The recent Great Recession is a singular episode of positive comovement. Greater integration in goods and asset markets seems to contribute at least somewhat to greater comovement.

3. A Framework to Organize Concepts

To explore the logic of how international trade in goods markets and asset markets can affect the transmission of macroeconomic shocks, I next construct a theoretical model that can be used to simulate relevant scenarios. The model consists of two counties, which is the minimum required to study cross-border transmission. It also features two tradable goods as well as two tradable assets. Again, this is the minimum requirement to study the relevant scenarios of integration in both goods and asset markets, as well as integration in each market alone. For example, to allow integration in goods market only, counties will trade one good for another. And to allow for integration in assets markets only, counties will trade one asset for another. The two goods will be country specific, standard in the business cycle literature. The two assets will be a global noncontingent nominal bond and money. For simplicity, both countries use the same money, that is, they are part of a monetary union. This provides a common numeraire for measuring variables throughout the model. Experiments will focus on two shocks, a standard supply shock in the form of a rise in total factor productivity, and a standard demand sock in the form of a rise in government expenditure.³

3.1. *Households*

Each country is population by a representative household, which derives utility from consumption (C), holding real money balances (M/P), and disutility from labor (L). P is the overall consumption price index. The household derives income by selling labor at the nominal wage rate (W), renting capital (K) to firms at the real rental rate (r), and interest (i) income

³One could also considered introducing a simple financial shock, in the form of an exogenous rise in money demand, but this would have minimal impacts on output in the absence of price rigidities.

on holding nominal bonds (B). Households decide the level of investment (I) in creating new capital each period, subject to a rate of depreciation (δ) and a quadratic adjustment cost (AC). Lump sum taxes fully fund government expenditures (G) each period.

More formally, household optimization for the home country may be written:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t U \left(C_t, L_t, \frac{M_t}{P_t} \right)$$

subject to the budget constraint:

$$P_t(C_t + I_t + G_t) + (M_t - M_{t-1}) + B_t - (1 + i_{t-1})B_{t-1} = W_t L_t + P_t r_t K_{t-1} \quad (1)$$

and law of motion for capital:

$$I_t = (K_t - (1 - \delta)K_{t-1}) + AC_t \quad (2)$$

$$AC_t = \frac{\xi}{2} \frac{(K_t - K_{t-1})^2}{K_{t-1}}, \quad (3)$$

where utility is defined by

$$U_t = \frac{\sigma}{\sigma - 1} C_t^{\frac{\sigma-1}{\sigma}} + \ln \frac{M_t}{P_t} - \frac{1}{1 + \psi} L_t^{1+\psi}.$$

Optimization implies an intertemporal Euler equation:

$$1 = \beta(1 + i_t)E_t \left[\frac{P_t C_t^{\frac{1}{\sigma}}}{P_{t+1} C_{t+1}^{\frac{1}{\sigma}}} \right] \quad (4)$$

which indicates that households try to smooth marginal utility of consumption across time periods, unless a high interest rate convinces them to raise saving and postpone consumption to the future. For reference, we can define rr as a home-country *ex-ante* real interest rate, adjusting the nominal

rate for expected inflation:

$$1 + rr_t = (1 + i_t)E_t \left[\frac{P_t}{P_{t+1}} \right].$$

Optimization also implies a labor-supply condition:

$$W_t = P_t C_t^{\frac{1}{\sigma}} L_t^{\psi} \quad (5)$$

which indicates that households equate the benefit of working more, in terms of marginal utility of extra consumption, to the marginal disutility of working.

A money demand condition:

$$M_t = P_t C_t^{\frac{1}{\sigma}} \left(\frac{1 + i_t}{i_t} \right) \quad (6)$$

indicates that households wish to hold more real money balances when consumption is high or the nominal interest rate is low.

An optimal capital accumulation decision:

$$\begin{aligned} & \left(1 + \frac{\xi(K_t - K_{t-1})}{K_{t-1}} \right) \\ &= \beta E_t \left[\frac{P_t C_t^{\frac{1}{\sigma}}}{P_{t+1} C_{t+1}^{\frac{1}{\sigma}}} \left(r_t + (1 - \delta) + \left(\frac{1}{2} \xi \frac{K_{t+1}^2 - K_t^2}{K_t^2} \right) \right) \right] \quad (7) \end{aligned}$$

indicates that households equate the benefit of more capital, in terms of the marginal utility of higher rental income less depreciation and lower future adjustment cost, to the cost of investment, including the current adjustment cost.

