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The effects of financial integration during crises ☆

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ABSTRACT

We investigate the role of financial integration in the spread of the 2008 global financial crisis. Using a rich dataset covering 31 countries between 1978 and 2018, we find that during the 2008 financial crisis, when two countries have a higher level of financial integration, their consumption cycles are more synchronized. Similar patterns are found for investment and output. However, we also find that during times outside of the 2008 financial crisis, higher financial integration leads to more divergent consumption and output cycles. We build a two-country model with global banks and variable capital utilization to illustrate that the impact of financial integration on business cycle synchronization depends on the type of shock and that variable capital utilization is the key to accounting for the relationship between financial integration and investment synchronization. The calibrated model replicates our empirical findings reasonably well. Finally, our welfare analysis indicates that financial integration leads to welfare losses during financial crises but to welfare gains outside of financial crises.

1. Introduction

How shocks are transmitted across countries is a central question in the international macro literature, and financial openness in general is viewed as a plausible and significant propagation channel. With the dramatic increase in international financial integration during the past decades and the deep global recession caused by the 2008 financial crisis, this question has become of paramount importance for both policy makers and researchers.

The previous literature investigating the effect of financial integration on business cycle synchronization shows mixed results. Using pre-2008 crisis data, Baxter and Kouparitsas (2005) and Imbs (2006) find a positive relationship between financial integration and business cycle synchronization. Kalemli-Ozcan et al. (2013) finds that increased cross-border financial linkages are associated with less synchronized output cycles. A recent paper by Kalemli-Ozcan et al. (2013a) takes into account the 2008 financial crisis and uses a sample of 18 developed countries to show that the relationship between financial integration and output synchronization differs sharply during the financial crisis from that during other periods.

Although there are many empirical studies on the linkage between financial integration and business cycle comovement, most of them investigate only the synchronization of output between countries. The comovement of other aggregate macroeconomic variables, such as consumption and investment, is often overlooked. However, we argue that it is equally

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important to investigate the effect of financial integration on the comovement of consumption and investment. First, since households make intertemporal saving choices, output synchronization does not necessarily translate to consumption synchronization. Second, most theoretical studies find that investment is one of the key variables driving business cycle comovement across countries. Hence, it is important to know whether the predictions of investment from theoretical models are in line with the data.

In this paper, we study how financial integration affects the comovement of consumption, investment, and output across countries. We use a rich database of cross-border banking linkages from the Bank of International Settlements (BIS) covering 31 countries, including developed and emerging economies, from 1978 to 2018. We find that the relationship between banking linkages and business cycle comovement during the 2008 financial crisis differs significantly from that during other periods. Specifically, we first find that during tranquil times (periods outside of financial crises), banking linkages are negatively associated with consumption synchronization. The same holds for banking linkages and output synchronization. Interestingly, we then find that these relationships turn positive during the 2008 financial crisis, suggesting that the financial crisis induces business cycle comovement in more financially integrated countries. Finally, we find that banking linkages has a strong and positive effect on cross-country investment synchronization during the crisis. This finding confirms the conventional wisdom that the 2008 financial crisis began with a negative financial shock in the US and spread to the world through banking linkages, which led to a substantial decline in investment worldwide. This is the first study that systemically analyzes how financial integration affects the comovement of major macroeconomic variables such as consumption, investment, and output.

To rationalize our empirical findings, we next build a two-country dynamic stochastic general equilibrium (DSGE) model with global bank and capital utilization to illustrate how exogenous changes in financial integration affect business cycle comovement. There are two sectors in each country: one sector that is financially segmented from the world and another that is financially integrated with the world through global banks. Our model shows that the impact of financial integration on business cycle synchronization depends crucially on the type of shock. When a productivity shock hits the home country, global banks reduce lending in the home country and increase lending in the foreign country, leading to an increase in investment, employment, and output in the foreign country and thus a more divergent business cycle between the two countries. On the other hand, if there is a negative shock to banking efficiency in the home country, global banks pull their lending from both countries, leading to a decline in economic activity worldwide. A quantitative evaluation of the model shows that it can replicate the empirical relationship between financial integration and the synchronization of output, consumption, and investment reasonably well and that capital utilization is the key to accounting for the relationship between financial integration and investment synchronization in the data. Based on our theoretical model, we analyze whether financial integration is welfare improving. We find that during financial crises, an increase in financial integration leads to a welfare loss. However, financial integration continues to be welfare improving outside of financial crisis episodes.

Our paper contributes to the empirical literature by documenting the asymmetric effect of financial integration on the synchronization of consumption, investment, and output. Thus, our study is related to two strands of empirical literature. First, it relates to the literature on business cycle synchronization and financial integration (See, for example, Otto et al., 2001; Kose et al., 2003; Imbs, 2004; Morgan et al., 2004; Imbs, 2006.). Most of the studies in this literature aim to clarify the role of financial integration in output comovement. Our paper builds on this literature and further studies the role of financial integration in consumption and investment comovement. Our paper is also related to the empirical literature on crisis contagion. Previous studies by Kaminsky and Reinhart (2000), Kaminsky et al. (2003), and Cetorelli and Goldberg (2011) focus mainly on crisis transmission in emerging economies. A later study by Rose and Spiegel (2010) investigates the 2008 financial crisis, but does not find any strong impact of financial integration on crisis transmission. Our paper distinguishes crisis periods from other periods, and by examining the behavior of investment, we show that investment is an important channel through which crises are transmitted from one country to another.

Our paper is also related to the theoretical literature on business cycle comovement. Early studies include Backus et al. (1992), Baxter and Crucini (1995), Heathcote and Perri (2002), Faia (2007). Since the global financial crisis in 2008, there has been renewed interest in studying the role played by financial intermediaries and the transmission of shocks that originate in the financial economy. See, for example, Quadrini and Perri (2011), Kollmann et al. (2011), Yao (2019), Devereux and Yu (2020). Most of these studies aim to match the unconditional moments of macroaggregates, such as the cross-country correlations of consumption, investment, and output. However, we know little about how these models match the data conditional on different types of shocks. Our paper contributes to this literature by building a standard two-country DSGE model with global banks to show that business cycle transmission depends on the type of shock and that the model is quantitatively consistent with our empirical findings.

Among all these studies, the work of Kalemli-Ozcan et al. (2013a) is closest to ours, as they investigate the relationship between financial integration and output synchronization during and outside of the 2008 financial crisis. Relative to this work, our article has four strengths. First, from the empirical perspective, we document the relationship between integration and consumption, investment, and output. While Kalemli-Ozcan et al. (2013a) focus only on integration and output, which is the first step toward understanding the relationship between financial integration and business cycle synchronization, it is important to document the empirical relationship between integration and investment synchronization during and outside the financial crisis, as any model that matches the pattern of output synchronization should also be able to match the pattern of investment. This provides a natural test for many theoretical studies on the contagion mechanism of the 2008 financial crisis. It is also important to investigate consumption comovement in the data because given that households can make

intertemporal saving choices, output comovement does not necessarily translate to consumption comovement. In addition, if we want to perform a welfare analysis, the model should at least match the empirical relationship between integration and consumption comovement. Second, the analysis of Kalemli-Ozcan et al. (2013a) is restricted to a sample of developed countries between 1978 and 2009. Our sample includes both developed and emerging economies from 1978 to 2018. Since the pattern of international financial flows and linkages has changed tremendously after the 2008 financial crisis, it is worthwhile to investigate whether the previous findings by Kalemli-Ozcan et al. (2013a) on output still hold with the postcrisis data. Third, from the theoretical perspective, Kalemli-Ozcan et al. (2013a)'s model predicts a negative relationship between financial integration and investment synchronization during noncrisis periods. They also find that this relationship is significantly weakened during the financial crisis but remains negative. This finding is contrary to the positive relationship that we document in the data. We introduce capital utilization into the two-country model and show that this variable is the key to accounting for investment behavior during and outside of the crisis. Fourth, we use our model to perform a welfare analysis of financial integration. We find that during financial crises, an increase in financial integration leads to a welfare loss. However, financial integration continues to be welfare improving outside of financial crisis episodes. Our findings contribute to the ongoing debate among policy makers and researchers about the benefits of financial integration.

The remainder of the paper is structured as follows. Section 2 introduces the data and the empirical model. Section 3 reports the empirical results. Section 4 sets forth the theoretical framework. Section 5 presents the quantitative results and discusses how banking integration affects the comovement of various economic activities under technology shocks and credit shocks. Section 6 performs a sensitivity analysis. Finally, Section 7 concludes.

2. Empirical Analysis

2.1. Business Cycle Synchronization

It has been standard in the literature to measure output synchronization $Synch^{Y}_{ij,t}$ between countries i and j based on the absolute differential in GDP growth rates by

$$Synch^{Y}_{ij,t} = -\left|\ln\frac{Y_{i,t}}{Y_{i,t-1}} - \ln\frac{Y_{j,t}}{Y_{j,t-1}}\right|, \tag{1}$$

where $Y_{i,t}$ and $Y_{j,t}$ are the output of countries i and j in quarter t. The definition is such that $Synch^{Y}_{ij,t}$ increases with the degree of synchronization. This measure has several advantages. First, it is available at high frequency—in our case quarterly. Second, as pointed out by Forbes and Rigobon (2002) and Corsetti et al. (2005), unlike the Pearson correlation, this measure is invariant to the volatility of the underlying shock. Third, it avoids errors from the selection of the rolling estimation window and different filtering methods. Therefore, it is widely used in the international literature to quantify the comovement of macroeconomic variables. See Giannone et al. (2010); Kalemli-Ozcan et al. (2013a); Pyun and An (2016); Cesa-Bianchi et al. (2019). Similarly, we can define consumption synchronization and investment synchronization as

$$Synch^{C}_{ij,t} = -\left|\ln\frac{C_{i,t}}{C_{i,t-1}} - \ln\frac{C_{j,t}}{C_{j,t-1}}\right|, \tag{2}$$

$$Synch^{I}_{ij,t} = -\left|\ln\frac{I_{i,t}}{I_{i,t-1}} - \ln\frac{I_{j,t}}{I_{j,t-1}}\right|, \tag{3}$$

where $C_{i,t}$ and $I_{i,t}$ are the consumption and investment of country i in quarter t, respectively. The data for output, consumption and investment are obtained from OECD Quarterly National Accounts statistics, which report the main GDP components by expenditure for all OECD member countries and most major economies since the 1960s at quarterly frequency.

2.2. Financial Integration

There are two methods of measuring the degree of bilateral financial integration in the literature. The first is a de jure measure of cross-border capital controls, which indirectly reflect the liberalization of capital movements. The other measures de facto cross-border banking activities as in Kalemli-Ozcan et al. (2013a), Davis (2014), Duval et al. (2016) and Cesa-Bianchi et al. (2019). In practice, the former measure is burdened with measurement errors. In some cases, for example, low cross-border capital flows result from an underdeveloped financial market, despite a low level of capital controls. Therefore, we adopt the latter, which is defined as the value of real bilateral asset and liability holdings normalized by the sum of the two countries' real GDP:

$$Integration_{ij,t} = \frac{Assets_{ij,t} + Liabilities_{ij,t} + Assets_{ji,t} + Liabilities_{ji,t}}{GDP_{i,t} + GDP_{j,t}}, \tag{4}$$

where $Assets_{ij,t}$ and $Liabilities_{ij,t}$ denote country i' s stock of foreign assets and liabilities issued by country j in period t.

