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The Great Recession: Divide between Integrated and Less Integrated Countries

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Abstract

No robust relationship between has been found between the decline in growth of countries during the Great Recession and their level of trade or financial integration. Here we confirm the absence of such a monotonous relationship, but document instead a strong discontinuous relationship. Countries whose level of economic integration was above a certain cutoff saw a much larger drop in growth than less integrated countries, a finding that is robust to a wide variety of controls. We argue that standard models based on transmission of exogenous shocks across countries cannot explain these facts. Instead we explain the evidence in the context of a multi-country model with business cycle panics that are endogenously coordinated across countries.

1 Introduction

There are two important features of business cycle synchronization across countries during the 2008-2009 Great Recession. The first is that synchronicity during this period was unparalleled historically. Perri and Quadrini (2013) show that business cycle correlations were much higher among industrialized countries during this period than any earlier time since 1965.[1] Remarkably, even though the origin of the recession is widely associated with the United States, the decline in GDP, investment, consumption and corporate profits were of a very similar magnitude in the rest of the world as in the United States.[2] The decline was also similar in emerging economies as in industrialized countries, and was of a similar magnitude in Europe, the US and Asia.[3]

A second feature relates to the link between business cycle synchronization and economic integration. There is an existing empirical literature that finds no robust relationship between measures of trade and financial integration on the one hand and the decline in growth during the Great Recession on the other hand.[4] In this paper we confirm the absence of a robust monotonic relationship between measures of economic integration and business cycle synchronization. However, we find that integration does matter beyond some threshold. When integration is sufficiently low, below a particular threshold, countries are considerably less impacted by the Great Recession. This finding is robust to introducing a wide variety of controls, different measures of crisis performance, and different subsets of countries.

The paper develops a theory that accounts for these two features of business cycle synchronization during the Great Recession. It is useful to start though by pointing out that the evidence goes against most existing theories of business cycles in open economy models. In most models synchronicity occurs either because

[1] See also Imbs(2010) and International Monetary Fund (2013).

[2] See Bacchetta and van Wincoop (2014).

[3] We are interested here in the unusual and sudden increase in synchronicity of business cycles during the Great Recession as opposed to trends in synchronicity over time. Regarding the latter, Bordo and Helbling (2010) find that there has been a trend towards increased integration during most of the twentieth century, while Hirata, Kose and Otrok (2014) find that over the past 25 years the global component of business cycles has declined relative to local components (region and country-specific).

[4] Among many others, see Rose and Spiegel (2010), Kamin and Pounder (2012), Kalemli-Ozcan et al.(2013) and International Monetary Fund (2013). Cecchetti, King and Yetman (2013) contain an overview of all the relevant studies.

of a common shock that affects all countries or because an exogenous fundamental shock is transmitted across countries through trade and financial linkages. Regarding the former, shocks that are typically attributed to this period apply to the housing market and financial markets. Those shocks, however, originated largely in the United States rather than being common across countries. Regarding transmission of shocks, it is well known that this depends on the nature of the shocks and even perfect integration does not need to imply perfect business cycle synchronization.[5] Even when a model implies that higher trade or financial integration leads to higher business cycle synchronization, transmission of shocks across countries is significantly limited by home bias in both goods and financial markets.[6]

Some papers focusing on complex networks have shown that with limited financial interconnectedness there can be a tipping point where shocks are spread across the entire network of banks.[7] But even here there is limited applicability to the two stylized facts discussed above about business cycle synchronization during the Great Recession. First, even if one takes for granted that a financial shock is spread across the globe this way with limited financial integration, there is extensive evidence that a decline in credit was not the main reason behind the 2008-2009 recession.[8] Second, it is much harder to tell such network stories based on a standard business cycle model with firms and households.[9] Finally, such tipping points in financial networks do not speak to the type of non-linearity we observe in the relationship between business cycle synchronization and economic integration in a

[5]For example, a standard open economy real business cycle model with perfect integration of goods and financial markets, such as Backus, Kehoe and Kydland (1992), implies that output is negatively correlated across countries.

[6]As an example of this, van Wincoop (2013) shows that under realistic financial home bias, transmission across countries of balance sheets shocks experienced by leveraged institutions is limited.

[7]See for example Gai et.al. (2011) or Nier et.al. (2007).

[8]Kahle and Stulz (2013) use firm level data to show that there was no relationship between the drop in investment by firms and their bank dependence. Helbling, Huidrom, Kose and Otrok (2011) estimate a global VAR to find that a global credit shock accounts for only 10% of the global drop in GDP in 2008-2009. Nguyen and Qiuan (2013) use firm level survey data to argue that the impact of the crisis on Eastern European firms took the form of a demand shock rather than a credit crunch. Adrian, Colla and Shin (2013) find that a decline in bank credit to firms in 2009 was replaced by an equal increase in bond financing.

[9]While one can easily imagine a financial institution being a critical node in a broader network, it is much harder to argue so for an individual household or firm, particularly on a global scale.

cross-section of countries. These tipping points refer to a general level of interconnectedness rather than the cross-sectional variation in interconnectedness that we have in mind here.

The theory we develop to explain the two features of business cycle synchronization during the Great Recession is based on an extension of Bacchetta and van Wincoop (2014), from here on BvW. BvW explain the Great Recession as the result of a self-fulfilling expectations shock as opposed to an exogenous shock to fundamentals. When agents believe that income will be lower in the future, they reduce current consumption, which reduces current output and firm profits. This in turn reduces investment and therefore future output, making beliefs self-fulfilling. However, the novel aspect of BvW is not the idea of self-fulfilling expectations shocks to explain business cycles. There are many such models.[10] The novel aspect is to show that in an open economy context such self-fulfilling beliefs are necessarily coordinated across countries beyond a certain threshold of integration. This coordination occurs because their interconnectedness makes it impossible for one country to have very pessimistic beliefs about the future, while the other country has very optimistic beliefs. BvW show that partial integration is therefore sufficient to generate a perfectly synchronized decline in output across countries.

However, the model in BVW does not address the second feature of business cycle synchronization, the non-linear relationship between economic integration and business cycle synchronization seen during the Great Recession. The model consists of only two countries, so that it cannot study cross-sectional variation in the degree of economic integration. By definition the two countries are equally integrated. We therefore develop a model that extends the framework of BvW to analyze the case where there is a continuum of countries, with the extent of integration varying across countries. The model is able to generate equilibria that are consistent with the empirical evidence. If we define integrated countries as all countries above a certain level of integration, then a panic that involves some of these countries will necessarily involve all of them. In general at most a subset of the remaining less integrated countries will panic. The reason that the integrated

[10] These are generally closed economy models. Examples include Aruoba and Schorfheide (2013), Bacchetta et.al (2012), Benhabib et al. (2012), Farmer (2012a,b), Heathcote and Perri (2013), Liu and Wang (2013), Mertens and Ravn (2013), Schmitt-Grohé and Uribe (2012) and Schmitt-Grohé (1997).

countries all panic together is the same as in BvW. When they are sufficiently interconnected, it is not possible for some to have very pessimistic views about the future and others very optimistic beliefs. The less integrated countries, however, are like countries in autarky. They may or may not experience a panic, but if they do it is more of a coincidence as it is unrelated to the panic happening in other countries.

In this setup the relationship between integration and business cycles is discontinuous. Integration matters significantly in terms of what side of the threshold of integration countries are on, with each of the highly integrated countries experiencing a sharp drop in output, while in general at most a fraction of the less integrated countries panic and see their output go down significantly. Within these two groups of countries there is no monotonous positive relationship between their level of integration and the drop in their output. Within the integrated group the drop in output will be identical, independent of their level of integration, while the subset of the less integrated countries that panics does not need to bear any relationship to their level of integration.

The remainder of the paper is organized as follows. In section 2 we discuss the empirical evidence. Section 3 develops the model. Section 4 reports the implications of the model for the synchronization of business cycles. Section 5 develops an extension with one large country and a continuum of small countries. Section 6 concludes.

2 Empirical Evidence

2.1 Data and methodology

We collect data for a sample of 151 countries, based on data availability. The precise sample of countries is tabulated in Table 1.[11] Our main data sources are the

[11] We also had data available for Armenia, Equatorial Guinea and Luxembourg, but we decided to exclude these countries from all our regressions. We excluded Armenia because, in addition to being one of the most affected countries by the crisis, it is more integrated than what our measures of economic integration reflect due to remittances. We excluded Equatorial Guinea for overall problems with data quality (see Lane and Milesi-Ferretti (2011)), and Luxembourg because of its extreme value for financial openness, which is well known to be associated with measurement error. Including these three countries does not substantially change our main results, though.

April 2014 World Economic Outlook (WEO) Database, and the World Development Indicators (WDI) from the World Bank Database. In addition, we get data on financial variables from the "External Wealth of Nations" dataset, constructed by Lane and Milesi-Ferretti (2007), data on the exchange rate regime from the "Shambaugh exchange rate classification" dataset, and data on the manufacturing share of GDP from the United Nations Database. Table 2 shows some descriptive statistics, together with the specific data source of each variable.