The foreign household has an analogous problem and optimality conditions.

3.2. Firms

Firms are perfectly competitive price takers. They hire labor and rent capital as inputs in production, with a multiplicative technology term (A) subject

to exogenous shocks:

$$Y_t = A_t K_{t-1}^\theta L_t^{1-\theta}. \quad (8)$$

The objective of the firm is to maximize profits,

$$\pi_t(h) = P_H Y - W_t L_t - r_t K_{t-1},$$

where P_H is the producer price of home goods. This implies factor demands:

$$W_t = P_{H,t} (1 - \theta) A_t K_{t-1}^\theta L_t^{-\theta} \quad (9)$$

$$r_t = P_{H,t} \theta A_t K_{t-1}^{\theta-1} L_t^{1-\theta}, \quad (10)$$

where firms hire workers and rent capital up to the point that the marginal cost of the factor equals the value of the marginal product of hiring an extra unit in terms of extra revenue from selling the additional output.

Foreign firm have an analogous problem and optimality conditions.

3.3. Goods market structure

Each of the components of final demand $D = \{C, I, G\}$ is an aggregate of the good produced in the home country and the good produced in the foreign country, with elasticity between home and foreign goods aggregates (ϕ), and a share ν indicating home bias:

$$D_t = \left(\nu^{\frac{1}{\phi}} (D_{H,t})^{\frac{\phi-1}{\phi}} + (1 - \nu)^{\frac{1}{\phi}} (D_{F,t})^{\frac{\phi-1}{\phi}} \right)^{\frac{\phi}{\phi-1}}. \quad (11)$$

The corresponding price index is

$$P_t = \left(\nu (P_{H,t})^{1-\phi} + (1 - \nu) (P_{F,t})^{1-\phi} \right)^{\frac{1}{1-\phi}}, \quad (12)$$

where P_F is the price of the imported foreign good. These definitions imply demand for a good that falls as its price relative to the average rises:

$$D_{H,t}/D_t = \nu (P_{H,t}/P_t)^{-\phi} \quad (13)$$

$$D_{F,t}/D_t = (1 - \nu) (P_{F,t}/P_t)^{-\phi}. \quad (14)$$

For reference, define net exports as

$$NX_t = P_{H,t} (C_{H,t}^* + I_{H,t}^* + G_{H,t}^*) - P_{F,t} (C_{F,t} + I_{F,t} + G_{F,t}), \quad (15)$$

where * indicates foreign country variables.

3.4. Market clearing and shock processes

Market clearing for the home goods market requires

$$C_{H,t} + C_{H,t}^* + I_{H,t} + I_{H,t}^* + G_{H,t} + G_{H,t}^* = Y_t, \quad (16)$$

and for the home bond market:

$$B_t + B_t^* = 0. \quad (17)$$

The world supply of money is assumed constant and normalized:

$$M_t + M_t^* = 1. \quad (18)$$

The home balance of payments condition may be derived by combining the budget constraint of the home household and firms, with goods market clearing conditions:

$$NX_t + i_{t-1}B_{t-1} = (B_t - B_{t-1}) + (M_t - M_{t-1}). \quad (19)$$

This indicates that a country can finance a current account, which is the sum of net exports with asset income, by trading assets in the international asset market.

The shocks, to technology and government expenditure, will be log-normally distributed:

$$\begin{aligned} (\log A_t - \log \bar{A}) &= \rho_A(\log \theta_{t-1} - \log \bar{A}) + \varepsilon_{At} \\ (\log A_t^* - \log \bar{A}^*) &= \rho_A^*(\log \theta_{t-1}^* - \log \bar{A}^*) + \varepsilon_{At}^* \\ (\log G_t - \log \bar{G}) &= \rho_G(\log G_{t-1} - \log \bar{G}) + \varepsilon_{Gt} \\ (\log G_t^* - \log \bar{G}^*) &= \rho_G^*(\log G_{t-1}^* - \log \bar{G}^*) + \varepsilon_{Gt}^* \\ [\varepsilon_{At}, \varepsilon_{At}^*, \varepsilon_{Gt}, \varepsilon_{Gt}^*] &\sim N(0, \Sigma). \end{aligned}$$

3.5. Simulation setup

See Table 2 for values of parameters, generally taken from the business cycle literature. In particular, the intertemporal elasticity is set at $\sigma = 0.5$, and the intratemporal elasticity at $\phi = 1.5$, both values from Backus, Kehoe, and Kydland (1992). Shock processes are specified so there is no contemporaneous correlation across countries, or exogenous lagged spillovers. This specification is chosen simply to focus on the endogenous international transmission via goods and asset markets.