The data on bilateral banks' asset and liability holdings are available from the Locational Banking Statistics (LBS) database of the BIS[1]. The LBS publishes outstanding financial assets and liabilities of internationally active banks located in reporting countries with counterparties residing in more than 200 countries. The statistics capture mainly international bank-to-bank debt instruments such as interbank loans and deposits, credit lines, and trade-related lines of credit. The data also cover banks' investments in equity-like instruments and foreign corporate and government bonds[2]. The definition of "banks" in the LBS is "deposit-taking corporations, except the central bank", which include commercial banks, savings banks, credit institutions, savings and loan associations, credit unions or cooperative credit banks, building societies, post office giro institutions, and other government-controlled savings banks.

Our sample covers 31 countries, including 20 developed countries and 11 emerging economies, from the first quarter of 1978 to the fourth quarter of 2018[3]. Table 1 gives descriptive statistics for the variables used in our empirical analysis.

2.3. Empirical Model

To investigate the effect of financial integration on the synchronization of consumption, investment and output, we estimate the following regression:

$$Synch^{x}_{ij,t} = \alpha + \beta Integration_{ij,t-k} + \gamma Integration_{ij,t-k} \times Crisis_t + X'_{ij,t-k}\phi + \mu_{ij} + \eta_{i,t} + \rho_{j,t} + \delta_t + \epsilon_{ij,t}, \quad (5)$$

where $Synch^{x}_{ijt}$ $(x = Y, C, I)$ denotes the synchronization of output, consumption, and investment between country i and country j in quarter t. $Integration_{ij,t-k}$ is the measure of bilateral banking integration defined in the previous section. To mitigate the problem of reverse causality running from business cycle dynamics to financial integration, we take a less contemporaneous measure for financial integration in our regression: the level of integration between the two countries in the previous year $(k = 4)$[4]. $Crisis_t$ is a dummy variable taking 1 during the 2008 global financial crisis and 0 otherwise. Following the definition by Perri and Quadrini (2018) and Kalemli-Ozcan et al. (2013b), we consider the global financial crisis period to run from 2008:Q3 to 2009:Q2[5]. Vector $X_{ij,t}$ captures other country-pair time-varying factors that may affect the dynamic evolution of synchronization such as bilateral trade integration (Frankel and Rose, 1998; Kalemli-Ozcan et al., 2001; Imbs, 2004; Di Giovanni and Levchenko, 2010; Duval et al., 2016). The bilateral trade index is constructed as the log of the sum of real bilateral exports and imports between the two countries in each quarter[6]. Following the specifications in Kalemli-Ozcan et al. (2013a), $X_{ij,t}$ also includes the log of the product of the two countries' GDP and log of the product of the two countries' population. All explanatory variables in vector X are also lagged by one year. The coefficient β reflects the effect of financial integration on synchronization outside of the financial crisis period. The coefficient on the interaction term, γ, captures the partial effect during the financial crisis. Hence, the total effect of financial integration is represented by $(\beta + \gamma)$.

We also include country-pair fixed effects (μ_{ij}), time fixed effects (δ_t), and country-specific time trends $(\eta_{i,t}$ and $\rho_{j,t})$. The country-pair fixed effects help eliminate the interference of certain time-invariant unobservable factors, such as cultural ties and a common religion, language, or legal system. The effects of time-varying factors such as common global shocks are absorbed by the time fixed effects. Meanwhile, the country-specific time trends account for those factors varying over time for each country, e.g., total trade and gross production of the country. In all specifications, we cluster standard errors at the country-pair level to account for arbitrary heteroskedasticity and autocorrelation within each country pair (Bertrand et al., 2004).

[1] The BIS statistics have by far the most extensive time and country coverage of cross-border investment holdings and are superior to those in all similar databases. Another widely used database, the Coordinated Portfolio Investment Survey (CPIS) of the IMF, reports bilateral cross-border financial flows and stocks only for years after 1999. In addition, the CPIS data from the IMF are available only at annual frequency, while the BIS data are available at quarterly frequency.

[2] The BIS data do not capture other forms of international investment such as foreign direct investment (FDI) and portfolio investment between nonbanks. However, based on the fact that the stock of cross-border banking takes up most of the overall amount of international holdings, and there is a high correlation between international banking and other forms of portfolio investment, our estimates will not be systematically biased. According to Lane and Milesi-Ferretti (2008), the stock of cross-border banking takes a large proportion of over 50% among overall nternational holdings, and even more than two-thirds in the 1980s and 1990s. Furthermore, the correlations of total debt, portfolio debt, banking, FDI and equity are in the range of 0.75 to 0.99.

[3] Sample countries are listed in Appendix Table A1.

[4] To address the issue of endogeneity, Kalemli-Ozcan et al., 2013b construct a bilateral index of legislative harmonization of financial services policies in the context of the Financial Services Action Plan (FSAP) as an instrumental variable. However, given that this index is not available for years after 2006, we follow Kalemli-Ozcan et al., 2013a and use the lagged integration level in the regression to address the endogeneity problem.

[5] In September 2008, Lehman Brothers filed for bankruptcy, and the crisis quickly spread across the world. By the second quarter of 2009, US GDP growth rates had recovered to close to precrisis levels.

[6] These bilateral trade data are obtained from the IMF Direction of Trade Statistics (DOTS). DOTS presents the monthly and quarterly data of merchandise exports and imports disaggregated by the country's primary trading partners. The data are available for years from 1960 for 184 countries and areas of the world. Exports are reported on a free on board (FOB) basis, and imports are reported on a cost, insurance and freight (CIF) basis. The FOB basis is used to estimate our bilateral trade index in consideration of comparability and our aim to reduce the statistical error associated with transit trade.

Table 1
Descriptive Statistics.

Variable	Obs.	Mean	Std. dev.	Min.	p25	p50	p75	Max.
Synch_Output	45398	−0.963	0.826	−3.170	−1.366	−0.721	−0.321	−0.069
Synch_Consumption	44367	−0.985	0.860	−3.323	−1.365	−0.728	−0.332	−0.071
Synch_Investment	44182	−3.344	3.066	−11.662	−4.572	−2.356	−1.064	−0.227
Integration	45398	0.009	0.016	0	0.0002	0.001	0.008	0.056

Note: Synchronization variables are in percentage points. All continuous variables are winsorized at the 5% level.

3. Empirical Results

3.1. Benchmark Results

Table 2 reports our benchmark estimates on the effect of financial integration on business cycle synchronization during the period 1978:Q1-2018:Q4, and columns (1)-(3) correspond to the synchronization of output, consumption and investment, respectively. We add country-pair fixed effects, time fixed effects, and country-specific time trends in the empirical model. It is important to include time fixed effects so that we can exclude the effects of common global shocks. The estimates in column (1) imply that for periods outside the 2008 global financial crisis, higher banking integration leads to more diverged output cycles, while for the global financial crisis period, greater bilateral banking integration is associated with more synchronized output cycles. Note that the total effect of financial integration $(\beta + \gamma)$ on output synchronization is positive for the financial crisis period, which is significantly different from the dampening effect found by Kalemli-Ozcan et al. (2013a). In other words, our results offer strong evidence of contagion effects on output during the 2008 financial crisis.

The estimates in column (2) show that consumption synchronization closely follows the pattern of output synchronization. In addition, the effect of integration on consumption comovement is slightly larger than that on output for the global financial crisis period. According to the estimates in column (2), with an increase in financial integration from the world average in 1978 to that in 2018, consumption synchronization would have fallen by 0.074 percentage points during noncrisis periods, while it would have increased by 0.14 percentage points during the 2008 financial crisis. Given that the median size of consumption synchronization approaches 0.728%, our estimates can explain up to 20% of the actual changes in consumption convergence during the financial crisis, indicating that bilateral banking integration is important for cross-country transmission of the consumption cycle.

Column (3) shows that although there is no significant relationship between banking linkages and investment synchronization during tranquil times, banking integration has a strong and positive effect on cross-country investment synchronization for the 2008 financial crisis period. This finding confirms the conventional wisdom that the 2008 financial crisis period began with a negative financial shock in the US and spread to the world through banking linkages, which led to a substantial decline in investment worldwide. This is the first study that confirms the crisis propagation mechanism by examining investment behavior. It is also interesting to note that financial integration has a much larger effect during the 2008 crisis on investment synchronization than on output and consumption.

3.2. Robustness: Alternative Measures of Synchronization

Our findings are robust to the use of alternative measures of business cycle synchronization. We follow the method of Morgan et al. (2004) and Kalemli-Ozcan et al., 2013b to construct our alternative measurements. We first regress the real growth rate of output, consumption or investment on country fixed effects and time fixed effects for each country i to obtain the residuals $v_{i,t}$.

$$\ln x_{i,t} - \ln x_{i,t-1} = \gamma_i + \phi_t + v_{i,t}, \tag{6}$$

where $x = Y, C, I$. We then proxy the degree of synchronization between countries i and j in period t as the negative absolute value of the difference in the two countries' residuals:

$$Synchres^{x}_{ij,t} = -\left|v_{i,t} - v_{j,t}\right|. \tag{7}$$

This index measures the similarity of the growth rates between the two countries in any given period, taking into account both the average growth in each country and the average growth in each period.

Table 3 reports the regression results from this alternative specification. The result indicates that our benchmark results still hold after we control for common growth trends in the measures of output, consumption and investment synchronization. Our estimates imply more divergent economic activity in noncrisis periods with higher financial integration, while countries with higher financial integration experienced more synchronized consumption, investment and output cycles during the 2008 financial crisis.

Table 2
Financial Integration and Business Cycle Synchronization.

	Synch_Output	Synch_Consumption	Synch_Investment
	(1)	(2)	(3)
Integration	−0.0215***	−0.0264***	0.0220
	(0.0071)	(0.0081)	(0.0245)
Integration×Crisis	0.0442***	0.0500***	0.1113***
	(0.0090)	(0.0097)	(0.0300)
Trade Index	−0.0104	0.0020	0.0495
	(0.0159)	(0.0177)	(0.0548)
Country-Pair Fixed Effects	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
Country Time Trends	Yes	Yes	Yes
Other Controls	Yes	Yes	Yes
Observations	45313	44320	44135
Adjusted R^2	0.258	0.242	0.304

Notes: The table reports the estimates on the effect of financial integration on the synchronization of economic activities over the period 1978:Q1 to 2018:Q4 and excludes the results of the constant terms. All continuous independent variables are expressed in logarithmic form and are lagged by one year. The log of the product of the two countries' GDP and the log of the product of the two countries' population in the previous year are included (coefficients are not reported). Country-pair fixed effects, time fixed effects, and country-specific time trends are added in the specification. Standard errors clustered at the country-pair level are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 3
Robustness Checks: Alternative Measures of Synchronization.