The set of countries and variables used in the regressions is similar to Lane and Milesi-Ferretti (2011). In particular, we use their same measures of integration, namely trade openness (defined as imports plus exports divided by GDP) and financial openness (defined as external assets plus external liabilities divided by GDP), both in percentage terms. We deviate from them, though, by choosing the forecast errors (the actual 2009 GDP growth rate minus the April 2008 WEO pre-crisis forecast) as our preferred measure of crisis performance. This measure, first proposed by Berkmen et al. (2012), has the advantage of controlling for other factors unrelated to the impact of the crisis that may have affected countries' growth rates during this period. Nevertheless, we use the 2009 GDP growth rate as an alternative measure of the crisis intensity in the robustness checks, with similar results.

In our main regressions, we exclude from our sample countries with a GDP per capita below a thousand 2007 dollars (poor countries), as well as countries above the 95^{th} percentile in financial openness (financial centers).[12] We exclude poor countries, both because of data quality issues and because extremely poor countries tend to rely heavily on official forms of international finance, thus being less exposed to private-sector financial flows (see Lane and Milesi-Ferretti (2011)). For these countries, high values of financial openness can be quite misleading. Similarly, we exclude financial centers because their extreme values of financial openness tend to reflect their role as financial intermediaries rather than true integration. We have 34 countries classified as poor and 7 countries classified as financial centers, thus leaving us with a benchmark sample of 110 countries. We will consider specifications including these subsets of countries in our robustness analysis.

We follow the empirical literature by regressing the forecast errors on several

[12] These include Mauritius, Iceland, Bahrain, Switzerland, Hong Kong, Ireland and Singapore.

2007 pre-crisis variables, as a way to identify "initial conditions" that help to explain the slowdown during the crisis. These variables include our two measures of economic integration, plus the following controls: the average GDP growth rate from 2004 to 2007; the trend growth rate (proxied by the average GDP growth rate from 1996 to 2007); the growth in the ratio of private credit to GDP over the period 2004-07; the share of the manufacturing sector in GDP (in percentage terms); the current account to GDP ratio; the net foreign asset position (as a percentage of GDP); the external reserves to GDP ratio; the log of country population (in millions); the level of GDP per capita (in thousands of 2007 dollars); the level of GDP (in billions of dollars); a dummy that equals 1 if the country had a de facto fixed exchange regime during 2007; and an oil dummy.[13] All these variables have been widely used in the literature examining what factors played a role in the cross country variation of business cycles during the Great Recession.[14]

In addition to this, we consider different integration dummies as we are mainly interested in whether the level of economic integration matters in a non-continuous or monotone way. We first experiment with simple trade and financial dummies, which take a value of 1 if the level of trade/financial openness is above some percentile level, and zero otherwise. We also consider a joint trade and financial integration dummy, constructed as follows. We first take a linear combination of our two measures of integration:

$$Integration_i = \alpha\, trade_i + (1-\alpha)\, financial_i,$$

where $trade_i$ and $financial_i$ are our two measures of trade and financial openness of country i, and $\alpha \in [0,1]$ is a parameter to be chosen. The joint dummy then equals 1 when the combined integration measure is above some cutoff γ, and zero otherwise.

Since we have a priori no idea about the proper values for α and γ, we follow the Threshold Estimation literature and estimate them by means of Maximum Likelihood (MLE), in a way similar to Hansen (2000). Specifically, we want to

[13] We define as oil exporters the 2007 OPEC members, plus the following countries: Azerbaijan, Belize, Brunei, Chad, Gabon, Kazakhstan, Republic of Congo, Russia, Sudan, and Trinidad and Tobago.

[14] See Cecchetti, King and Yetman (2013) for a summary of selected studies examining crisis impact, their main explanatory variables, and their findings.

estimate the following model:

$$y_i = \theta_0 + \beta' x_i + e_i, \qquad q_i(\alpha) \leq \gamma$$

$$y_i = \theta_1 + \beta' x_i + e_i, \qquad q_i(\alpha) > \gamma$$

where y_i is a measure of the crisis performance, x_i is our vector of pre-crisis controls, β' is a vector of coefficients, θ_0 and θ_1 are the intercepts, $q_i(\alpha)$ is our combined measure of integration described above, and e_i is an error term. Thus, in this model we allow the intercept θ to change when the threshold variable q is above some unknown cutoff γ. Moreover, the threshold variable depends on some unknown parameter α.[15] To write the model in a single equation, define the dummy variable

$$d_i(\alpha, \gamma) = \{q_i(\alpha) > \gamma\}$$

where $\{\cdot\}$ denotes the indicator function. Then, the model above can be rewritten as

$$y_i = \theta_0 + \eta d_i(\alpha, \gamma) + \beta' x_i + e_i,$$

where η is the dummy coefficient. The regression parameters are $(\beta', \theta_0, \eta, \alpha, \gamma)$, and the natural estimator is least squares (LS), which is also the MLE if one assumes that e_i is iid $N(0, \sigma^2)$. By definition, the LS estimators $(\widehat{\beta}', \widehat{\theta}_0, \widehat{\eta}, \widehat{\alpha}, \widehat{\gamma})$ jointly minimize the sum of the squared errors S_n. To compute these estimators, we proceed as follows. First, we choose some values for α and γ. Conditional on these values, we run a OLS regression and obtain the sum of squared errors $S_n(\alpha, \gamma)$, where we just make explicit that S_n depends upon α and γ. Then, the MLE estimator $(\widehat{\alpha}, \widehat{\gamma})$ are those values for α and γ that minimize $S_n(\alpha, \gamma)$, or more formally,

$$(\widehat{\alpha}, \widehat{\gamma}) = \underset{\alpha, \gamma}{\arg\min}\; S_n(\alpha, \gamma)$$

In practice, this reduces to choose the regression for which the sum of the squared residuals is the smallest. Finally, we can test whether the estimated threshold is significant or not just by checking the p-value of $\widehat{\eta}$. After following this procedure for different subsets of the controls, we consistently find point estimates of $\widehat{\alpha} =$

[15] The procedure described here also applies to the simpler case with a trade or a financial dummy. One just have to set either $\alpha = 1$ or $\alpha = 0$.

0.10 and $\widehat{\gamma} = 137.61$,[16] which corresponds to the 35^{th} percentile of the combined integration variable.[17]

Figure 1 provides a visual illustration with raw data. In this picture, we plot two subsets of countries in the trade-financial openness space. Specifically, we distinguish between good performers (countries with a forecast error higher than the mean plus $\frac{1}{2}$ of the standard deviation) and bad performers (with a forecast error lower than the mean minus $\frac{1}{2}$ of the standard deviation).[18] The plotted line consists of all the values in the trade-financial space for which the combined integration variable, with $\alpha = 0.10$, takes a value of 137.61. We refer to the region above the line as the integrated region, and to the region below as the not-integrated region.

Two facts are immediate from Figure 1. First, we have both good and bad performers in each region. Second, the ratio of bad performers to good performers is much higher in the integrated region than in the not-integrated one (2.18 in the former, 0.41 in the latter). Moreover, the group of bad performers does not follow any particular pattern, other than most of them (77.41%) being concentrated in the integrated region. Finally, a simple regression of the forecast error on the joint dummy plus the logs of trade and financial openness gives a coefficient of -4.09 on the joint dummy with a p-value well below 0.01. It means that, on average, countries in the integrated region suffered an unexpected GDP growth downturn around 4 percentage points compared to the others. These initial results may look encouraging, but it remains to be seen whether they still hold after a more formal econometric analysis, introducing various controls, to which we turn next.

[16] In fact, all values of α between 0.06 and 0.14 conditional to $\widehat{\gamma} = 137.61$ delivered the same sum of squared residuals, so we just pick the midpoint between the two.

[17] During the search process, we sometimes found another local minimum for a much higher value of γ around the 70^{th} percentile, but this finding was not robust to different subsets of the controls.

[18] Recall that in general the forecast error are negative, meaning that countries tended to perform worse in the crisis than expected. Thus, a more negative forecast error implies a worse crisis performance.

2.2 Regression results

2.2.1 Without integration dummies

Table 3 reports the results from regressions without integration dummies included. In Column 1 we regress the forecast error on the logs of trade and financial openness and the controls discussed in the previous subsection. We observe that neither the trade openness nor the financial openness variables are significant. Column 2 runs the same regression but with 2009 GDP growth as the dependent variable. Since we include both the growth trend and the pre-crisis average GDP growth in the regressors, this specification is the same as one where the dependent variable is the change in the growth rate relative to trend or relative to the period 2004-07. As before, both integration coefficients are insignificant.

Column 3 includes the financial centers and column 4 includes the poor countries. The inclusion of these subsets of countries makes trade openness significant at the 10% level, but financial openness remains insignificant. Columns 5 and 6 replicates our first two columns but including all the countries in our sample. In column 5 trade openness now becomes significant at the 5% level, but this is not a robust finding as it loses significance once we change our measure of crisis performance in column 6. Overall, we have little success finding any robust relationship between pre-crisis variables and measures of crisis performance, in line with the previous crisis literature.[19]

2.2.2 With integration dummies

In Table 4 we experiment with the different integration dummies discussed before. Column 1 regresses the forecast errors on all the explanatory variables plus a trade dummy that equals one when the value of trade openness is above the 41^{th} percentile. The coefficient of this dummy alone is quite negative (-3.01) and significant at the 5% level. The coefficients of trade and financial openness are still insignificant, and the remaining controls follow the same pattern as in Table 3. In column 2 we run the same regression, but this time with a financial dummy that equals one if financial openness is above the 34^{th} percentile instead. The coefficient of this financial dummy (-4.54) is even lower than the trade one, and strongly significant.