Table 2. Benchmark parameter values

Preferences	
Intertemporal elasticity	$\sigma = 0.5$
Elasticity of intratemporal substitution	$\phi = 1.5$
Time preference	$\beta = 0.99$
Labor-supply elasticity	$\psi = 0.5$
Home bias share	$\nu = 0.8$
Technology	
Capital share	$\theta = 0.3$
Investment adjustment cost	$\xi = 0.1$
Depreciation rate	$\delta = 0.025$
Shocks:	
$\rho_A = \rho_A^* = \rho_G = \rho_G^* = 0.9$	
$\sigma_A = \sigma_A^* = \sigma_G = \sigma_G^* = 0.00852$	

As is standard, the model is linearized around a determinist steady state, then simulated under a sequence of random draws from the shock processes. The artificial data thus generated are then HP-filtered and used to compute moments such as standard deviations and correlations.

4. Simulation Results

A series of simulations are conducted to investigate the international transmission of shocks. Special attention will be focused on the roles that international integration in goods and asset markets play, separately and in combination. The key lessons to emerge are as follows. First, it is not inevitable that international integration promotes greater positive comovement in the recessions of countries, since greater integration can lead to either positive or negative spillovers to a foreign country, depending on the type of shock and the characteristics of the economy. Second, both goods market and asset market integration contribute to international transmission, with asset markets tending to work primarily through the interest rate and goods market integration through the terms of trade. Goods market integration, on its own, can generate substantial international transmission of shocks, even in the absence of asset trade. Integration in asset markets alone, in isolation from goods trade, does not provide a transmission channel for the usual supply or demand shocks, but can provide a potent

transmission channel for other types of shocks hitting the financial market of one of the countries.

4.1. *Integration in both goods and asset markets*

The first experiment considers productivity shocks in the benchmark model with both trade in goods and assets. Column (1) of Table 3 shows that the correlation of home and foreign GDP is negative, suggesting negative business cycle comovement. The negative cross-country correlation applies also to employment and investment, but not to consumption. Intuition can be gained from impulse responses to a shock raising home productivity 1%, reported in Fig. 6. The largest response is in investment, with a large rise at home and large fall abroad. We also see a rise in home output on impact and a negative movement in foreign output that is two orders of magnitude smaller. The fall in foreign output results from the fall in foreign labor inputs, and is compounded in later periods by the fall in capital inputs due to low investment. The shift in investment expenditure away from foreign toward home is reflected in a home trade deficit.

The logic is similar to that in Backus, Kehoe, and Kydland (1992), although our model tracks explicitly the asset trade, in terms of non-contingent one period bonds, rather than assuming a complete set of state-contingent securities operating in the background. The rise in home marginal product of capital raises the benefit of owning capital and stimulates significant investment. This rise in the demand for goods for investment expenditure beyond the rise in goods supply raises the real interest rate in both countries. This rise in interest rate enters the capital accumulation equation of the foreign country, discouraging investment abroad. The home country finances its additional investment expenditure by selling bonds to foreign, which finances a home trade deficit during the initial period of investment. In later periods, as the investment demand returns to normal, world demand falls below the supply of goods, and the trade deficit reverses to a surplus. This surplus is used to pay the interest on the bonds that have been accumulated by the foreign households. The drop in foreign labor input observed in Fig. 6 results in large part from the fact that foreign consumption rises along with home consumption, not shown in the figure, due to the improving foreign terms of trade. A rise in consumption induces a desire for more leisure, and in the absence of a