	Synchres_Output	Synchres_Consumption	Synchres_Investment
	(1)	(2)	(3)
Integration	−0.0240***	−0.0224***	0.0275
	(0.0063)	(0.0074)	(0.0230)
Integration×Crisis	0.0340***	0.0426***	0.1084***
	(0.0082)	(0.0094)	(0.0305)
Trade Index	−0.0016	−0.0122	0.0221
	(0.0153)	(0.0151)	(0.0531)
Country-Pair Fixed Effects	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
Country Time Trends	Yes	Yes	Yes
Other Controls	Yes	Yes	Yes
Observations	45313	44320	44135
Adjusted R^2	0.248	0.230	0.296

Notes: The table reports the results of regressions in which synchronization is measured by the difference between two countries' growth rate residuals and excludes the results of the constant terms. All continuous independent variables are expressed in logarithmic form and are lagged by one year. The log of the product of the two countries' GDP and the log of the product of the two countries' population in the previous year are also included (coefficients are not reported). Country-pair fixed effects, time fixed effects, and country-specific time trends are added in the specification. Standard errors clustered at the country-pair level are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

3.3. Robustness: Alternative Measures of Financial Integration

We now extend our benchmark findings by using two alternative measures of financial integration. In our benchmark regression, financial integration is measured by cross-holding assets and liabilities normalized by countries' GDP level. Following Kalemli-Ozcan et al., 2013a and Cesa-Bianchi et al. (2019), we now normalize the cross-holding of assets and liabilities by the total population, denoted by $Integration\_pop_{ij,t}$:

$$Integration\_pop_{ij,t} = \frac{Assets_{ij,t} + Liabilities_{ij,t} + Assets_{ji,t} + Liabilities_{ji,t}}{Population_{i,t} + Population_{j,t}}, \tag{8}$$

or by the sum of total external assets and liabilities, denoted by $Integration\_tot_{ij,t}$:

$$Integration\_tot_{ij,t} = \frac{Assets_{ij,t} + Liabilities_{ij,t} + Assets_{ji,t} + Liabilities_{ji,t}}{Tot\_Assets_{i,t} + Tot\_Assets_{j,t} + Tot\_Liabilities_{i,t} + Tot\_Liabilities_{j,t}}. \tag{9}$$

Table 4 shows the results based on these two alternative normalizations. Columns (1), (3), and (5) report the results when financial linkages are normalized by the total population. Columns (2), (4), and (6) report the results when financial linkages are normalized by the sum of total external assets and liabilities. The estimates in Table 4 are consistent with those of our benchmark regression.

Table 4
Robustness Checks: Alternative Measures of Financial Integration.

	Synch_Output		Synch_Consumption		Synch_Investment	
	(1)	(2)	(3)	(4)	(5)	(6)
Integration_pop	−0.0205***		−0.0266***		0.0254	
	(0.0069)		(0.0077)		(0.0240)	
Integration_pop×Crisis	0.0423***		0.0453***		0.1235***	
	(0.0079)		(0.0085)		(0.0262)	
Integration_tot		−0.0181**		−0.0173**		0.0306
		(0.0074)		(0.0084)		(0.0249)
Integration_tot×Crisis		0.0322***		0.0514***		0.0595*
		(0.0110)		(0.0115)		(0.0355)
Trade Index	−0.0105	−0.0126	0.0022	−0.0018	0.0490	0.0462
	(0.0159)	(0.0159)	(0.0177)	(0.0177)	(0.0547)	(0.0548)
Country-Pair Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country Time Trends	Yes	Yes	Yes	Yes	Yes	Yes
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	45313	45313	44320	44320	44135	44135
Adjusted R^2	0.258	0.257	0.242	0.242	0.304	0.303

Notes: The table reports the results of regressions in which alternative measures of financial integration are used and excludes the results of the constant terms. The dependent variable is output synchronization in columns (1) and (2), consumption synchronization in columns (3) and (4), and investment synchronization in the last two columns. In the odd columns, the financial integration variable is standardized by total population, while in the even columns, the variables are normalized by the sum of total external assets and liabilities. All continuous independent variables are expressed in logarithmic form and are lagged by one year. The log of the product of the two countries' GDP and the log of the product of the two countries' population in the previous year are also included (coefficients are not reported). Country-pair fixed effects, time fixed effects, and country-specific time trends are added in the specification. Standard errors clustered at the country-pair level are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

3.4. Robustness: Controls for Other Banking Crises

Since our data span 1978 to 2018, a period during which several systemic banking crisis episodes appeared successively, the 2008 financial crisis is not the only financial crisis in the sample. Therefore, we perform a robustness check by controlling for all other financial crises and investigate whether the pattern in the 2008 financial crisis still holds.

We use the banking crises identified by Laeven and Valencia (2018), who construct a comprehensive database of systemic banking crises, providing rich information about crisis dates, policy responses, fiscal costs, output losses, and other stylized facts. To properly identify the dates of crisis episodes, Laeven and Valencia (2018) investigate not only the significant signs of financial distress, such as significant bank runs, losses in the banking system, and bank liquidations but also banking policy interventions, including deposit freezes, significant bank nationalizations, bank restructuring, and extensive liquidity support. These crises include the Finnish banking crisis, Mexican peso crisis, Asian financial crisis, European sovereign debt crisis, and so on. A complete list of these crises appears in Table A2 in the Appendix.

We define systemic banking crises other than the 2008 financial crisis with the dummy variable *Other_Crises*. In Table 5, we find a positive and significant coefficient of the interaction between financial integration and other banking crises, which implies that country pairs that are highly integrated via the international banking system experienced more synchronized contractions during all other financial crises. Meanwhile, our benchmark results for the 2008 financial crisis still hold.

3.5. Robustness: Addition of Other Control Variables

In this section, we control for factors other than financial integration that could affect business cycle comovement between countries. These factors have been studied extensively in the literature and include, for example, specialization (Kalemli-Ozcan et al., 2001; Imbs, 2004; Imbs, 2006), exchange rate regimes (Kim and Pyun, 2018), free trade agreements (Calderon et al., 2007), and regional monetary unions (Elbourne and de Haan, 2006).

We use the dissimilarity of industrial production in manufacturing to measure specialization, following Imbs (2004), Imbs (2006), and Kalemli-Ozcan et al. (2001). $Specialization_{ij,t}$ is defined as

$$Specialization_{ij,t} = \sum_{n=1}^{N} \left| S_{i,t}^{n} - S_{j,t}^{n} \right|, \tag{10}$$

where $S_{i,t}^{n}$ and $S_{j,t}^{n}$ denote the GDP share of industry n in country i and country j in period t. The larger the index is, the greater the difference in industrial structure between the two countries, and vice versa. Value-added data by industry are available from the National Accounts Main Aggregates Database from the United Nations[7].

[7] See https://unstats.un.org/unsd/snaama/.

Table 5
Robustness Checks: Controls for Other Banking Crises.

	Synch_Output	Synch_Consumption	Synch_Investment
	(1)	(2)	(3)
Integration	−0.0210***	−0.0261***	0.0229
	(0.0070)	(0.0080)	(0.0242)
Integration×Crisis	0.0456***	0.0512***	0.1150***
	(0.0090)	(0.0096)	(0.0298)
Integration×Other_Crises	0.0170***	0.0165***	0.0504***
	(0.0030)	(0.0034)	(0.0108)
Trade Index	−0.0138	−0.0008	0.0413
	(0.0158)	(0.0178)	(0.0546)
Country-Pair Fixed Effects	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
Country Time Trends	Yes	Yes	Yes
Other Controls	Yes	Yes	Yes
Observations	45313	44320	44135
Adjusted R^2	0.259	0.244	0.305

Notes: The table reports the estimates after we control for banking crises other than the 2008 global financial crisis over the period 1978:Q1 to 2018:Q4 and excludes the results of the constant terms. All continuous independent variables are expressed in logarithmic form and are lagged by one year. The log of the product of the two countries' GDP and the log of the product of the two countries' population in the previous year are also included (coefficients are not reported). Country-pair fixed effects, time fixed effects, and country-specific time trends are added in the specification. Standard errors clustered at the country-pair level are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

We use the exchange rate regime (*ERR*) measure constructed by Ilzetzki et al. (2019). Their approach systematically provides information to classify exchange arrangements in that they (i) explicitly determine the anchor or reference currency, (ii) allow for de facto baskets of currencies as anchors, (iii) classify and analyze de jure inflation targeting cases, and (iv) pay explicit attention to the Eurozone.

The indicators for bilateral free trade agreements (*FTA*) and regional monetary unions (*RMU*) are series from José de Sousa[8]that end in 2015. We update these two indicators to the year 2018[9].

Table 6 shows the regression results when specialization, exchange rate regimes, free trade agreements, and regional monetary unions are accounted for. We find that these factors do not alter our benchmark conclusion.

4. Theoretical Model

In this section, we develop a two-country two-sector DSGE model. There are three types of agents in each country: households, firms, and banks. Households supply labor to firms in return for wages, receive dividends as the owners of firms, and allocate their income between consumption and savings. Firms hire labor, invest capital to undertake production, and pay wages and dividends. The wages are financed by working capital from banks. Banks collect deposits from households, use part of the funds to lend to firms, and use the rest to invest in risky assets.

In each country, there are two sectors, sector 1 and sector 2. Each sector has three types of agents. The two sectors differ only in the degree of financial integration. Sector 1 is in financial autarky. The banks in sector 1 can only raise deposits and offer loans within their own sector. Sector 2 is financially integrated. The banks in sector 2 can raise deposits and offer loans from sector 2 in both countries. In each country, there is a continuum of households of size 1. The households in sector 1 are of size $(1-n)$, and the households in sector 2 are of size n.

Both sectors are subject to country-specific productivity and credit shocks. In the following, we describe the model setup in terms of the home country (foreign counterparts are marked with asterisks).

4.1. Households

Each country has a continuum of infinitely lived households that supply labor, earn wages, receive dividends from the firm and earn interest on their savings. The income of a household is allocated between consumption and savings. In our setup, the household has a Greenwood-Hercowitz-Huffman (GHH) preference, as in much of the open macro literature[10]:

$$\max E_0 \sum \beta^t \frac{\left(c_{it} - \mu \frac{l_{it}^{1+\theta}}{1+\theta}\right)^{1-\gamma} - 1}{1-\gamma} \qquad i = 1, 2. \tag{11}$$

[8] See http://jdesousa.univ.free.fr/data.htm.
[9] A regional trade agreement between Canada and the European Union went into force in 2017.
[10] The advantage of the GHH preference is that there is no wealth effect on the labor supply. Thus, only a substitution effect operates on hours, thereby suggesting that the path of hours closely follows that of output. Early papers using the GHH preference include Mendoza (1991) and Devereux et al. (1992). For recent examples see Mendoza and Smith Evans (2002) and Raffo (2010).