[19] See for example Rose and Spiegel (2011).

Column 3 includes the joint dummy in the regression. It has a coefficient of -4.72 that is significant at all the conventional levels. It means that, everything else equal, the forecast errors of countries above the 35^{th} percentile in the combined integration measure were on average 4.72 percentage points lower. Given that the average forecast error was around -5, this represents a highly sizable effect. Moreover, the subset of countries for which this dummy equals 1 comprises a high share of World's GDP, as it includes the U.S., Japan, and most of the E.U. countries.[20]

2.3 Robustness checks

In this subsection we choose the joint dummy as our most preferred measure of a non-continuous effect of integration on crisis performance, and run several robustness tests on it.

First, in Table 6 we explore the sensitivity of the dummy to different choices of α and percentiles' cutoffs. In this table, different rows correspond to different values of α, ranging from 0 to 1, and different columns correspond to different choices of the percentile cutoff, ranging from the 19^{th} percentile of the combined integration variable to the 45^{th} percentile. The numerical entries in the table are the coefficient values of joint dummies from regressions with the same specification as in column 3 of Table 4. Bold numbers mean that the dummy is significant at the 10% level at least. We find that coefficients between the 19^{th} and the 41^{th} percentile tend to be significant at the 10% level, and in most cases (specially around our benchmark joint dummy with $\alpha = 0.10$ and the 35^{th} cutoff) we achieve significance at the 5% or 1% level. These results suggest that the discontinuous effect of integration on crisis performance is not particularly sensitive to different choices of the parameter values or percentile cutoffs.

Next, in Table 7 we run additional robustness checks for alternative measures of crisis performance and different subsets of countries. Here, column 1 simply replicates our results from column 3 in Table 4, just for comparison purposes. In column 2 we change our measure of crisis performance and use the 2009 GDP growth as our dependent variable. As we see, the magnitude of the dummy coefficient (-4.41) is similar to column 1, and it is also significant at all the conventional

[20] Table 5 provides the specific list of countries for which the joint dummy equals 0 (the less integrated countries).

levels.

In column 3 we recover the forecast error as our dependent variable and explore whether extremes outcomes in the forecast errors might be driving our results by excluding countries with forecast errors below the 5^{th} percentile. In this case, the coefficient takes a value of -2.89, higher than in column 1 but still significant at the 1% level. Columns 4 and 5 include the financial centers and the poor countries. In both cases the coefficient on the dummy is higher than in column 1, but they remain strongly significant. Finally, columns 5 and 6 include all the countries in our sample. With the forecast errors as the dependent variable, we still achieve significance at the 1% level and a coefficient of -3.46, and with the 2009 GDP growth we achieve significance at the 5% level and a coefficent of -2.79.

Additionally, we tested whether our integration dummy might just be capturing some non-linear, but still continuous effect by including different combinations of second and higher order terms of trade and financial openness. The results (not reported) indicate that it is not the case, as all the higher order terms are insignificant whereas the dummy still shows a strong and statistical significant effect. If anything, the coefficient on the dummy decreases. Finally, we also experimented with different subsets of the controls. The coefficients on trade and financial openness may or may not become significant, depending on the specification, but we consistently find that the integration dummy is significant at the 5% level at least, and in most cases with a coefficient below -3.[21]

In summary, the empirical evidence presented here suggests that there was indeed a strong, non-continuous effect of trade and financial integration on crisis performance during the Great Recession. This effect is robust to the inclusion of a variety of controls, different parameter values or percentile cutoffs, different measures of crisis performance, and different subsets of countries. We now turn to a model aimed at explaining these empirical findings.

3 Model Description

There are two periods and a continuum of countries on the interval $[0, 1]$. We will first describe households, firms, central banks and market clearing conditions. The entire model is then summarized in a condensed form that is used in the next

[21] We also run regressions excluding the oil exporters, but it did not affect our results.

section to analyze the equilibria.

While in the empirical work we considered both trade and financial integration, the model only introduces trade integration. A single parameter measures trade integration for each country. What is key to the results is that the integration generates a positive linkage between countries. The same results hold under financial integration as long as it also generates a positive linkage. We focus on trade integration only because it is analytically more tractable and easier to characterize with a single parameter for each country.

3.1 Households

Utility of households in country i is

$$ln\left(c_1^i\right) + \lambda l_1^i + \beta\left(ln\left(c_2^i\right) + \lambda l_2^i\right) \tag{1}$$

where l_t^i is the fraction of time devoted to leisure in period t and c_t^i is the period t consumption index.

The consumption index is

$$c_t^i = \left(\frac{c_{i,t}^i}{\psi_i}\right)^{\psi_i}\left(\frac{c_{F,t}^i}{1-\psi_i}\right)^{1-\psi_i} \tag{2}$$

where $c_{i,t}^i$ is an index of country i goods consumed by country i residents and $c_{F,t}^i$ is an index of foreign goods consumed by country i residents:

$$ln\left(c_{F,t}^i\right) = \int_0^1 \frac{1-\psi_j}{1-\bar{\psi}}\left(ln\left(c_{j,t}^i\right) - ln\left(\frac{1-\psi_j}{1-\bar{\psi}}\right)\right)dj \tag{3}$$

Here $\bar{\psi} = \int_0^1 \psi_j dj$ and

$$c_{j,t}^i = \left(\int_0^1 \left[c_{j,t}^i(m)\right]^{\frac{\sigma-1}{\sigma}} dm\right)^{\frac{\sigma}{\sigma-1}} \tag{4}$$

is an index of country j goods consumed by country i residents, with $c_{j,t}^i(m)$ consumption at time t by country i of good m from country j.

The parameter ψ_i is a measure of integration for country i, ranging from 0 if it is perfectly integrated to 1 when it is in autarky. A couple of comments need to be made to justify this utility specification. First, the friction we introduce to generate imperfect integration is home bias in preferences. An alternative is to introduce trade costs, while leaving preferences the same for all countries. However, proportional trade costs have the disadvantage that no matter the level of these costs, as the relative size of countries goes to zero, the fraction of home goods countries consume approaches zero as well. One would need to introduce a fixed cost of goods trade to generate a positive fraction of home goods consumed for infinitesimally small countries, but this significantly complicates the analysis.

Second, the consumption index (3) of foreign goods needs some explanation. There are two types of home bias in preferences. First, country i has a bias towards its own goods and therefore a bias away from foreign goods. This is captured by the parameter ψ_i in the overall consumption index (2). In this case a larger ψ_i reduces imports. Second, to the extent that countries buy foreign goods, they have a different bias against goods from different countries. The index (3) implies that a larger ψ_j leads country i to have a larger bias against goods from country j. Similarly, a larger ψ_i implies that all countries other than i have a larger bias against the goods from country i. This reduces the exports of country i. Putting the two together, a higher ψ_i simultaneously reduces imports and exports of i. If we allowed a higher ψ_i only to reduce the imports by country i, and not exports, a higher ψ_i would have a large effect on relative prices to generate balanced trade, which significantly complicates the analysis.

The budget constraint in period 1 is:

$$\int_0^1 P_1^i(m)c_{i,1}^i(m)dm + \int_0^1 \int_0^1 S_{i,1}\frac{P_1^j(m)}{S_{j,1}}c_{j,1}^i(m)dmdj + B_i + M_1^i = W_1^i(1-l_1^i) + \Pi_1^i + \bar{M}_1^i \tag{5}$$

where $P_1^i(m)$ is the price of good m from country i measured in the currency of country i, $S_{i,1}$ is units of country i currency per unit of a base currency (say country 1) and B_i is holdings of a domestic bond. M_1^i are money holdings and $\bar{M}_1^i$ is a money transfer at time 1 from the central bank. W_1^i is the wage rate and Π_1^i is profits from firms. $W_1^i(1-l_1^i) + \Pi_1^i$ is nominal GDP of country i measured in the currency of country i.

The domestic bond of country i is in zero net supply and delivers R^i units of country i currency in period 2. The period 2 budget constraint is then

$$\int_0^1 P_2^i(i)(m)c_{i,2}^i(m)dm + \int_0^1 \int_0^1 S_{i,2}\frac{P_2^j(m)}{S_{j,2}}c_{j,2}^i(m)dmdj + M_2^i = W_2^i(1-l_2^i) + \Pi_2^i + M_1^i + R^iB_i + (\bar{M}_2^i - \bar{M}_1^i) \tag{6}$$

We assume a cash-in-advance constraint with the buyer's currency being used for payment:

$$\int_0^1 P_t^i(i)(m)c_{i,t}^i(m)dm + \int_0^1\int_0^1 S_{i,t}\frac{P_t^j(m)}{S_{j,t}}c_{j,t}^i(m)dmdj \leq M_t^i \tag{7}$$