Table 3. Business cycle moments from model simulations

	Both goods and asset trade			Only goods trade			Only asset trade		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Productivity shock, benchmark parameters	Productivity shock, alternate parameters	Government spending shock	Productivity shock, benchmark parameters	Productivity shock, alternate parameters	Government spending shock	Productivity shock, benchmark parameters	Government spending shock	Financial shock
Standard deviations:									
Output	0.0130	0.0132	0.0041	0.0125	0.0117	0.0048	0.0126	0.0052	0.0016
Employment	0.0028	0.0032	0.0059	0.0023	0.0035	0.0069	0.0026	0.0073	0.0023
Consumption	0.0027	0.0046	0.0062	0.0028	0.0036	0.0080	0.0032	0.0082	0.0002
Investment	0.0605	0.0557	0.0538	0.0445	0.0469	0.0729	0.0501	0.0681	0.0071
Net exports	0.0075	0.0129	0.0159	0.0000	0.0000	0.0000	—	—	—
Real interest rate	0.0004	0.0004	0.0003	0.0000	0.0000	0.0000	0.0042	0.0122	0.0005
Terms of trade	0.0070	0.0171	0.0960	0.0097	0.0634	0.0037	—	—	—
Correlations between home and foreign variables:									
Output	−0.0440	0.1107	0.4044	0.0290	0.4127	0.0542	0.0000	0.0000	0.4697
Employment	−0.1096	0.6181	0.3617	0.2429	0.3756	0.0507	0.0000	0.0000	0.4697
Consumption	0.4306	−0.0799	0.5844	0.3095	0.5225	−0.0160	0.0000	0.0000	0.4711
Investment	−0.3139	−0.0282	0.6931	0.2650	0.3728	−0.0795	0.0000	0.0000	0.4694

Figure 6. Impulse response to a positive home productivity shock in benchmark model
Note: Vertical axis is percent deviation ($0.01 = 1\%$) from steady state levels. Horizontal axis is time (in quarters).

productivity shock raising the real wage, results in a fall in the quantity of labor supplied.

In sum, this simulation illustrates the lesson that international integration can transmit a productivity shock negatively via a rise in the real interest rate if the home investment response is large, reducing international comovement rather than raising it. Further we see that this effect involves trade of assets for goods, as observed in the balance of payments condition, as home exports bonds (fall in B_t) in order to finance a net import of goods (fall in NX_t) to use for investment purposes.

We next demonstrate that international integration can generate positive international comovement, depending in certain key characteristics of the goods market. In the benchmark model above, home and foreign goods were assumed to be substitutes for each other, with an elasticity of

intratemporal substitution greater than unity ($\phi = 1.5$). But suppose now instead a case where home and foreign goods are complementary, with an intratemporal elasticity less than unity ($\phi = 0.5$). Change also the elasticity summarizing substitutability across time from a value greater than one in the benchmark case ($\sigma = 0.5$) to a value greater than unity ($\sigma = 1.5$). Importantly, this indicates that agents are more willing to substitute across time than across goods within a period.

Column (2) of Table 3 now shows that the cross-country correlations of output as well as labor are positive, indicating positive international comovement for productivity shocks. This is confirmed in Fig. 7, showing that a positive home productivity shock leads to a positive spillover on foreign output and labor. The fundamental logic is that when home output

Figure 7. Impulse response to a positive home productivity shock in model with alternative parameter values

Note: Vertical axis is percent deviation (0.01 = 1%) from steady state levels. Horizontal axis is time (in quarters).

risers, home goods are more useful in combination with foreign goods, so foreign production must also rise. Incidentally, this case is useful for suggesting a resolution to another puzzle in the international business cycle literature. Data suggest a lower cross-country correlation in consumption levels than for outputs, whereas the benchmark calibration implies the opposite. However, the case with alternative parameter values implies a negative consumption correlation at the same time as a positive output correlation. The logic is that if the home country needs foreign as well as home goods for its rise in investment expenditure, it imports more foreign goods, driving down foreign consumption. This is reflected in a larger home trade deficit than for the benchmark case.

The direction of comovement also depends on the nature of the shock. Column (3) in Table 3 reports moments for simulations involving shocks to government expenditure instead of productivity (for the original parameter settings).⁴ The table shows a marked positive international comovement, with a correlation between home and foreign output of 0.40. Figure 8 shows the effect of a rise in home government expenditure, indicating a rise in output and employment in both countries. This illustrates the idea that, in contrast with supply shocks, demand shocks tend to generate large positive spillovers and substantial cross-country comovement in business cycles.

4.2. *Integration in goods market only*

Next isolate the role of goods market integration in transmitting shocks, by repeating the simulations above, but shutting down international asset trade. This takes the form of specifying that the net bond position of the home country is zero, and that each country has a separate money supply that is held constant and cannot be traded internationally. This also implies that a nominal exchange rate be introduced in the model to convert all foreign prices from foreign money units to home money units. The fact that no asset trade can be used to finance a trade imbalance implies that the balance of payment condition reduces to a requirement that net exports equal zero.

⁴The role of demand shocks in an international business cycle model first was demonstrated by Stockman and Tesar (1995) using taste shocks.

Figure 8. Impulse response to a positive home government expenditure shock

Note: Vertical axis is percent deviation ($0.01 = 1\%$) from steady state levels. Horizontal axis is time (in quarters).