Table 6
Robustness Checks: Addition of Other Control Variables.

	Synch_Output	Synch_Consumption	Synch_Investment
	(1)	(2)	(3)
Integration	−0.0329***	−0.0305***	−0.0113
	(0.0079)	(0.0089)	(0.0255)
Integration×Crisis	0.0432***	0.0491***	0.1229***
	(0.0089)	(0.0096)	(0.0299)
Trade Index	−0.0136	0.0197	0.0558
	(0.0170)	(0.0184)	(0.0572)
Specialization	0.0319	−0.0437*	−0.0230
	(0.0254)	(0.0243)	(0.0923)
ERR	0.1378***	0.0284	−0.0222
	(0.0415)	(0.0323)	(0.0937)
FTA	−0.0542*	−0.0505*	−0.1617
	(0.0306)	(0.0292)	(0.1048)
RMU	−0.0456*	0.0053	−0.1803*
	(0.0246)	(0.0231)	(0.0950)
Country-Pair Fixed Effects	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
Country Time Trends	Yes	Yes	Yes
Other Controls	Yes	Yes	Yes
Observations	42128	41242	41057
Adjusted R^2	0.250	0.238	0.287

Notes: The table reports the estimates on the effect of financial integration on the synchronization of economic activities over the period 1978:Q1 to 2018:Q4 and excludes the results of the constant terms. The regression control for additional factors such as specialization, exchange rate regimes, free trade agreements, and regional monetary unions. All continuous independent variables are expressed in logarithmic form and are lagged by one year. The log of the product of the two countries' GDP and the log of the product of the two countries' population in the previous year are also included (coefficients are not reported). Country-pair fixed effects, time fixed effects, and country-specific time trends are added in the specification. Standard errors clustered at the country-pair level are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

The budget constraint of the household in sector i is

$$c_{it} + \frac{b_{it+1}}{R_{it}} = w_{it} l_{it} + d_{it} + b_{it}. \tag{12}$$

In each period, the household chooses its consumption c_{it} and saves b_{it+1} at the rate R_{it}. The household works and receives labor income $w_{it} l_{it}$; it also receives dividend d_{it} from the firm and bank deposits b_{it} carried over from the last period.

Solving the home-country household's problem leads to the following first-order conditions (FOCs):

$$w_{it} = \mu l_{it}^{\theta}, \tag{13}$$

$$\left(c_{it} - \mu \frac{l_{it}^{1+\theta}}{1+\theta}\right)^{-\gamma} = \beta E_t \left(c_{it+1} - \mu \frac{l_{it+1}^{1+\theta}}{1+\theta}\right)^{-\gamma} R_{it}. \tag{14}$$

Note that since sector 2 is financially integrated, households in sector 2 in both countries can allocate their savings to global banks. Therefore, deposit rates in sector 2 are equalized across countries, i.e., $R_{2t} = R_{2t}^*$.

4.2. Firms

There is a representative firm in each sector with a Cobb-Douglas production function:

$$Y_{it} = e^{z_t} (u_{it} K_{it})^{\alpha} L_{it}^{1-\alpha}, \tag{15}$$

where α denotes the capital share. z_t is an exogenous country-specific productivity shock, which follows an AR(1) process:

$$\begin{bmatrix} z_t \\ z_t^* \end{bmatrix} = A_z \begin{bmatrix} z_{t-1} \\ z_{t-1}^* \end{bmatrix} + \begin{bmatrix} \varepsilon_t^z \\ \varepsilon_t^{z^*} \end{bmatrix}. \tag{16}$$

Output is produced with labor L_{it} and capital K_{it}. Following Baxter and Farr (2005) and Mandelman et al. (2011), we assume that the firm can also choose capital utilization rate u_{it}. In each period, the firm chooses the optimal rate of utilization as well as input factors to maximize its expected profit:

$$\max E_t \sum_{k=0}^{\infty} m_{it+k} D_{it+k}, \tag{17}$$

where m_{it+k} is the household's stochastic discount factor ($m_{it+k} = \beta^k \frac{U_c(c_{it+k}, l_{it+k})}{U_c(c_{it}, l_{it})}, k = 0, 1, 2, \ldots$) and

$$D_{it} = Y_{it} - w_{it}L_{it} - X_{it} - (R^e_{it} - 1)\chi w_{it}L_{it}, \tag{18}$$

where D_{it} denotes the firm's profit and X_{it} denotes investment. We follow Mendoza (2010) in assuming that the firm raises funds as working capital to cover a fraction of wages before the final output is available. The need for working capital to finance the wage bill makes the labor demand sensitive to the interest rate, amplifying the effects of shocks on business cycles. R^e_{it} is the interest rate paid on working capital and χ determines the fraction of the wage bill that must be financed. Since the firms in sector 2 can raise funds from both countries, the lending rates are equal in sector 2, i.e., $R^e_{2t} = R^{e^*}_{2t}$.

We assume that increases in the utilization rate of capital are costly because a higher utilization rate implies a higher depreciation rate. Hence, when choosing an optimal utilization rate, the firm must weigh the benefit of greater output against the cost of higher capital depreciation. Capital accumulates according to

$$K_{it+1} = [1 - \delta(u_{it})]K_{it} + \Phi\left(\frac{X_{it}}{K_{it}}\right)K_{it}, \tag{19}$$

where the depreciation of capital $\delta(u_{it})$ is given by

$$\delta(u_{it}) = \delta_1 + \frac{\delta_2}{1+\zeta}u_{it}^{1+\zeta}, \tag{20}$$

with $\delta_1 > 0, \delta_2 > 0$, and $\zeta > 0$. The investment is subject to costs of adjustment governed by the function Φ according to

$$\Phi\left(\frac{X_{it}}{K_{it}}\right) = \frac{\eta_1}{1-\xi}\left(\frac{X_{it}}{K_{it}}\right)^{1-\xi} + \eta_2, \tag{21}$$

where $\Phi > 0,\ \Phi' > 0,$ and $\Phi'' < 0$, as in Baxter and Crucini (1995) and Jermann (1998). η_1 and η_2 are set so that in the steady state, $\Phi(\delta) = \delta$ and $\Phi'(\delta) = 1$.

Solving the firm's problem in the home country leads to the following FOCs:

$$E_t\left\{\beta m_{it+1}\left[\alpha e^{z_{t+1}}u_{it+1}\left(\frac{u_{it+1}K_{it+1}}{L_{it+1}}\right)^{\alpha-1} + \frac{1-\delta(u_{it+1}) + \Phi\left(\frac{X_{it+1}}{K_{it+1}}\right)}{\Phi'\left(\frac{X_{it+1}}{K_{it+1}}\right)} - \frac{X_{it+1}}{K_{it+1}}\right]\right\} = \frac{1}{\Phi'\left(\frac{X_{it}}{K_{it}}\right)}, \tag{22}$$

$$(1-\alpha)e^{z_t}\left(\frac{u_{it}K_{it}}{L_{it}}\right)^{\alpha} = [1 + \chi(R^e_{it} - 1)]w_{it}, \tag{23}$$

$$\alpha e^{z_t}(u_{it}K_{it})^{\alpha-1}L_{it}^{1-\alpha}\Phi'\left(\frac{X_{it}}{K_{it}}\right) = \delta_2 u_{it}^{\zeta}. \tag{24}$$

4.3. Banks

There is a continuum of identical competitive banks in each sector. The banks in sector 1 are financially segmented; hence, they can collect deposits from households in sector 1 only in their own country. Following Kalemli-Ozcan et al. (2013a), we assume that the activity of raising deposits is costly and that banks need to pay a fraction τ of deposits to cover intermediation costs. The bank uses part of the deposits to lend to firms to finance the latter's need for working capital. The rest of the deposits are invested in risky assets, which earn a country-specific risky return R^m_t. We assume that the expected return of the risky asset is relatively high so that each bank can invest only the maximum fraction allowed by regulation, denoted by $\overline{m}$. The assumption of bank competitiveness ensures that the bank makes zero profits; hence, in sector 1,

$$\overline{m}R^m_t + (1-\overline{m})R^e_{1t} = R_{1t} + \tau, \tag{25}$$

$$\overline{m}R^{m^*}_t + (1-\overline{m})R^{e^*}_{1t} = R^*_{1t} + \tau. \tag{26}$$

In sector 2, banks can invest in risky assets in both countries[11]; hence,

$$\overline{m}\left(\frac{R^m_t}{2} + \frac{R^{m^*}_t}{2}\right) + (1-\overline{m})R^e_{2t} = R_{2t} + \tau. \tag{27}$$

The returns on risky assets in the two countries follow an AR(1) process:

$$\begin{bmatrix} R^m_t \\ R^{m^*}_t \end{bmatrix} = [I - A_R]\begin{bmatrix} \overline{R}^m \\ \overline{R}^m \end{bmatrix} + A_R\begin{bmatrix} R^m_{t-1} \\ R^{m^*}_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon^R_t \\ \varepsilon^{R^*}_t \end{bmatrix}, \tag{28}$$

where $\overline{R}^m$ denotes the average return on risky assets, A_R is a 2×2 matrix, and ε^R_t and $\varepsilon^{R^*}_t$ are *iid* innovations.

[11] For simplicity, we assume equal shareholdings for banks. Our quantitative results are robust to alternative specifications of shareholdings.

4.4. Market Clearing

Labor market clearing in each sector gives

$$L_{1t} = (1-n)l_{1t}, \tag{29}$$
$$L_{2t} = nl_{2t}. \tag{30}$$

In each sector, the total dividend of the firm is distributed to each household, which implies that

$$D_{1t} = (1-n)d_{1t}, \tag{31}$$
$$D_{2t} = nd_{2t}. \tag{32}$$

Loan market clearing means that the demand for working capital is equal to the supply of loans:

$$\chi w_{1t} L_{1t} = (1-\overline{m})\frac{(1-n)b_{1t+1}}{R_{1t}}, \tag{33}$$

$$\chi w^*_{1t} L^*_{1t} = (1-\overline{m})\frac{(1-n)b^*_{1t+1}}{R^*_{1t}}, \tag{34}$$

$$\chi\left(w_{2t}L_{2t} + w^*_{2t}L^*_{2t}\right) = (1-\overline{m})\frac{n\left(b_{2t+1} + b^*_{2t+1}\right)}{R_{2t}}. \tag{35}$$

Note that the loans in sector 1 are limited to sector 1 of that country while the loans in sector 2 are global.