Let P_t^i denote the country i consumer price index in the local currency and $P_t(i)$ the price index of country i goods measured in the country i currency. $P_{F,t}$ is the price index of all Foreign goods measured in the base currency. The first-order conditions are then

$$\frac{1}{c_1^i} = \beta R^i \frac{P_1^i}{P_2^i}\frac{1}{c_2^i} \tag{8}$$

$$c_{i,t}^i = \psi_i \frac{P_t^i}{P_t(i)} c_t^i \tag{9}$$

$$c_{F,t}^i = (1-\psi_i)\frac{P_t^i}{S_{i,t}P_{F,t}} c_t^i \tag{10}$$

$$c_{j,t}^i = \frac{1-\psi_j}{1-\bar{\psi}}\frac{S_{j,t}P_{F,t}}{P_t(j)} c_{F,t}^i \quad i \neq j \tag{11}$$

$$c_{j,t}^i(m) = \left(\frac{P_t^j(m)}{P_t(j)}\right)^{-\sigma} c_{j,t}^i \quad \forall i,j \tag{12}$$

$$\frac{W_t^i}{P_t^i} = \lambda c_t^i \tag{13}$$

where the price indices are

$$P_t^i = P_t(i)^{\psi_i}(S_{i,t}P_{F,t})^{1-\psi_i} \tag{14}$$

$$P_t(i) = \left(\int_0^1 [P_t^i(m)]^{1-\sigma} dj\right)^{\frac{1}{1-\sigma}} \tag{15}$$

$$ln\left(P_{F,t}\right) = \int_0^1 \frac{1-\psi_j}{1-\bar{\psi}} ln\left(\frac{P_t(j)}{S_{j,t}}\right) dj \tag{16}$$

3.2 Firms

Each firm produces a different good. We assume that prices are set at the start of each period. Since all firms within a country face the same problem, they set the same price: $P_t^i(m) = P_t(i)$. Given these prices, firms in period 1 will produce whatever the demand is for their products. The only shock in the model is a sunspot shock that is realized during period 1 that may generate a self-fulfilling shift in expectations. Period 1 prices are set before the realization of this shock. In period 2 the prices are also set at the start of the period, but since there are no shocks during period 2 this is the same as period 2 prices being flexible. Period 2 is therefore neoclassical.

Output of good m in period 2 in country i is

$$y_2^i(m) = \left[A_i L_2^i(m)\right]^\alpha \tag{17}$$

where $L_2^i(m)$ is labor input and A_i productivity that is endogenous and will be discussed below. Firms in period 2 in country i maximize profits

$$P_2^i(m) y_2^i(m) - \frac{W_2^i}{A_2}[y_2^i(m)]^{1/\alpha} \tag{18}$$

subject to demand

$$y_2^i(m) = c_{i,2}^i(m) + \int_0^1 c_{i,2}^j(m)dj = \left(\frac{P_2^i(m)}{P_2(i)}\right)^{-\sigma}\left(c_{i,2}^i + \int_0^1 c_{i,2}^j dj\right) \tag{19}$$

The optimal price is then a markup over marginal cost:

$$P_2^i(m) = \frac{\sigma}{\sigma - 1}\frac{W_2^i}{\alpha A_i}[y_2^i(m)]^{\frac{1-\alpha}{\alpha}} \tag{20}$$

The production function is the same in period 1, except that productivity is set at 1 for all firms. Using that all firms within a country set the same price and produce the same amount, profits of all firms in country i are equal to

$$\Pi_1^i = P_1(i) y_1^i - W_1^i [y_1^i]^{1/\alpha} \tag{21}$$

Dividing by the consumer price index, we get real profits:

$$\pi^i = \frac{\Pi_1^i}{P_1^i} = \frac{P_1(i)}{P_1^i} y_1^i - \frac{W_1^i}{P_1^i}[y_1^i]^{1/\alpha} \tag{22}$$

Now assume that firms either invest a constant k in period 1, or they do not. If they do, productivity in period 2 is $A_H = 1$. Otherwise productivity is $A_L < 1$. The investment k is real, in terms of the consumption index. The nominal investment costs is therefore kP_1^i in the country i currency. The cost is paid to intermediaries, who bear no production costs and whose profits are simply returned to the households that own them. This simplifies in that the investment does not involve a real use of resources. Firms cannot borrow and will only incur the investment if they have sufficient internal funds. Therefore

$$A_i = A_H = 1 \text{ when } \pi^i \geq k \tag{23}$$

$$= A_L < 1 \text{ when } \pi^i < k \tag{24}$$

3.3 Central Banks

We will be brief about central banks as they behave the same as in BvW. They set the second period money supply to stabilize prices, so that $P_2^i = P_1^i$. They set the first period interest rate such that $R_i\beta = 1$. This corresponds to the interest rate in the flexible price version of the model. BvW also consider countercyclical monetary policy, but they show that this will not help to avoid a self-fulfilling panic when the central bank has little room to maneuver close to the ZLB.

3.4 Market Clearing

The market clearing conditions are

$$y_t^i(m) = c_{i,t}^i(m) + \int_0^1 c_{i,t}^j(m)dj \;\; \forall i, m \tag{25}$$

$$\int_0^1 L_t^i(m)dm = 1 - l_t^i \;\; \forall i \tag{26}$$

$$M_t = \bar{M}_t \tag{27}$$

$$B_i = 0 \;\; \forall i \tag{28}$$

3.5 Condensed Version of the Model

Appendix A derives a condensed version of the model that solves consumption, output and profits as a function of second period productivity. This is only a partial solution to the model as second period productivity is endogenous. We have

$$c^i = \frac{1}{\theta} V_i^{\psi_i} \bar{V}^{1-\psi_i} \tag{29}$$

$$y^i = \frac{V_i}{\theta} \tag{30}$$

$$\pi^i = \frac{1}{\theta} V_i^{\psi_i} \bar{V}^{1-\psi_i} \left(1 - \alpha \frac{\sigma - 1}{\sigma} V_i^{1/\alpha}\right) \tag{31}$$

where

$$V_i = A_i^{\alpha} \tag{32}$$

$$ln\ \bar{V} = \int_0^1 \frac{1-\psi_j}{1-\bar{\psi}} ln\ V_j dj \tag{33}$$

and

$$\theta = \left(\frac{\sigma}{\sigma - 1}\frac{\lambda}{\alpha}\right)^{\alpha}$$

Here c^i and y^i do not have a time subscript as consumption and output are the same in both periods. Real profits π^i refer to period 1.

A full solution of the model now involves a set of V_i for all countries such that $V_i = 1$ when $\pi_i \geq k$ and $V_i = V_L$ when $\pi_i < k$. Any such set of V_i describes an equilibrium to the model. In the next section we will consider such equilibria.

4 Analysis of Equilibria

Equilibria of the model depend on the assumed distribution across countries of the integration parameter ψ_i. We will first consider the case where $\psi_i = \psi$ is equal across all countries in order to generalize the two-country results from BvW to a multi-country setup. After that we consider the implications of a uniform distribution of ψ_i across countries.

4.1 Uniform Integration

It is useful to start by considering symmetric equilibria, where the V_i are the same for all countries, taking on either the value of 1 or V_L. We will make two assumptions that guarantee that both of these equilibria exist:

Assumption 1

$$\frac{1}{\theta}\left(1 - \alpha\frac{\sigma - 1}{\sigma}\right) \geq k \tag{34}$$

Assumption 2

$$\frac{1}{\theta}V_L\left(1 - \alpha\frac{\sigma - 1}{\sigma}V_L^{1/\alpha}\right) < k \tag{35}$$

Assumption 1 implies that profits are sufficient to cover the investment cost when no country panics, such that $V_i = \bar{V} = 1$ for all countries. Assumption 2 assures that a symmetric panic equilibrium exists, where $V_i = \bar{V} = V_L$ for all countries. The assumption implies that profits are then insufficient in all countries to cover the investment cost k.

The logic behind the existence of these multiple equilibria is as follows. When all households in the world expect much lower income in period 2, they reduce consumption in period 1. This reduces demand for goods, which reduces period 1 output and profits. When profits drop enough to fall below what is needed to cover the investment cost, productivity and output will be lower in period 2, consistent with expectations of lower income in period 2. If, on the other hand, households are all optimistic about the future, first period consumption will be strong. Profits will then be high, so that firms will all invest and productivity and output will be high in period 2. Beliefs are therefore self-fulfilling.

Next we need to consider whether there exist asymmetric equilibria, where a subset of countries panics ($V_i = V_L$), while another subset does not ($V_i = 1$). In Appendix B we prove the following proposition:

Proposition 1 *When all countries are equally integrated, there is a threshold $\tilde{\psi}$, which is larger than 0 and less than 1, such that*

1. *when $\psi < \tilde{\psi}$ there exist only equilibria where either all countries panic or all countries do not panic*

2. *when $\psi \geq \tilde{\psi}$ there also exist equilibria where only a subset of countries panic*

The proposition says that when countries are sufficiently integrated, asymmetric equilibria do not exist. If one country panics, all countries must panic in equilibrium. This generalizes the same result in the two-country case in BvW. A key point is that countries do not need to be perfectly integrated as $\tilde{\psi} > 0$. Partial but sufficient integration guarantees that the equilibrium is perfectly coordinated across countries.

To understand this result, consider for example the case where a large subset panics, while a smaller subset does not panic. When the level of integration is relatively high, the smaller subset is greatly impacted by the panic in most of the world. This will reduce their profits to a level below k, so that they necessarily panic as well. Similarly, when only a small subset of countries panics, they are greatly affected by the absence of a panic in most of the world. Their profits will then be high, so that they can cover the investment cost and will not panic. Sufficient integration assures that countries share a common fate.[22]

[22] The same intuition applies as well when half the countries panic and half do not. This brings us essentially in the BvW framework of a two-country model.