Shutting down the asset market has a significant effect on the transmission of a productivity shock. Column (4) of Table 3 shows that the output correlation switches sign relative to column (1), to become a small positive correlation. It no longer is possible for the home country to finance a large expansion of investment spending by borrowing abroad and forcing the foreign country to cut back on expenditure, since trade is now limited to be balanced period by period. As a result, home investment expenditure rises less than in the case with asset trade, and the foreign counterpart now rises rather than falls. While there is no longer transmission via asset trade and the associated interest rate, transmission is possible via the terms of trade, the relative price of home goods in terms of foreign goods. The rise in supply of home goods makes them relatively cheaper, which lowers the overall price index in the foreign country. This is equivalent to a rise in the real wage, which induces a rise in labor supply, and hence production. These effects are visible in the impulse responses shown in Fig. 9.

Figure 9. Impulse response to a positive home productivity shock, under no asset trade

Note: Vertical axis is percent deviation ($0.01 = 1\%$) from steady state levels. Horizontal axis is time (in quarters).

In the case where home and foreign goods are complements, column (5) of the table show that the cross-country correlation rises even higher in the absence of asset trade than the level in column (2) in the case with asset trade. Impulse responses are qualitatively similar to those in Fig. 7 but with magnified values, and hence are not reported. The terms of trade improvement here is quite strong, leading to a very large fall in foreign price index. Again, this implies a rise in the foreign real wage, leading to a rise in labor supply and production.

Recall that the case of government demand shock, positive transmission relied upon the home country borrowing abroad and raising demand for foreign goods. This channel is shut down in the absence of the asset market. So it is not a surprise that the positive comovement in column (6) is much smaller than in column (3). Impulse responses are generally qualitatively similar to those in Fig. 8, and are not reported here.

4.3. Integration in asset market only

We finally investigate the role of asset market integration on its own, by repeating the simulations above, but shutting down all international goods trade. This takes the form of assuming households have preferences for only their domestic goods and no desire for imported goods, by setting the home bias parameter $\nu = 1$. With no trade in goods, the balance of payments condition indicates that bonds are traded only in exchange for money, that is, an international swap of one asset for another. So again it is not possible to run a trade deficit, because this would imply consumption of imported goods. In this setting neither the home productivity shock nor the government spending shock leads to any spillover to foreign output. Table 3 reports the zero comovement in columns (7) and (8). It appears that asset market integration in the absence of goods market integration does not support international transmission of the real shocks considered so far.

So we now extend the model to consider a financial market shock. Consider a simple example, a money demand shock that takes the form of a multiplication of the utility benefit of money, χ_t . Generalize the utility function to also specify an interest elasticity of money demand, μ :

$$U_t = \frac{\sigma}{\sigma - 1} C_t^{\frac{\sigma-1}{\sigma}} + \frac{\mu}{\mu - 1} \chi_t \left(\frac{M_t}{P_t} \right)^{\frac{\mu-1}{\mu}} - \frac{1}{1 + \psi} L_t^{1+\psi}.$$

This implies a revised money demand condition:

$$M_t = P_t \chi_t^\mu C_t^{\frac{\mu}{\sigma}} \left(\frac{1 + i_t}{i_t} \right)^\mu. \quad (20)$$

Further, in order to give nominal shocks potency over real variables, introduce a nominal rigidity in the form of a labor-supply condition that needs to preset the wage four quarters ahead of time based upon expectations for the future state of the economy.

$$W_t = E_{t-4} \left(P_t C_t^{\frac{1}{\sigma}} L_t^\psi \right). \quad (21)$$

Simulations reported in the last column of Table 3 show substantial positive comovement arising from money demand shocks. Intuition comes from Fig. 10, showing that when the home country experiences a shock raising demand for money balances, it acquires more by exchanging bonds

Figure 10. Impulse response to a positive home money preference shock, under no goods trade

Note: Vertical axis is percent deviation ($0.01 = 1\%$) from steady state levels. Horizontal axis is time (in quarters).

for money with the foreign country. The shock is transmitted abroad in part via the rise in the interest rate, which helps lower foreign money demand and induce the foreign country to give up some of its money holdings to the home country. The shortfall of money supply relative to money demand in each of the countries leads to a drop in price levels. Given the predetermined nominal wages, this implies a rise in real wages in both countries, and hence a fall in labor demand and production. This process is an example where financial integration transmits a financial shock to generate strong international output comovement. While the money preference shock is a particularly simple version of a financial shock, it offers insight into the mechanisms by which the financial crisis in the Great Recession in the US could be transmitted so strongly to other countries.