4.5. Equilibrium

Given the exogenous shock processes $\left\{z_t, z^*_t, R^m_t, R^{m^*}_t\right\}$ and the level of financial integration, an equilibrium is defined as a sequence of prices $\left\{R_{it}, R^*_{it}, R^e_{it}, R^{e^*}_{it}, w_{it}, w^*_{it}\right\}$ and allocations $\{c_{it}, c^*_{it}, l_{it}, l^*_{it}, d_{it}, d^*_{it}, b_{it+1}, b^*_{it+1}, u_{it}, u^*_{it}, K_{it+1}, K^*_{it+1}, X_{it}, X^*_{it}, L_{it}, L^*_{it}, D_{it}, D^*_{it}\}$ such that on the premise of satisfying various constraints, (1) the household maximizes its the expected lifetime utility, (2) the firm maximizes its the expected profit, (3) the profit of competitive commercial banks is zero, and (4) each market clears.

4.6. Calibration

A period in the model corresponds to one quarter. Following the literature, we set the discount factor for households as $\beta = 0.99$, and the coefficient of relative risk aversion γ is set to 2. In line with Greenwood et al. (1988), the elasticity of labor supply is calibrated to 1.7, which corresponds to $\theta = 0.6$. We choose $\mu = 4.561$ such that the steady state labor supply is equal to 1/3.

The capital share of income α is set to 0.36. In line with Baxter and Farr (2005),Mandelman (2010), and Mandelman et al. (2011), the elasticity of marginal depreciation with respect to the utilization rate ζ is set to 1. We set the capital utilization rate to 1 in the steady state, which gives $\delta_2 = 0.0351$. δ_1 is set to 0.0075 such that the steady state depreciation rate is 0.025. Following Baxter and Crucini (1995), the elasticity of the price of capital with respect to the investment capital ratio ξ is set to 0.067. The parameter χ reflects the fraction of the wage bill that is paid in advance; following Mendoza (2010) and Perri and Quadrini (2018), we set χ to 0.26, which matches the ratio of working capital to GDP in the data.

Following Kalemli-Ozcan et al., 2013, we set the persistence of the productivity shock ρ_z to 0.95 and the correlation of productivity innovations ρ^z_e to 0.3. Two cases in our model are examined simultaneously: one with only productivity shock and the other with both productivity and credit shocks. Hence, the variances of innovations of productivity in the two cases are chosen such that the volatility of output growth is the same to ensure comparability. Specifically, $\sigma^z_e = 0.467\%$ for productivity shocks only, and $\sigma^z_e = 0.385\%$ when both shocks hit.

We set $\overline{R}^m = 0.06$ to represent the observed average real return on risky assets (such as stocks) of approximately 6%. Following Kalemli-Ozcan et al., 2013a, we set the banking intermediation cost τ to 0.04 so that the spread between the lending and deposit rate is 3% on average. The persistence and correlation of the innovations of the credit shocks are set to be the same as those of the productivity shock. We calibrate the standard deviation of the credit shocks σ^R_e with the quarterly GDP growth rate in the US. The data show that the standard deviation of this growth rate increased from 0.5% in the noncrisis period to 1.1% during the 2008 financial crisis. We attribute the increase in volatility during the 2008 financial crisis to the credit shock, which gives $\sigma^R_e = 3.69\%$. In this case, credit shocks alone account for a standard deviation of the growth rate of GDP of 0.6%.

Referring to Bekhtiar et al. (2019), we set the share of risky assets $\overline{m}$ to 0.46, which corresponds to the share of risky assets in total financial wealth in the United States. The size of sector 2, n, determines the degree of financial integration. In the extreme case of $n = 1$, the financial markets of the two countries are fully integrated, while at the other extreme of $n = 0$,

Table 7
Calibration.

Parameter	Values
Preference	
Discount factor	$\beta = 0.99$
Labor supply level	$\mu = 4.561$
Elasticity of labor supply	$\theta = 0.6$
Risk aversion	$\gamma = 2$
Production	
Capital share	$\alpha = 0.36$
Depreciation rate	$\delta_1 = 0.0075,\ \delta_2 = 0.0351$
Elasticity of marginal depreciation	$\zeta = 1$
Investment adjustment cost	$\xi = 0.067$
Working capital ratio	$\chi = 0.26$
Size of sector 2	$n = 0.487$
Productivity shock	$A_z = \begin{pmatrix} \rho_z & 0 \\ 0 & \rho_z \end{pmatrix},\ \rho_z = 0.95,\ \rho_e^z = 0.3,$ $\sigma_e^z = \begin{cases} 0.467\%, \textit{ if Prod. only} \\ 0.385\%, \textit{ if Prod. \& Credit} \end{cases}$
Banking parameters	
Share of risky assets	$\overline{m} = 0.46$
Average return to risky asset	$\overline{R}^m = 0.06$
Intermediation cost	$\tau = 0.04$
Credit shock	$A_R = \begin{pmatrix} \rho_R & 0 \\ 0 & \rho_R \end{pmatrix},\ \rho_R = 0.95,\ \rho_e^R = 0.3,\ \sigma_e^R = 3.69\%$

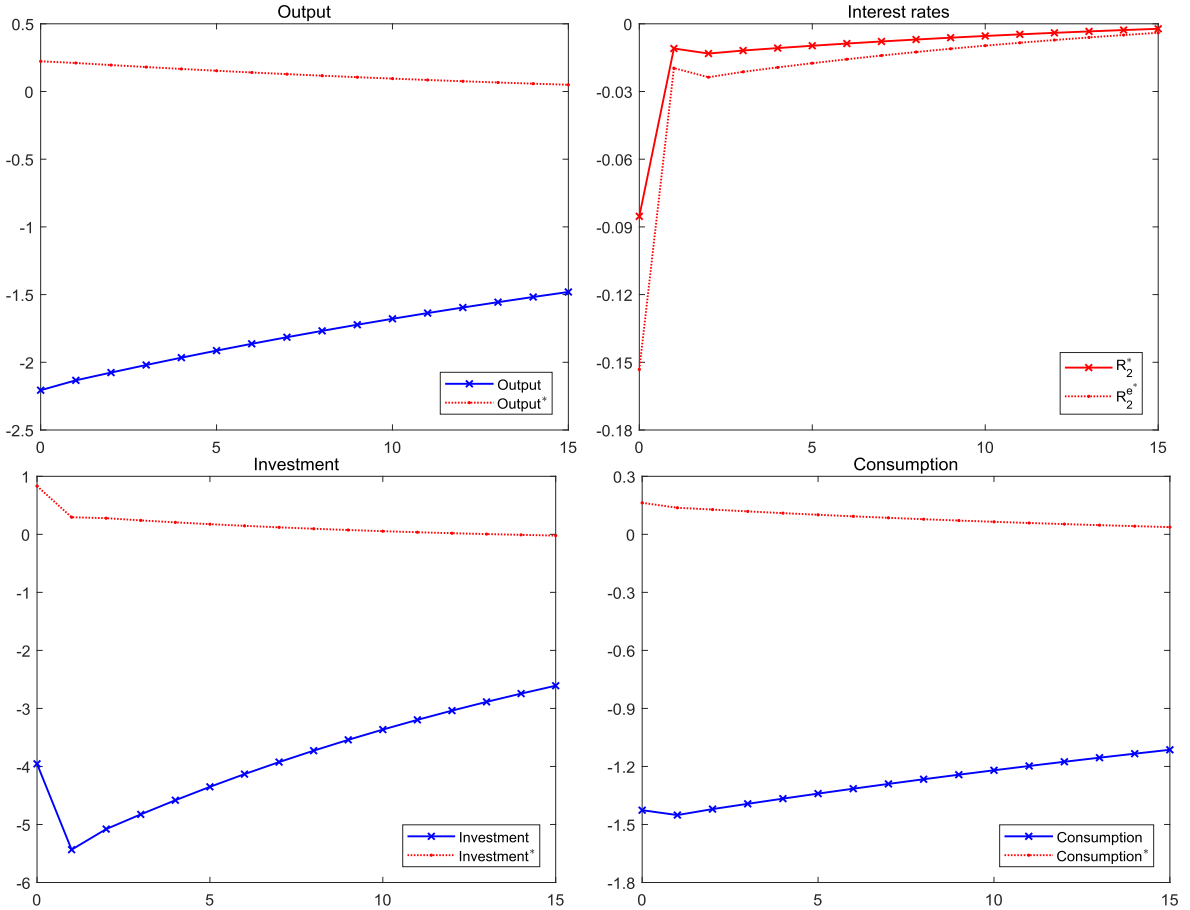

Fig. 5.1. Impulse Responses to Productivity Shocks: Aggregate Variables.

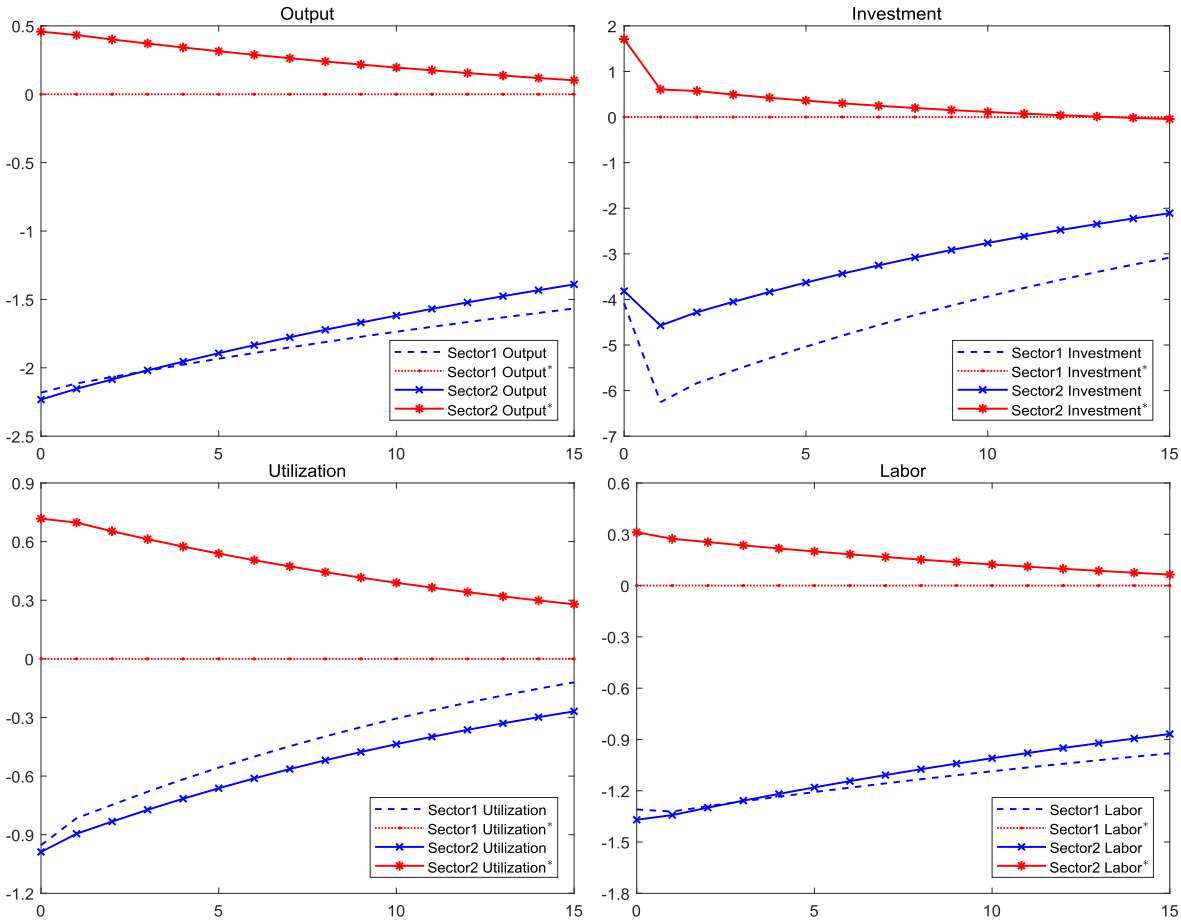

Fig. 5.2. Impulse Responses to Productivity Shocks: Sectoral Variables.

the two countries are completely segmented from each other. We calibrate $n = 0.487$ such that the financial integration level implied by the model, λ, matches the value obtained from the BIS data of 0.15.