4.2 Integration Heterogeneity

We next consider differences in the level of integration across countries. There are of course many distributions of ψ_i across countries that one can consider. But for illustrative purposes we will focus on the case where ψ is uniformly distributed across countries over the interval [0,1]. Without loss of generality, one can order the countries such that $\psi_i = i$. Equilibria where either all countries panic or no countries panic still exist under Assumptions 1 and 2 as these equilibria do not depend on the distribution of ψ. We will therefore focus on other equilibria, where only a subset of countries panic.

Let π_H^i and π_L^i be profits of country i if it respectively does not panic and does panic:

$$\pi_H^i = \frac{1}{\theta}\bar{V}^{1-\psi_i}\left(1-\alpha\frac{\sigma-1}{\sigma}\right) \tag{36}$$

$$\pi_L^i = \frac{1}{\theta}V_L^{\psi_i}\bar{V}^{1-\psi_i}\left(1-\alpha\frac{\sigma-1}{\sigma}V_L^{1/\alpha}\right) \tag{37}$$

$\bar{V}$ is an endogenous variable between V_L and 1 that remains to be solved, which depends on how many and which countries panic. But conditional on different values of $\bar{V}$ from V_L to 1, there are three possible scenarios for what these schedules as a function of ψ_i look like. These three cases are shown in Figure 2.

Figure 2 is based on several features of the profit schedules that are immediate. First, π_H^i is monotonically increasing in ψ_i, while π_L^i is monotonically decreasing. Second, when $\psi_i = 0$, $\pi_L^i > \pi_H^i$. Third, when $\psi_i = 1$ these functions do not depend on $\bar{V}$ and Assumptions 1 and 2 imply that $\pi_H^i \geq k$ and $\pi_L^i < k$. Fourth, for $\psi_i < 1$, both profit schedules will be lower when $\bar{V}$ is lower. Finally, when $\psi_i = 0$, both profit schedules are larger than k when $\bar{V} = 1$ and both are less than k when $\bar{V} = V_L$.

It is important to keep in mind that these are not necessarily equilibrium schedules as the equilibrium value of $\bar{V}$ remains to be established. But if an equilibrium exists, it must be the case that one of the three cases in Figure 2 applies. It can be seen immediately that scenario 2 cannot be an equilibrium. For highly integrated countries (ψ_i close to zero) neither a panic equilibrium nor a no-panic equilibrium is possible as profits are higher than k when they panic and lower than k when they do not panic.

We can therefore focus on scenarios 1 and 3. Scenario 1 applies to equilibria where $\bar{V}$ is high, so that few countries panic. In this case all countries in the interval $[0, \tilde{\psi}_1]$ do not panic as profits under a panic are larger than k. Only the no-panic equilibrium is feasible for these countries. The remaining countries are less integrated and each may or may not panic in such equilibria as their profits are below k when they panic and above k when they do not panic.

Scenario 3 applies to equilibria where $\bar{V}$ is low and therefore a lot of countries panic. In this case all countries in the interval $[0, \tilde{\psi}_2]$ panic. The no-panic equilibrium is not feasible for these countries as profits are less than k when they do not panic. As was the case for scenario 1, the remaining less integrated countries may or may not panic as their profits are below k when they panic and above k when they do not panic. As was the case for Scenario 1, each of the remaining less integrated countries may or may not panic.

These results have the flavor of Proposition 1, even though in that case all countries were equally integrated. Figure 2 implies that integrated countries either panic together as a group or they do not panic as a group. At the same time, less integrated countries may or may not panic. Integrated countries share the same fate for the same reason as before. Since they are significantly interconnected, it is not possible for one such country to expect a strong future economy and another to expect a depression. The less integrated countries, however, are not affected much by such interconnectedness. They are like countries in autarky that may or may not panic, independent of what is happening in the rest of the world. While it is possible for such countries to panic when the integrated countries panic, this would be more of a coincidence that is unrelated to what is happening in the rest of the world.

We already know that equilibria exist where no countries panic and all countries panic. These are extreme versions of scenarios 1 and 3, where $\bar{V}$ is respectively 1 and V_L. But in general $\bar{V}$ can be in between V_L and 1, leading to equilibria where only a subset of countries panic. We therefore need to establish which values of $\bar{V}$ are equilibria and what the associated group of countries is that panics.

For equilibria in scenario 1 it must be the case that $\pi_H^i \geq k$ when $\psi_i = 0$ and in addition that $\bar{V}$ is at least as large as it would be when only countries in the interval $[0, \tilde{\psi}_1]$ do not panic. This is because we know for sure that these integrated countries cannot panic in this scenario. If more countries do not panic, $\bar{V}$ will be larger. When only countries in the interval $[0, \tilde{\psi}_1]$ do not panic, $ln(\bar{V}) =$

$(1-\tilde{\psi}_1)^2 ln\ V_L$.[23] These two conditions are summarized as

$$\bar{V} \geq \frac{\theta k}{1-\alpha(\sigma-1)/\sigma}$$
$$\bar{V} \geq V_L^{(1-\tilde{\psi}_1)^2}$$

where $\tilde{\psi}_1$ is defined as the value of ψ_i for which $\pi^i_L = k$, which is a function of $\bar{V}$:

$$\tilde{\psi}_1(\bar{V}) = \frac{ln\ k\theta - ln\ \bar{V} - ln(1-\alpha V_L^{1/\alpha}(\sigma-1)/\sigma)}{ln\ V_L - ln\ \bar{V}}$$

Similarly, for equilibria in scenario 3 it must be the case that $\pi^i_L < k$ when $\psi_i = 0$ and in addition that $\bar{V}$ is no larger than what it would be when only countries in the interval $[0, \tilde{\psi}_2]$ panic. When only these integrated countries panic, $ln(\bar{V}) = \tilde{\psi}_2(2-\tilde{\psi}_2) ln\ V_L$. These two conditions are summarized as

$$\bar{V} < \frac{\theta k}{1-\alpha V_L^{1/\alpha}(\sigma-1)/\sigma}$$
$$\bar{V} \leq V_L^{\tilde{\psi}_2(2-\tilde{\psi}_2)}$$

where $\tilde{\psi}_2$ is defined as the value of ψ_i for which $\pi^i_H = k$, which is a function of $\bar{V}$:

$$\tilde{\psi}_2(\bar{V}) = 1 - \frac{ln\ k\theta - ln(1-\alpha(\sigma-1)/\sigma)}{ln\ \bar{V}}$$

Appendix C investigates for what values of $\bar{V}$ these conditions are satisfied. With $\bar{\sigma}$, $\bar{V}_1 < 1$ and $\bar{V}_2 > V_L$ defined in Appendix C as a function of model parameters, the appendix provides a proof for the following Proposition:

Proposition 2 *Assume that ψ_i is uniformly distributed across countries over the interval [0,1], and $\sigma > \bar{\sigma}$. Then there exists a continuum of equilibria of two types:*

1. *There is an interval $[\bar{V}_1, 1]$ such that for each $\bar{V}$ in the interval there are equilibria with two features. First, none of the countries in the interval $[0, \tilde{\psi}_1(\bar{V})]$ panic. Second, when $\bar{V} < 1$ at least some of the remaining countries will panic.*

2. *There is an interval $\left[V_L, \bar{V}_2\right]$ or $\left[V_L, \bar{V}_2\right\rangle$ such that for each $\bar{V}$ in the interval there are equilibria with two features. First, all countries in the interval $[0, \tilde{\psi}_2(\bar{V})]$ panic. Second, when $\bar{V} > V_L$ at most a subset of remaining countries will panic.*

[23] It is equal to the integral of $[(1-\psi_i)/(1-\bar{\psi})] ln\ V_L = 2(1-i) ln\ V_L$ over the interval $\tilde{\psi}_1$ to 1.

Of particular interest to us in light of the evidence from the Great Recession is the second type of equilibria in Proposition 2. If we define countries with $\psi_i < \tilde{\psi}_2$ as integrated countries and the remaining countries as the less integrated countries, Proposition 2 tells us that all integrated countries will panic as a group, while in general at most a subset of the less integrated countries will panic.

Figure 3 provides an illustration of the equilibria in the second part of Proposition 2. The assumed parameters are $\sigma = 2$, $\alpha = 0.6$ and $A_L = 0.8$. $k = 0.682$ is chosen to be exactly in the middle of the feasible range defined by Assumptions 1 and 2. Both panels show on the horizontal axis the range of $\bar{V}$ for which equilibria exist. Note that the range is very narrow, from $V_L = 0.8747$ to $\bar{V}_2 = 0.8793$. When $\bar{V}$ is lower, more of the less integrated countries will panic. But they do not contribute much to the value of $\bar{V}$ as their weight $1 - \psi_i$ in the expression for $\bar{V}$ in (33) is small.

Panel A shows that almost independent of $\bar{V}$, $\tilde{\psi}_2$ is about 0.8. This means that the integrated group of countries make up 80% of all countries. Panel B reports the percentage of the remaining less integrated ones that may panic. It shows both the minimum and the maximum fraction of these countries that may panic. In general $\bar{V}$ is less than it would be if only the integrated group of countries on the interval $[0, \tilde{\psi}_2]$ would panic. Some fraction of the less integrated countries ($\psi_i > \tilde{\psi}_2$) must then panic as well. This can be any subset of these countries consistent with $\bar{V}$. The percentage of the less integrated countries that panic is the smallest if only the ones with the lowest ψ_i of that group panic and largest if only the ones with the higher ψ_i of that group panic. Panel B shows that in general, dependent on $\bar{V}$ and on which of the less integrated countries panic, anywhere from 0 to 100% of the less integrated countries panic. As long as $\bar{V} > V_L$ the fraction of the less integrated countries that panics is always less than 1.