5. Contributions of Chapters in This Volume

The main message of this study of business cycle comovement is that greater integration in goods and asset markets tends to imply more extensive transmission of business cycle shocks across borders. Globalization makes countries more interdependent in terms of macroeconomic cycles, and this may have implications for the conduct of domestic macroeconomic policies. But the experience of comovement can vary widely over time and among countries, depending on the nature of shocks and the characteristics of the economy. The Great Recession episode in the US is a recent example of how linkages in goods and financial markets can produce a truly global recession.

The chapters of this volume will revisit contributions to the literature addressing the fundamental questions raised above. The first section (Section I) addresses the question of when comovement is positive. Chapters 2 and 3 study the interesting case of Mexico, where US recessions seem to be transmitted with strong amplification. This positive comovement seems to be associated with the rise of offshoring production, and a theoretical model shows how this channel provides particularly potent transmission, whereby the effect of a US shock on Mexican employment in the offshoring sector can actually be larger in magnitude than the effect on employment in the corresponding sector in the US. While these two chapters were motivated by earlier episodes of recession, the lessons appear to apply well to the extensive transmission of the US Great Recession to Mexico. Among major trading partners, Mexico had the second highest correlation in GDP levels with the US during the Great Recession period.

Chapters 4 and 5 present among the earliest examples of modern business cycle models estimated econometrically as a structural dynamic system. Such models have since become widespread tools used by policy makers at central banks. The lessons arising from these chapters point to the importance of asset market shocks driving international financial flows. At the time, this stood in contrast to the view that financial flows were driven mainly by optimal saving and investment decisions. The empirical relevance of financial market shocks is a conclusion made all the more relevant by later experience with the financial crisis underlying the Great Recession.

Section II of this volume focuses on evidence of international integration in goods markets, which was seen above to be one prominent mechanism

transmitting macroeconomic shocks. While one obvious metric of goods market integration is the quantity of goods traded, arguably a better metric is the degree of price convergence across national goods markets. If two countries function as a single market, arbitrage should enforce the convergence of prices across the two countries. Such arbitrage may not necessarily require a large volume of cross-border trade.

Chapters 6–8 of this volume offer explanations for several puzzling aspects of the deviation in overall price levels between countries, measured by the real exchange rate. Chapter 6 offers an explanation for the high persistence and volatility of real exchange rates, Chapter 7 for the fact that real exchange rates are more volatile than the corresponding relative price between a country's exports and nontraded goods, and Chapter 8 for why the association of real exchange rates with relative income between countries appeared to have strengthened over time. These chapters also contributed for some methodological innovations. Chapter 6 introduced the use of translog preferences to explain why firms choose different price markups in different countries, which is a tool that subsequently has become widespread in the international trade literature. Chapter 7 was one of the first two chapters to introduce endogenous tradability to the macroeconomic literature to explain international relative prices.

Chapter 9 differs in studying the international differences in prices of individual goods rather than the overall price level. Again harnessing the idea endogenous tradability, it shows that depending on whether goods market integration expands trade at the extensive margin of previously nontraded goods, integration can actually lead to greater average price deviations across countries rather than convergence.

Section III studies integration in asset markets, the other channel of international transmission demonstrated above. How has asset integration contributed to the development of unprecedentedly large global financial imbalances? Chapter 10 estimates when these imbalances can be justified in terms of rational economic behavior, suggesting they are not a problem for policy to solve. Chapter 11 discusses the role of equity rather than bond markets, providing an explanation for how one can reconcile extensive integration in terms of trading volume of equity assets, with a low degree of diversification in terms of asset holdings.

The final section (Section IV) explores policy implications of globalization and macroeconomic comovement, in terms of the conduct of a

country's monetary and fiscal policies. Chapter 12 raises the question of how countries sharing a common currency need to coordinate their fiscal policies in light of their integrated monetary policy. While this chapter was written in 2000, when monetary union in Europe was viewed with significant optimism, the issues first raised here came to the fore in recent years as causes of disintegration and financial crisis in Europe. Chapter 13 shows theoretically under what conditions it is optimal for monetary policy in a global environment to formally respond to international variables such as the exchange rate. We identify cases where it is important for policy makers to take an international view, rather than focus just on domestic economic conditions. Chapter 14 finds evidence that countries often implicitly coordinate their monetary policies with other countries, regardless of an official stance of policy independence.

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