The calibration of the above parameters is summarized in Table 7.

5. Quantitative Results

In this section, we analyze the quantitative implications of the model with different shocks. First, we use impulse response functions (IRFs) to analyze the model mechanism. Second, we use the model-simulated data to run the same regression as in our empirical study to check whether the model predictions align with the data. Finally, we report the unconditional moments of the model and compare them with those in the data.

5.1. Impulse Response Analysis

5.1.1. Responses to Productivity Shocks

We present the IRFs for a one-percentage-point negative productivity shock in the home country. In sector 1, as shown in Figs. 5.1 and 5.2, a fall in home productivity leads to a decline in investment and firm demand for labor. The decline in demand for working capital results in a decline in the lending rate R^e_{1t}. Since sector 1 is financially segmented, the foreign country is not affected by changes in this sector.

However, for sector 2, which is financially integrated, a decline in demand for working capital in the home country lowers the interest rate, R^{e*}_{2t}, faced by both countries. Firms in the foreign country respond to the lower interest rate by increasing their working capital, hiring more labor, making more investments, and increasing capital utilization. Therefore, employment, investment, and capital utilization rise in the foreign country, leading to an increase in output and consumption. The response of sector 2 to a productivity shock is similar to the dynamic in a canonical two-country real business cycle model in the style of Backus et al. (1992), in which a productivity shock leads to divergent responses of labor, investment,

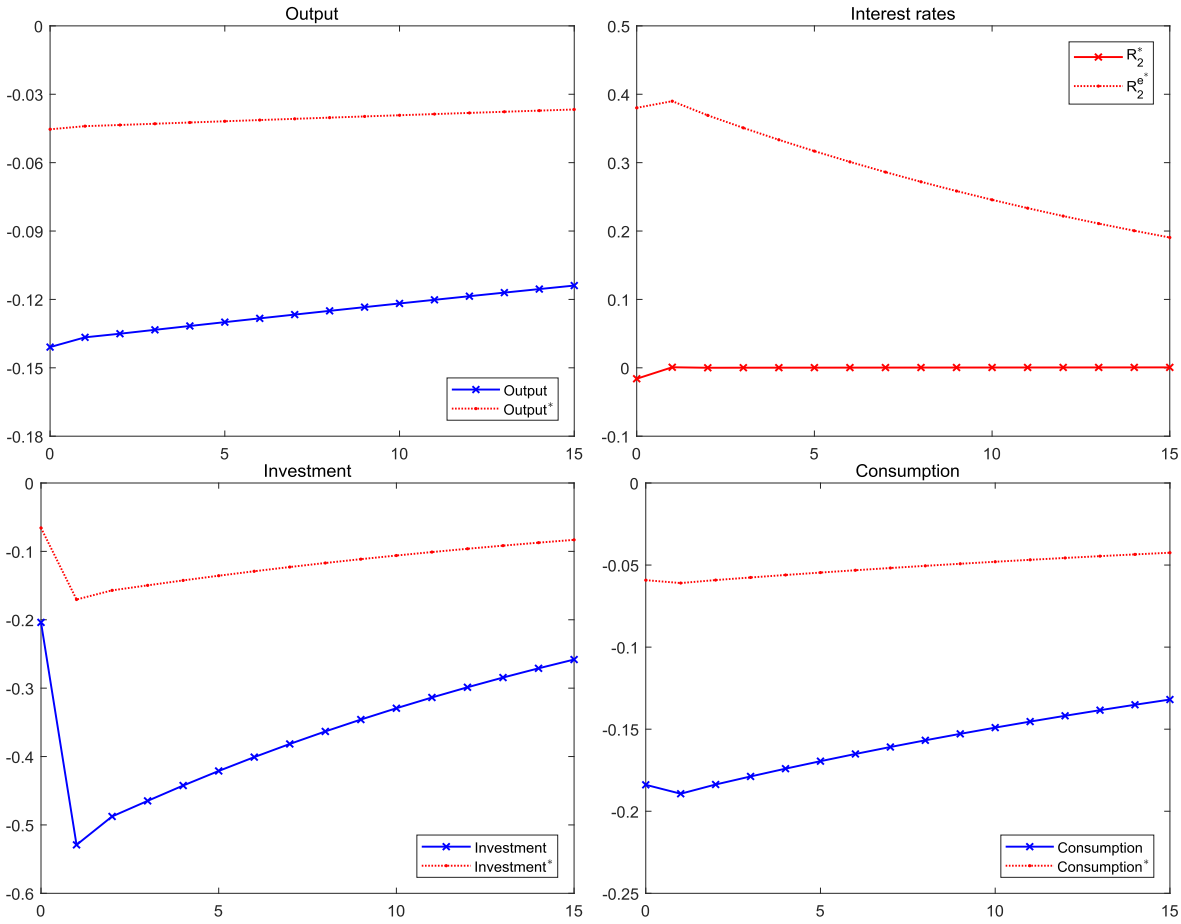

Fig. 5.3. Impulse Responses to Credit Shocks: Aggregate Variables.

and output between the countries. Therefore, as the size of sector 2 increases (the two countries become more integrated), home-country productivity shocks have a larger effect on the foreign country, and the two countries become less correlated.

5.1.2. Responses to Credit Shocks

Credit shocks are shocks to returns on banks' holdings of risky assets R_t^m and R_t^{m*}. These shocks mimic the large losses that banks suffered during the 2008 financial crisis when mortgage-backed securities lost their value. Figs. 5.3 and 5.4 show the IRFs to a one-percentage-point negative credit shock in the home country. In sector 1, when the return on risky assets falls, the bank suffers investment loss. Given that the bank must keep its balance sheet balanced, it needs to raise revenue by increasing the interest rate on loans to firms and lowering the deposit rate paid to households. The rising loan rate reduces the demand for labor through working capital, which leads to a contraction of employment, investment, and capital utilization in sector 1. Note that the negative credit shock also hits sector 2 in the home country. The bank in sector 2 also suffers a loss from risky investments, which tightens its balance sheet. The bank then increases its interest rate on loans to firms to cover the loss. Since the financial market is integrated in sector 2, the interest rate on loans rises for the foreign country as well, as shown in the upper right panel of Fig. 5.3. An increase in the loan rate lowers demand for working capital in the foreign country. Hence, firms in both countries start to reduce their demand for labor, reduce investment and lower capital utilization. This leads to a simultaneous decline in output in sector 2. Therefore, as the size of sector 2 increases, the two countries become more synchronized under the credit shock.

From the analysis of the IRFs, it is clear that financial integration has a different impact on business cycle synchronization depending on the type of shock. With a technology shock, higher financial integration leads to lower business cycle synchronization. However, with a credit shock, higher financial integration leads to higher business cycle synchronization.

5.2. Financial Integration and Business Cycle Synchronization

In this section, we check whether the model can reproduce the empirical pattern that we identify. In particular, we use the simulated data from the model and run the same regression as in the empirical analysis. Specifically, we first select 20

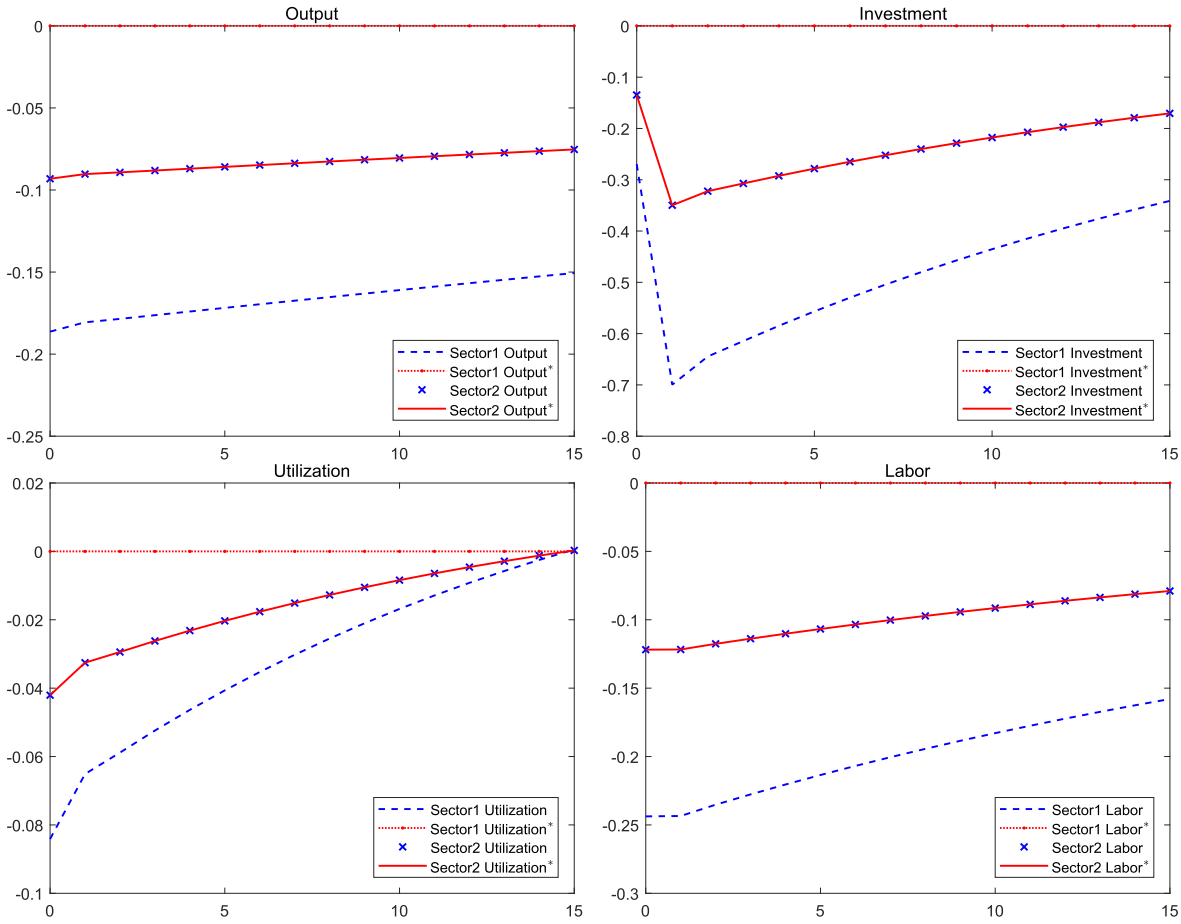

Fig. 5.4. Impulse Responses to Credit Shocks: Sectoral Variables.