While we have chosen some particular parameter values, the results are quite similar for other parameter values. The range of $\bar{V}$ tends to be quite narrow, and so is the value $\tilde{\psi}_2$ that defines the range of integrated countries. The value of $\tilde{\psi}_2$ does depend on the other parameters. For example, when $\sigma = 1.6$ the group of integrated countries make up about 70% of all countries, while for $\sigma = 2.5$ they make up about 90% of all countries.

These equilibria are consistent with various features of the data. First, it is consistent with the result that the drop in output was larger during the Great Recession for countries whose integration level was beyond some threshold than for countries that were less integrated. In general only a subset of the latter group will panic. Second, it is also consistent with evidence that there is no monotonic relationship between integration and the drop in output. The level of output is V_i/θ. This means that the integrated countries all experience an identical drop in output, independent of their level of integration. Moreover, the subset of less integrated countries that panics does not need to bear any relationship to their level of integration. As discussed above, it can be any subset consistent with $\bar{V}$, including the most or the least integrated countries within that group, or any mixture. Within each of these groups there is then in general no relationship between integration and their drop in output. Integration only matters across these two groups.

One unrealistic aspect of the model is that all integrated countries see an equal drop in growth. There is no growth dispersion across these countries. In reality there are of course also country-specific shocks. In addition, countries may be unequally affected by a panic. To illustrate the latter, in Appendix D we consider an extension of the model with non-traded goods in which countries that spend a larger share on non-traded goods are less affected by the panic. More precisely, Propositions 1 and 2 still hold, but with non-traded goods the percentage drop in output during a panic is now equal to the percentage drop in V_i (from 1 to V_L) times the share spent on traded goods. When non-traded goods make up a larger share of production in a country, the impact of a panic on aggregate output is smaller. One can similarly expect that countries that produce more durable and capital goods are more affected than countries that produce more non-durable goods.

5 Extension with a Large Country

So far we have assumed that all countries are infinitesimally small. A continuum of countries is an improvement over the standard assumption of two-country models as in reality there are of course a very large number of countries rather than two, and it allows us to consider the role of cross-sectional variation in integration. While the far majority of countries are indeed quite small, this setup abstracts from the role of a large country like the United States, which happened to be a central player during the Great Recession. We therefore now consider an extension in which there is one large country, while there remains a measure 1 of other countries that are infinitesimally small. We will assume that the population and labor force of the big country, which we denote B, is equal to N. For the aggregate of the small countries it is 1, so that the share of the large country in the world economy is $N/(N+1)$.

For all countries the utility specification remains (1). The index of consumption by any country of the goods from another country also remains as in (4), with σ the elasticity of substitution among the different goods within a country. What changes now is the overall consumption index. For a small country i it is

$$c_t^i = \left(\frac{c_{i,t}^i}{\psi_i}\right)^{\psi_i} \left(\frac{c_{F,t}^i}{(1-\psi_i)\kappa}\right)^{(1-\psi_i)\kappa} \left(\frac{c_{B,t}^i}{(1-\psi_i)(1-\kappa)}\right)^{(1-\psi_i)(1-\kappa)} \tag{38}$$

where

$$\kappa = \frac{1-\bar{\psi}}{N(1-\psi_B)+(1-\bar{\psi})} \tag{39}$$

and $c_{B,t}^i$ is consumption by country i of goods from the big country B. $c_{F,t}^i$ is the index of consumption of foreign goods from all small countries and remains defined as before.

Country i spends a fraction ψ_i on domestic goods as before. Of the remaining fraction $1-\psi_i$ that is allocated towards foreign goods, a fraction κ is spent on goods from the other small countries and $1-\kappa$ on goods form the big country. This relative allocation is analogous to the relative allocation among the foreign goods of small countries that is implied by the index $c_{F,t}^i$, where the relative fraction that country i spends on goods from $j1$ to goods from $j2$ is equal to $(1-\psi_{j1})/(1-\psi_{j2})$. The definition of κ implies that the share spent on goods from the big country relative to the small foreign countries is $N(1-\psi_B)/(1-\bar{\psi})$. The share for the big country is scaled by N because it captures the number of goods in the large country relative to those offered by all small countries.

For the large country the consumption index is

$$c_t^B = \left(\frac{c_{B,t}^B}{1-(1-\psi_B)\kappa}\right)^{1-(1-\psi_B)\kappa} \left(\frac{c_{F,t}^B}{(1-\psi_B)\kappa}\right)^{(1-\psi_B)\kappa} \tag{40}$$

This index is analogous to that for the small countries. If in the index (38) for country i the i is replaced by B, one gets the same overall spending share on country B goods and small country goods as in (40).

Firms in the large country behave in a way analogous to the small counties. Market clearing conditions are as follows. There is a measure N firms in the big country. With consumption denoted per capita, we have

$$Ny_t^B = Nc_{B,t}^B + \int_0^1 c_{B,t}^j dj \tag{41}$$

$$y_t^i = c_{i,t}^i + Nc_{i,t}^B + \int_0^1 c_{i,t}^j dj \tag{42}$$

Here y_t^B is output per firm in the big country.

One can again derive, after significant algebra, a condensed version to the model as before. We make the simplifying assumption that $\alpha = 1$. Leaving the algebra to a separate Technical Appendix, the expressions for consumption, output and profits are exactly as before in (30)-(31), with $\alpha = 1$.[24] Only the expression for $\bar{V}$ has changed as this average index of second period productivity is now also affected by the large country:

$$ln\ \bar{V} = \kappa \int_0^1 \frac{1-\psi_j}{1-\bar{\psi}} ln\ V_j dj + (1-\kappa) ln\ V_B \tag{43}$$

Productivity in the big country has a weight $(1-\kappa)$, which is larger the bigger it is (higher N) and the more integrated it is relative to the small countries: higher $(1-\psi_B)/(1-\bar{\psi})$.

As before, there exists the same equilibrium where none of the countries panic. Our interest in the large country though stems from equilibria in which the large country panics. In terms of the Great Recession one can think of this as a panic in the United States. Rather than develop another general Proposition, in what follows we will focus on equilibria in which the large country panics and then consider what will happen in such equilibria to the other countries.

Figure 2 provides a useful starting point for thinking about this. These pictures still hold as they apply to a given value of $\bar{V}$. The only thing that has changed is that the large country now affects $\bar{V}$. The case of interest that we will focus on is where the large country is sufficiently large, so that when it panics it brings $\bar{V}$ down to a level corresponding to scenario 3 in Figure 2. This means that automatically all countries with integration levels in the range 0 to $\tilde{\psi}_2$ will also panic. In this case, conditional on a panic in the large country, the only equilibrium for these small

[24]The Technical Appendix is available on our web sites.

integrated countries is to panic as well. The remaining less integrated countries may or may not panic.

We can derive an expression for the minimum size of the large country for this to be the case. Assume that only the large country panics. Then $ln\ \bar{V} = (1-\kappa) ln\ V_L$. In order for the panic of the large country to push us into scenario 3 all by itself, it must be the case that $\pi_L^i < k$ when $\psi_i = 0$. Define

$$\omega = \frac{ln\left(\frac{k\theta}{1-\frac{\sigma-1}{\sigma}V_L}\right)}{ln\ V_L}$$

Assumptions 1 and 2 imply that $0 < \omega < 1$. Then the condition $\pi_L^i < k$ when $\psi_i = 0$ and $ln\ \bar{V} = (1-\kappa) ln\ V_L$ becomes

$$(1-\psi_B)N > \frac{\omega}{2(1-\omega)} \tag{44}$$

This will be the case when the large country is sufficiently big and is also more likely to be the case when the large country is highly integrated (ψ_B low).

Assume that this condition is satisfied. Then we know that there is a minimum set of integrated countries that panics as well. The precise set of countries that panics implies a value of $\bar{V}$. We know that this includes at least the integrated small countries on the interval $[0, \tilde{\psi}_2(\bar{V})]$, with $\tilde{\psi}_2(\bar{V})$ defined as before. The values for $\bar{V}$ for which an equilibrium exists must satisfy the following conditions. First, since the big country and at least the integrated small countries with $\psi_i \leq \tilde{\psi}_2(\bar{V})$ panic, it must be the case that

$$\bar{V} \leq V_L^{\kappa(1-\tilde{\psi}_2(\bar{V}))\tilde{\psi}_2(\bar{V})+1-\kappa} \tag{45}$$

Second, since the large country panics, its profits under a panic must be less than k. This implies that

$$\bar{V} < V_L \left[\frac{k\theta}{(1-\frac{\sigma-1}{\sigma}V_L)V_L}\right]^{1/(1-\psi_B)} \tag{46}$$

Assumption 2 implies that the term on the right hand side multiplying V_L is larger than 1.

Figure 4 provides a numerical illustration. As already mentioned, we now set $\alpha = 1$. We continue to assume a uniform distribution for ψ_i in the small countries, which implies $\bar{\psi} = 0.5$. We assume $\psi_B = 0.1$, in which case the large country is quite integrated. We assume $N = 0.4$, so that the large country accounts for about 30% of world GDP. For the other parameters we assume $\sigma = 1.4$, $V_L = 0.6$ and $k = 0.68$. These parameters also imply that the big country has an import to GDP ratio of 50%. These numbers are certainly not intended to match any particular data. The model is much too stylized for that. But they provide a useful illustration of the general point.