Table 8
Regressions in Model and Data.

	Output		Consumption		Investment	
	Data	Model	Data	Model	Data	Model
	(1)	(2)	(3)	(4)	(5)	(6)
Integration	−0.0215***	−0.0504***	−0.0264***	−0.0380***	0.0220	−0.0838***
	(0.0071)	(0.0010)	(0.0081)	(0.0007)	(0.0245)	(0.0114)
Integration×Crisis	0.0442***	0.0609***	0.0500***	0.1333***	0.1113***	0.2181***
	(0.0090)	(0.0057)	(0.0097)	(0.0052)	(0.0300)	(0.0163)
Country-Pair FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country Time Trends	Yes	Yes	Yes	Yes	Yes	Yes
Observation	45313	39600	44320	39600	44135	39600
Adjusted R^2	0.258	0.084	0.242	0.115	0.304	0.088

Notes: The table reports the results of regressions in which simulated data are generated by the theoretical model; the coefficient of the constant term is excluded. Columns (1), (3), and (5) report the benchmark regression results from the data, and in columns (2), (4), and (6), we run the regression on simulated data from the model. Country-pair fixed effects, time fixed effects and country time trends are included. All continuous variables are expressed in logarithmic form. Standard errors clustered at the country-pair level are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

values of financial integration at equal spacing. Then, for each value, we simulate the model for 100 periods under productivity shocks only and then under both productivity and credit shocks. We repeat the above process 10 times.

Table 8 reports the estimates from both the model and the data. Columns (1), (3), and (5) show the benchmark estimates from the data, as in Table 2, and columns (2), (4), and (6) show the regression results from model-simulated data for comparison.

Table 9
Business Cycle Statistics.

	Data	Productivity Shocks	Both Shocks
Percentage Standard Deviation			
Output	1.32	1.32	1.32
Standard Deviation Relative to Output			
Consumption	0.62	0.67	0.95
Investment	2.85	2.51	2.88
Labor	0.66	0.62	0.92
Net Export	0.40	0.20	0.26
Cross-Correlation with Output			
Consumption	0.78	1.00	0.94
Investment	0.94	0.96	0.92
Labor	0.84	1.00	0.92
Net Export	−0.44	−0.22	−0.18
Cross-Country Correlations			
Output	0.49	0.20	0.37
Consumption	0.20	0.21	0.56
Investment	0.35	0.35	0.53
Labor	0.38	0.20	0.57

Notes: Statistics from the model are produced by simulating the model for 200 periods and taking averages over the 200 simulations (the values of the first 10 periods are dropped). All variables are Hodrick-Prescott (HP) filtered with a smoothing parameter of 1,600. All statistics except net exports are in logs. Net export statistics refer to the ratio (Exports - Imports)/GDP. Data statistics are calculated from Heathcote and Perri (2013).

Table 10
Welfare Analysis.

	Financial Autarky		**Financial Integration**		**Change of $\bar{c}$ (%)**
	Welfare	Certainty equivalence $\bar{c}$	Welfare	Certainty equivalence $\bar{c}$	
	(1)	(2)	(3)	(4)	(5)
Prod. shocks only	−275.4846	0.3630	−275.3749	0.3631	0.0398
Both shock types	−275.0162	0.3636	−275.0715	0.3635	−0.0201

Columns (2) and (4) indicate that our model matches the relationship between financial integration and the comovement of output and consumption reasonably well. We find that the effect of financial integration on consumption and output synchronization is negative, as reflected in the coefficients −0.0504 and −0.0380, respectively. Moreover, the coefficients on the interaction term are both positive, indicating that with a credit shock, countries that are more financially integrated have more synchronized output and consumption movements. Interestingly, the interaction terms indicate that during financial crises, financial integration has a stronger effect on consumption comovement than output comovement in the model, in line with what we find in the data.

Column (6) reports the regression results on investment synchronization. The model generates a strong and positive effect of integration on investment synchronization, consistent with the data. Note that the effect of integration on investment comovement is much larger than the effects on consumption and output comovement in both the data and the model. The first line of column (6) indicates a negative relationship between investment synchronization and the integration level, although we do not find such a significant effect in the data.

5.3. Business Cycle Moments

In this section, we check the unconditional moments generated from our model and compare them with those in the data. Table 9 reports business cycle statistics from the model under two scenarios, one with productivity shocks only and one with both productivity and credit shocks. The first column of the table reports the moments from the data.

The second column shows the moments when only productivity shocks are simulated and credit shocks are kept to zero. The model does a good job of replicating the positive correlations of consumption, employment, investment, and output in the data. Since each country has a financially integrated sector and a financially segmented sector, the cross-country correlations are a combination of the correlations in the two sectors. Note that with capital utilization, the model is able to generate a positive correlation of investment and a countercyclical net export. This is because when the firm wants to adjust its capital, it can adjust both the capital utilization rate and investment. This will reduce the response of investment, leading to

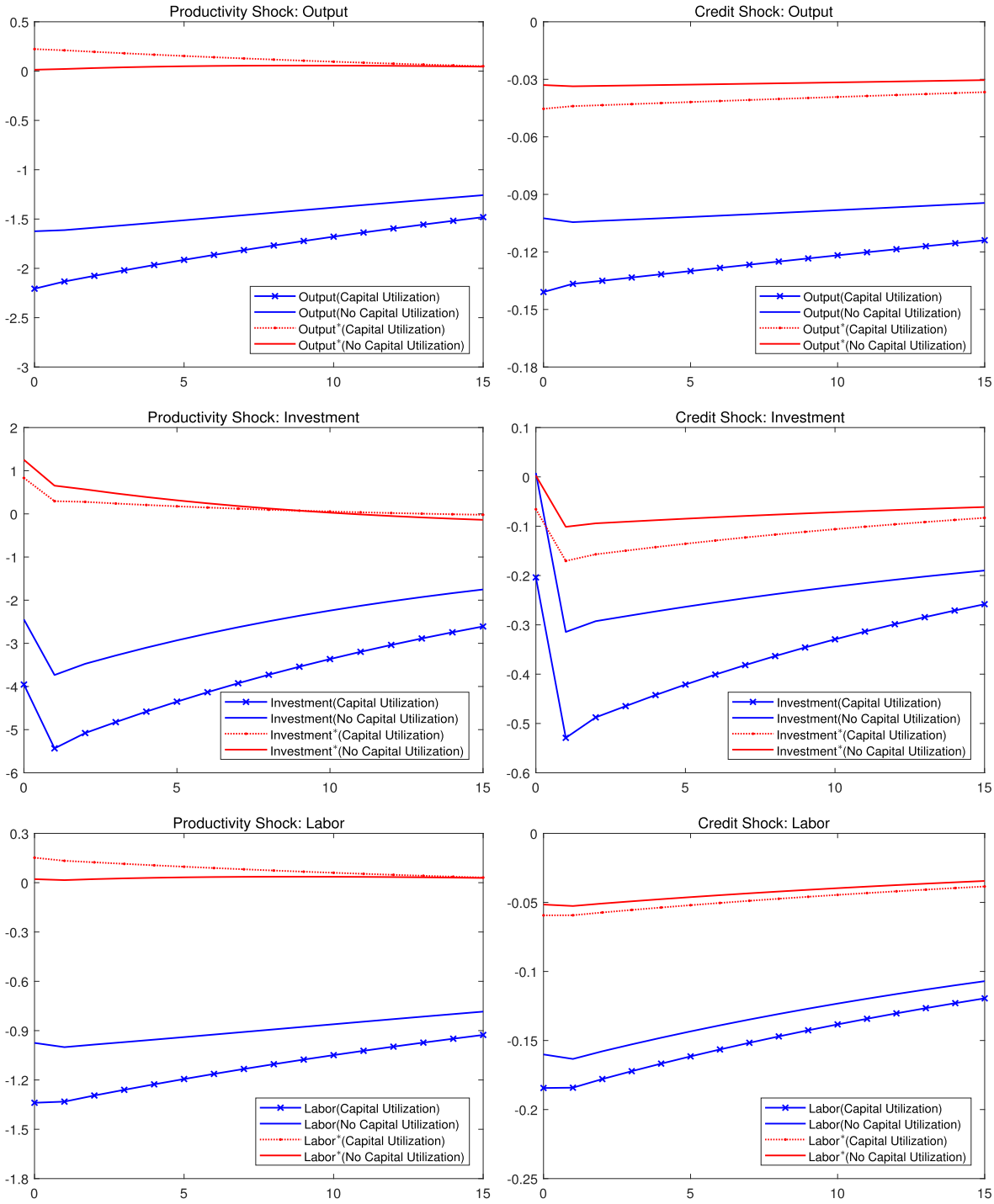

Fig. 6.1. Impulse Responses to Productivity and Credit Shocks.

less divergent investment cycles across countries. In the sensitivity analysis in Section 6, we compare our benchmark model results with a version without capital utilization and discuss the importance of capital utilization in shaping business cycle comovement outside and during financial crises, and we show how it helps us match both the unconditional moments and the regression coefficients.

The third column shows the moments when the model is simulated with both productivity and credit shocks. After the credit shocks are introduced, the cross-country correlations of consumption, labor, investment and output increase signifi-

Table 11
Sensitivity: No Capital Utilization.

Dependent Variable	Benchmark			No Capital Utilization		
	Output	Consumption	Investment	Output	Consumption	Investment
	(1)	(2)	(3)	(4)	(5)	(6)
Integration	−0.0504***	−0.0380***	−0.0838***	−0.0056***	−0.0091***	−0.4033***
	(0.0010)	(0.0007)	(0.0114)	(0.0002)	(0.0003)	(0.0110)
Integration×Crisis	0.0609***	0.1333***	0.2181***	0.0442***	0.1332***	0.2619***
	(0.0057)	(0.0052)	(0.0163)	(0.0041)	(0.0045)	(0.0115)
Country-Pair FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country Time Trends	Yes	Yes	Yes	Yes	Yes	Yes
Observations	39600	39600	39600	39600	39600	39600
Adjusted R^2	0.084	0.115	0.088	0.085	0.157	0.121

Notes: The table reports the results of regressions in which simulated data are generated by the theoretical model; the coefficient of the constant term is excluded. Country-pair fixed effects, time fixed effects and country time trends are included. All continuous variables are expressed in logarithmic form. Standard errors clustered at the country-pair level are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 12
Sensitivity: Cross-Country Correlations.

	Data	Productivity Shock	Both Shocks
Benchmark			
Output	0.49	0.20	0.37
Consumption	0.20	0.21	0.56
Investment	0.35	0.35	0.53
Labor	0.38	0.20	0.57
No Capital Utilization			
Output	0.49	0.28	0.43
Consumption	0.20	0.28	0.63
Investment	0.35	−0.11	0.31
Labor	0.38	0.26	0.64
ζ**=2**			
Output	0.49	0.27	0.43
Consumption	0.20	0.26	0.61
Investment	0.35	0.25	0.50
Labor	0.38	0.26	0.62
χ**=0.5**			
Output	0.49	0.19	0.53
Consumption	0.20	0.19	0.68
Investment	0.35	0.37	0.67
Labor	0.38	0.17	0.69

cantly. Moreover, we find that credit shocks have a stronger effect on consumption dynamics than on output dynamics. Note that net exports are less correlated with GDP in the model with both financial and productivity shocks. This corresponds to the view that credit shocks have similar effects on both countries and thus reduce international flows of resources.

5.4. Financial Integration and Welfare

Financial integration helps diversify risk. However, it could also accelerate the spread of financial crises across countries. In this section, we answer the question of financial globalization raised by the 2008 financial crisis—that is, whether financial integration is welfare improving. Following Backus et al. (1992), we define the welfare for the household in sector i as its expected lifetime utility:

$$Welfare_i \equiv E_0\left\{\sum_{t=1}^{\infty}\beta^t U(c_{it}, l_{it})\right\} \qquad i = 1, 2. \tag{36}$$

We can obtain a measure of economy-wide social welfare by aggregating the utilities of all households in the economy:

$$Welfare = (1-n)Welfare_1 + nWelfare_2. \tag{37}$$

We then compare welfare under two different circumstances: financial autarky and financial integration. Following Devereux and Yu (2020), we define the certainty equivalence of effective consumption $\tilde{c}$ by

$$Welfare = \frac{\tilde{c}^{1-\gamma} - 1}{1-\gamma} \frac{1}{1-\beta}, \tag{38}$$

and compare the equivalences across different financial integration levels.

Table 10 shows our welfare analysis. The first row is the case with productivity shocks, which corresponds to the period outside the financial crisis in the data. Column (5) indicates that moving from financial autarky ($n = 0$) to complete integration ($n = 1$) leads to a welfare gain of 0.0398% in the certainty equivalence of effective consumption. Interestingly, this conclusion is reversed if we take financial crises into consideration. The second row shows that with both productivity and credit shocks, financial integration leads to a welfare loss of 0.0201%. Hence, our theory indicates that during financial crises, an increase in financial integration leads to a welfare loss. However, financial integration continues to be welfare improving outside of financial crisis episodes.

6. Sensitivity Analysis

We now assess the sensitivity of our benchmark results. To show the importance of variable capital utilization, we first compare our benchmark model results with the model without capital utilization. We also show the robustness of our quantitative results with respect to the elasticity of the utilization response and the working capital ratio.

6.1. Capital Utilization

In this section, we show the importance of incorporating variable capital utilization both for matching the unconditional business cycle moments and for improving the regression results. For comparison, we solve a model without capital utilization and compare it to our benchmark model.

The left panel of Fig. 6.1 reports the IRFs of aggregate variables under a one-percentage-point negative productive shock and the right panel those under a one-percentage-point negative credit shock to the home country. The left panel shows that without capital utilization, the negative shock leads to a greater increase in aggregate investment in the foreign country. The reason for this is that the overreaction of investment flows abroad can be mitigated by the response of capital utilization, which is ignored in Kalemli-Ozcan et al., 2013a. Moreover, the impulse responses indicate that the divergence in output is less pronounced without capital utilization.

Table 11 shows how capital utilization can improve the regression results. Columns (4)-(6) of Table 11 report the regression results for the model without capital utilization. As shown in column (6), the total effect of integration on investment synchronization is negative, −0.14, which is contrary to what we find in the data[12]. This is caused by the fact that the magnitude of the negative relationship between financial integration and investment synchronization outside of the financial crisis is greater than its empirical counterpart. The model with capital utilization greatly improves the relationship between integration and investment comovement, and column (3) in Table 11 shows that with capital utilization, the model predicts a positive total effect, 0.13, of integration on investment synchronization, consistent with the data.

Table 12 reports the cross-country correlations for the model without capital utilization. The model generates a negative investment correlation that fails to match the data. Capital utilization is effective in strengthening the model-predicted cross-country correlations. Specifically, introducing capital utilization leads to a remarkable improvement in the correlation of investment to the point where this correlation is consistent with that in the data.

We also show how the model's predictions change with the elasticity of marginal depreciation with respect to the capital utilization rate. A higher value of ζ implies a less-elastic response. In this exercise, we consider a value of $\zeta = 2$, which is the empirical upper bound estimated by Basu and Kimball (1997). Table 13 shows that our model predictions still hold with the alternative ζ.

6.2. Working Capital

A predominant role of banks in the model is to finance short-term working capital needs to cover labor costs. Thus, labor inputs are sensitive to the interest rate on loans (Mendoza, 2010; Perri and Quadrini, 2018). The parameter χ reflects the fraction of the labor costs paid in advance. For example, $\chi = 1$ corresponds to the case where the full amount of labor costs must be financed at the beginning of each period. When $\chi = 0$, no advanced financing is required. In this exercise, we experiment with a higher χ that is set to 0.5.

Columns (4)-(6) of Table 14 report the model regression results under this alternative calibration for working capital. When χ is higher, a loss in a bank's risky assets leads to a larger decline in demand for employment, which results in more synchronized business cycles across countries. The coefficients on the interaction term for output, consumption and investment are much larger than those in the benchmark. The last panel of Table 12 reports the cross-country correlations under a higher χ; our baseline results remain robust with respect to χ.

Table 13
Sensitivity: Capital Utilization.

Dependent Variable	Benchmark			ζ=2		
	Output	Consumption	Investment	Output	Consumption	Investment
	(1)	(2)	(3)	(4)	(5)	(6)
Integration	−0.0504***	−0.0380***	−0.0838***	−0.0138***	−0.0167***	−0.1773***
	(0.0010)	(0.0007)	(0.0114)	(0.0003)	(0.0005)	(0.0118)
Integration×Crisis	0.0609***	0.1333***	0.2181***	0.0533***	0.1241***	0.2752***
	(0.0057)	(0.0052)	(0.0163)	(0.0048)	(0.0046)	(0.0156)
Country-Pair FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country Time Trends	Yes	Yes	Yes	Yes	Yes	Yes
Observations	39600	39600	39600	39600	39600	39600
Adjusted R^2	0.084	0.115	0.088	0.085	0.139	0.094

Notes: The table reports the results of regressions in which simulated data are generated by the theoretical model; the coefficient of the constant term is excluded. Country-pair fixed effects, time fixed effects and country time trends are included. All continuous variables are expressed in logarithmic form. Standard errors clustered at the country-pair level are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 14
Sensitivity: Working Capital.

Dependent Variable	Benchmark			χ=0.5		
	Output	Consumption	Investment	Output	Consumption	Investment
	(1)	(2)	(3)	(4)	(5)	(6)
Integration	−0.0504***	−0.0380***	−0.0838***	−0.0626***	−0.0552***	−0.0689***
	(0.0010)	(0.0007)	(0.0114)	(0.0011)	(0.0015)	(0.0097)
Integration×Crisis	0.0609***	0.1333***	0.2181***	0.1591***	0.2935***	1.1203***
	(0.0057)	(0.0052)	(0.0163)	(0.0074)	(0.0078)	(0.0318)
Country-Pair FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country Time Trends	Yes	Yes	Yes	Yes	Yes	Yes
Observations	39600	39600	39600	39600	39600	39600
Adjusted R^2	0.084	0.115	0.088	0.105	0.212	0.261

Notes: The table reports the results of regressions in which simulated data are generated by the theoretical model; the coefficient of the constant term is excluded. Country-pair fixed effects, time fixed effects and country time trends are included. All continuous variables are expressed in logarithmic form. Standard errors clustered at the country-pair level are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

7. Conclusion

In this paper, we study how financial integration affects the comovement of consumption, investment, and output across countries. We use a rich dataset on cross-border banking linkages covering 31 countries from 1978 to 2018. We find that the relationships between banking linkages and consumption, investment, and output comovement differ significantly during the 2008 financial crisis from those during other periods. Specifically, we find that during tranquil times, higher financial linkages are associated with lower synchronization of consumption and output. These relationships become positive during the 2008 financial crisis, suggesting that the financial crisis induced business cycle comovement for more financially integrated countries. We also find that banking linkages have a strong positive effect on cross-country investment synchronization during the crisis.

Based on our empirical findings, we build a two-country DSGE model with global banks and variable capital utilization to illustrate how exogenous changes in financial integration affect business cycle comovement. Our model shows that the impact of financial integration on business cycle synchronization depends crucially on the type of shock. A quantitative evaluation shows that the model can replicate our empirical relationship between financial integration and business cycle synchronization reasonably well. We also point out that capital utilization is important in accounting for investment behavior during and outside of financial crises.

Our paper also contributes to the discussion of the benefits of financial integration. Our theory indicates that during financial crises, an increase in financial integration leads to a welfare loss. However, financial integration continues to be welfare improving outside of financial crisis episodes.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. List of Countries

Table A1.

Table A1
List of Countries.

Emerging Countries (11)	OECD Countries (20)
Argentina, Brazil, Chile, Colombia, Costa Rica, Mexico, India, Indonesia, South Africa, Saudi Arabia, Turkey	Austria, Australia, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States

Data Source: OECD Statistics.

Appendix B. List of Systemic Banking Crises

Table A2.

Table A2
Systemic Banking Crises (1978–2018).

Country	Start	End	Country	Start	End
Argentina	1980Q1	1982	Indonesia	1997Q4	2001
	1989Q4	1991	Ireland	2008Q3	2012
	1995Q1	1995	Italy	2008Q3	2009
	2001Q4	2003	Japan	1997Q4	2001
Austria	2008Q3	2012	Luxembourg	2008Q3	2012
Belgium	2008Q3	2012	Mexico	1981	1985
Brazil	1990Q1	1994		1994Q4	1996
	1994Q4	1998	Netherlands	2008Q3	2009
Chile	1976	1976	Portugal	2008Q3	2012
	1981Q4	1985	Spain	1977	1981
Colombia	1982Q3	1982		2008Q3	2012
	1998Q2	2000	Sweden	1991Q3	1995
Costa Rica	1987	1991		2008Q3	2009
	1994	1995	Switzerland	2008Q3	2009
Denmark	2008Q3	2009	Turkey	1982	1984
Finland	1991Q3	1995		2000Q4	2001
France	2008Q3	2009	United Kingdom	2007Q3	2011
Germany	2008Q3	2009	United States	1988	1988
Greece	2008Q3	2012		2007Q4	2011
India	1993	1993			

Data Source: Laeven L, Valencia F. 2018. Systemic banking crises revisited, IMF.

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