Panels A and B are analogous to those in Figure 3. On the horizontal axis it reports the range of $\bar{V}$ for which there are equilibria of this type. Panel A shows that in all possible equilibria of this type, small countries whose integration level is in the interval $[0, 0.9]$ will necessarily panic. For the remaining less integrated countries, there is a minimum and maximum fraction that panics that is shown in panel B that again depends on the precise value of $\bar{V}$ in the equilibrium.

Figure 4 is qualitatively very similar to Figure 3. The key point to take away from this is that a panic in one large country automatically triggers a panic in small integrated countries. For countries whose integration level is below a certain cutoff, in general only a limited subset will panic. The other less integrated countries do not panic and therefore experience a stronger growth performance.

6 Conclusion

In the introduction we argued that two features characterize cross-country business cycle synchronicity during the Great Recession. The first is that the degree of business cycle synchronicity at this time was historically unparalleled. The second feature is about the relationship between economic integration and the extent that countries were impacted by the Great Recession. While there is no monotonic relationship between levels of integration and the drop in output during the Great Recession, we have developed evidence of a strong non-linear relationship. Countries below a certain threshold of integration were much less affected than those above the threshold.

In this paper we have shown that these features are consistent with a model that extends BvW to a multi-country setting. The key features of the model are self-fulfilling expectations shocks and an extent of economic integration that is partial and varies across countries. The model is driven by a sunspot shock that can set off a self-fulfilling panic in the form of pessimistic beliefs about future income.

During the Great Recession this sunspot can be roughly equated to developments in US financial markets since September, 2008.

We find that integrated countries necessarily panic as a group as their interconnectedness makes it impossible to have widely varying outlooks on the future. At the same time less integrated countries are less dependent on other countries and therefore in equilibrium may not panic even if most of the rest of the world panics. This creates a dichotomy, with a larger drop in output for countries whose level of integration is above a certain threshold cutoff than those that are less integrated. Within both groups of countries the theory implies no relationship between the decline in output and the level of integration. This explains why integration only matters in a discontinuous way.

A natural extension for future work would be to introduce financial integration. The model considered here only allows for trade integration. The same mechanism should also hold with financial integration as long as it implies a positive interconnectedness between countries. This means a country is negatively impacted through financial linkages if there were an exogenous panic in the rest of the world.

Appendix

A. Condensed Version of the Model

In this Appendix we derive the condensed version of the model described in section 3.5. Using the fact that all firms in country i set the same price and output in all firms is the same, goods market equilibrium is described by

$$y_t^i = c_{i,t}^i + \int_0^1 c_{i,t}^j dj \tag{47}$$

Substituting the expressions for consumption we have

$$P_t(i) y_t^i = \psi_i P_t^i c_t^i + (1 - \psi_i) \int_0^1 \frac{1 - \psi_j}{1 - \bar{\psi}} \frac{S_{i,t} P_t^j}{S_{j,t}} c_t^j dj \tag{48}$$

Using the budget constraints of the households of country i, and imposing money market and bond market equilibrium, we have

$$P_t^i c_t^i = P_t(i) y_t^i \tag{49}$$

Together with the goods market equilibrium condition above we then have

$$\frac{P_t^i c_t^i}{S_{i,t}} = \int_0^1 \frac{1 - \psi_j}{1 - \bar{\psi}} \frac{P_t^j}{S_{j,t}} c_t^j dj \tag{50}$$

from which it follows that for all i, j:

$$\frac{P_t^i c_t^i}{S_{i,t}} = \frac{P_t^j c_t^j}{S_{j,t}} \tag{51}$$

This says that nominal consumption is equal across countries.

If we substitute the expression for the price index on both sides and take logs, we can write

$$ln\ c_t^j = ln\ c_t^i + (1 - \psi_i) ln\ P_{F,t} + \psi_i ln\ \frac{P_t(i)}{S_{i,t}} - \psi_j ln\ \frac{P_t(j)}{S_{j,t}} - (1 - \psi_j) ln\ P_{F,t} \tag{52}$$

Define c_t^* such that

$$ln(c_t^*) = \frac{\int_0^1 \frac{1-\psi_j}{(1-\bar{\psi})\psi_j} ln(c_t^j) dj}{\int_0^1 \frac{1-\psi_j}{(1-\bar{\psi})\psi_j} dj} \tag{53}$$

Applying the same weights to (52) and integrating over j, we get after some rearranging

$$ln\ c_t^* = ln\ c_t^i + \psi_i ln\ \frac{P_t(i)}{S_{i,t} P_{F,t}} = ln\ c_t^i - \frac{\psi_i}{1 - \psi_i} ln\ \frac{P_t^i}{P_t(i)} \tag{54}$$

In levels this becomes

$$\frac{P_t^i}{P_t(i)} = \left(\frac{c_t^i}{c_t^*}\right)^{\frac{1-\psi_i}{\psi_i}} \tag{55}$$

Next consider the expression (20) for the optimal price. Using that output and prices are the same for all firms in country i, and substituting $W_2^i/P_2^i = \lambda c_2^i$, it becomes

$$\frac{P_2(i)}{P_2^i} = \frac{\sigma}{\sigma-1}\frac{\lambda c_t^i}{\alpha A_i}[y_2^i]^{\frac{1-\alpha}{\alpha}} \tag{56}$$

Substituting (49) and rearranging, we have

$$\theta c_2^i \frac{P_2^i}{P_2(i)} = V_i \tag{57}$$

where $V_i = A_i^\alpha$ and

$$\theta = \left(\frac{\sigma}{\sigma-1}\frac{\lambda}{\alpha}\right)^\alpha \tag{58}$$

Substituting (55) for period 2 into (57), we get

$$c^i = (c^*)^{1-\psi_i}\left(\frac{V_i}{\theta}\right)^{\psi_i} \tag{59}$$

Here we have removed time subscripts as the central bank policy setting $\beta R_i = 1$ and $P_1^i = P_2^i$ implies that consumption is the same in both periods. Substitution into (53) delivers

$$c^* = \frac{\bar{V}}{\theta} \tag{60}$$

where

$$ln\ \bar{V} = \int_0^1 \frac{1-\psi_j}{1-\bar{\psi}} ln\ V_j dj \tag{61}$$

Substituting this expression for c^* back into (59), we have

$$c^i = \frac{1}{\theta}V_i^{\psi_i}\bar{V}^{1-\psi_i} \tag{62}$$

Using (49) and (55), together with the solutions for c^i and c^*, output in country i (which is also the same in both periods) is

$$y^i = \frac{V_i}{\theta} \tag{63}$$

We finally need to derive an expression for profits. We can substitute into (22) $W_1^i/P_1^i = \lambda c_1^i$, $y^i = V_i/\theta$ and $P_1^i/P_1(i) = [V_i/\bar{V}]^{1-\theta_i}$. The latter follows from (55) and the solutions for c^i and c^*, using that consumption is the same in both periods. Rearranging, the expression for profits becomes

$$\pi_i = \frac{1}{\theta} V_i^{\psi_i} \bar{V}^{1-\psi_i} \left(1 - \alpha \frac{\sigma - 1}{\sigma} V_i^{1/\alpha} \right) \tag{64}$$

B. Proof of Proposition 1

Assume that a fraction ω of countries does not panic ($V_i = 1$) and a fraction $1-\omega$ does panic ($V_i = V_L$). Then $\bar{V} = V_L^{1-\omega}$. Defining π_H and π_L as respectively profits of countries that do not panic and do panic, we have

$$\pi_H = \frac{1}{\theta} V_L^{(1-\psi)(1-\omega)} \left(1 - \frac{\sigma - 1}{\sigma} \alpha \right) \tag{65}$$

$$\pi_L = \frac{1}{\theta} V_L^{1-(1-\psi)\omega} \left(1 - \frac{\sigma - 1}{\sigma} \alpha V_L^{1/\alpha} \right) \tag{66}$$

There are asymmetric equilibria when $\pi_H \geq k$ and $\pi_L < k$ for some ω between 0 and 1. Consider a particular value for ψ. Then $\pi_H \geq k \ \forall \omega \geq min(0, \omega_1)$ and $\pi_L < k \ \forall \omega < max(1, \omega_2)$ where

$$\omega_1 = 1 - \frac{1}{1-\psi} \frac{ln\ k\theta - ln\,(1 - \alpha(\sigma - 1)/\sigma)}{ln\ V_L}$$

$$\omega_2 = \frac{1}{1-\psi} - \frac{1}{1-\psi} \frac{ln\ k\theta - ln\left(1 - \alpha V^{1/\alpha}(\sigma - 1)/\sigma\right)}{ln\ V_L}$$

There are no asymmetric equilibria when there exist no ω such that $\omega \geq min(0, \omega_1)$ and $\omega < max(1, \omega_2)$. This is the case if and only if $\omega_1 > \omega_2$. Based on the expressions above for ω_1 and ω_2, this is the case when $\psi < \tilde{\psi}$, where

$$\tilde{\psi} = \frac{1}{ln\ V_L} ln \left(\frac{1 - \frac{\sigma-1}{\sigma}\alpha}{1 - \frac{\sigma-1}{\sigma}\alpha V_L^{1/\alpha}} \right) \tag{67}$$

Assumptions 1 and 2 imply that $\tilde{\psi}$ is larger than 0 and less than 1. It follows that asymmetric equilibria exist when $\psi \geq \tilde{\psi}$ and do not exist when $\psi < \tilde{\psi}$.

C. Proof of Proposition 2

Define

$$V_1 = \frac{k\theta}{1 - \frac{\sigma-1}{\sigma}\alpha} \ \ and \ \ V_2 = \frac{k\theta}{1 - \frac{\sigma-1}{\sigma}\alpha V_L^{\frac{1}{\alpha}}}$$

Notably $1 > V_1 > V_2 > V_L$. The proposition assumes that $\sigma > \bar{\sigma}$. The latter is defined as

$$1/\bar{\sigma} = 1 - \frac{1 - V_L^{\frac{2\sqrt{3}}{9}\left(\sqrt{3}-1\right)}}{\alpha\left(1 - V_L^{\frac{1}{\alpha}+\frac{2\sqrt{3}}{9}\left(\sqrt{3}-1\right)}\right)} \tag{68}$$

We already know from the discussion in the text that when equilibria exist, they can only be of the two types in Proposition 2. We therefore need to focus on the existence of such equilibria. Denote $\pi_H(\psi_i, \bar{V})$ and $\pi_L(\psi_i, \bar{V})$ as profits as a function of ψ_i and $\bar{V}$, defined in (36)-(37).

First consider the first part of the proposition. The sufficient conditions for equilibria of this type to exist are

1. $\pi_H\left(0, \bar{V}\right) = \frac{\bar{V}}{\theta}\left(1 - \frac{\sigma-1}{\sigma}\alpha\right) \geq k$

2. $\bar{V}$ is at least as large as it would be when only countries in the interval $\left[0, \tilde{\psi}_1(\bar{V})\right]$ do not panic.

The first condition implies $\bar{V} \geq V_1$. The second condition says that

$$\bar{V} \geq V_L^{(1-\tilde{\psi}_1)^2} \tag{69}$$

where $\tilde{\psi}_1 = \frac{\ln\bar{V} - \ln V_2}{\ln\bar{V} - \ln V_L}$. Substituting this expression for $\tilde{\psi}_1$ into (69) yields

$$\left(\ln\bar{V} - \ln V_L\right)^2 \ln\bar{V} \geq \left(\ln V_2 - \ln V_L\right)^2 \ln V_L \tag{70}$$

Let $f_1(\bar{V}) = \left(\ln\bar{V} - \ln V_L\right)^2 \ln\bar{V}$. Then

$$\frac{\partial f_1(\bar{V})}{\partial\bar{V}} = \frac{\ln\bar{V} - \ln V_L}{\bar{V}}\left(3\ln\bar{V} - \ln V_L\right)\begin{cases} > 0 & if \quad 3\ln\bar{V} > \ln V_L \\ < 0 & if \quad 3\ln\bar{V} < \ln V_L \end{cases}$$

Note that $f_1(1) = f_1(V_L) = 0$ and $f_1(\bar{V})$ reaches its local minimum at $\bar{V} = V_L^{\frac{1}{3}}$. To check whether (70) holds, there are three cases we need to consider:

Case 1: Choose $k \geq \frac{V_L^{1-\frac{2\sqrt{3}}{9}}}{\theta}\left(1 - \frac{\sigma-1}{\sigma}\alpha V_L^{\frac{1}{\alpha}}\right)$. This means $f_1(V_L^{\frac{1}{3}}) \geq \left(\ln V_2 - \ln V_L\right)^2 \ln V_L$. Because $f_1(V_L^{\frac{1}{3}})$ is local minimum, (70) is always satisfied. It therefore follows that there is an equilibrium for all $\bar{V} \in [V_1, 1]$. In this case, $\bar{V}_1 = V_1$.

Case 2: Choose $\frac{V_L^{\frac{1}{3}}}{\theta}\left(1-\frac{\sigma-1}{\sigma}\alpha\right) \le k < \frac{V_L^{1-\frac{2\sqrt{3}}{9}}}{\theta}\left(1-\frac{\sigma-1}{\sigma}\alpha V_L^{\frac{1}{\alpha}}\right)$. $\sigma > \bar{\sigma}$ implies that the left hand side of this inequality is indeed less than the right hand side, so that such values of k exist. This means $f_1(V_L^{\frac{1}{3}}) < (\ln V_2 - \ln V_L)^2 \ln V_L$ and $V_1 \ge V_L^{\frac{1}{3}}$. The latter implies that $f_1(\bar{V})$ is monotonically increasing on $[V_1, 1]$. There are then two possibilities:

1. If $f_1(V_1) > (\ln V_2 - \ln V_L)^2 \ln V_L$, then (70) holds for all $\bar{V} \ge V_1$. In this case, $\bar{V}_1 = V_1$ and there is an equilibrium for all $\bar{V}$ in the range $[\bar{V}_1, 1]$.
2. If $f_1(V_1) \le (\ln V_2 - \ln V_L)^2 \ln V_L$, then there exists $\tilde{V} < 1$ such that $f_1(\tilde{V}) = (\ln V_2 - \ln V_L)^2 \ln V_L$. It follows that (70) holds for any $\bar{V} \ge \tilde{V}$. Therefore, $\bar{V}_1 = \tilde{V}$ and there is an equilibrium for all $\bar{V}$ in the range $[\bar{V}_1, 1]$.

Case 3: Choose $k < \frac{V_L^{\frac{1}{3}}}{\theta}\left(1-\frac{\sigma-1}{\sigma}\alpha\right)$. This means $f_1(V_L^{\frac{1}{3}}) < (\ln V_2 - \ln V_L)^2 \ln V_L$ and $V_1 < V_L^{\frac{1}{3}}$. $\sigma > \bar{\sigma}$ implies $\frac{V_L}{\theta}\left(1-\frac{\sigma-1}{\sigma}\alpha V_L^{\frac{1}{\alpha}}\right)\left(\frac{1-\frac{\sigma-1}{\sigma}\alpha V_L^{\frac{1}{\alpha}}}{1-\frac{\sigma-1}{\sigma}\alpha}\right)^{\frac{1+\sqrt{3}}{2}} > \frac{V_L^{\frac{1}{3}}}{\theta}\left(1-\frac{\sigma-1}{\sigma}\alpha\right)$. Then for each selected k in this case, there exists a $b \in \left(0, \frac{1+\sqrt{3}}{2}\right)$ such that $k = \frac{V_L}{\theta}\left(1-\frac{\sigma-1}{\sigma}\alpha V_L^{\frac{1}{\alpha}}\right)\left(\frac{1-\frac{\sigma-1}{\sigma}\alpha V_L^{\frac{1}{\alpha}}}{1-\frac{\sigma-1}{\sigma}\alpha}\right)^{b}$. This implies that $\ln V_L = (b+1)\ln V_2 - b \ln V_1$. Thus

$$
\begin{aligned}
& (\ln V_1 - \ln V_L)^2 \ln V_1 - (\ln V_2 - \ln V_L)^2 \ln V_L \\
= \; & (b+1)^2 (\ln V_1 - \ln V_2)^2 \ln V_1 - b^2 (\ln V_1 - \ln V_2)^2 \ln V_L \\
= \; & b^2 (\ln V_1 - \ln V_2)^2 \left(\left(1+\frac{1}{b}\right)^2 \ln V_1 - \ln V_L\right) < 0
\end{aligned}
$$

where the inequality follows because $\left(1+\frac{1}{b}\right)^2 \ln V_1 < 3 \ln V_1 < \ln V_L$. Therefore, there exists a $\tilde{V} < 1$, where $f_1(\tilde{V}) = (\ln V_2 - \ln V_L)^2 \ln V_L$, and (70) holds for any $\bar{V} \ge \tilde{V}$. In this case, $\bar{V}_1 = \tilde{V}$ and there is an equilibrium for all $\bar{V}$ in the range $[\bar{V}_1, 1]$.

In all three cases, since all countries in the region $[0, \tilde{\psi}_1]$ do not panic, it follows that for all $\bar{V} < 1$ at least a subset of the remaining less integrated countries must panic.

For the second part of proposition, the sufficient conditions for equilibria are

1. $\pi_L\left(0, \bar{V}\right) = \frac{\bar{V}}{\theta}\left(1-\frac{\sigma-1}{\sigma}\alpha V_L^{\frac{1}{\alpha}}\right) < k$

2. $\bar{V}$ is at most as large as it would be when only countries in the interval $\left[0, \tilde{\psi}_2(\bar{V})\right]$ panic.

The first condition implies $\bar{V} < V_2$. The second condition implies that

$$\bar{V} \leq V_L^{\tilde{\psi}_2(2-\tilde{\psi}_2)} \tag{71}$$

where $\tilde{\psi}_2 = 1 - \frac{\ln V_1}{\ln \bar{V}}$. Substituting the value for $\tilde{\psi}_2$ into (71), we have

$$\left(\ln \bar{V}\right)^2 \ln V_L - \left(\ln \bar{V}\right)^3 \geq (\ln V_1)^2 \ln V_L \tag{72}$$

Let $f_2(\bar{V}) = \left(\ln \bar{V}\right)^2 \ln V_L - \left(\ln \bar{V}\right)^3$. Then

$$\frac{\partial f_2(\bar{V})}{\partial \bar{V}} = \frac{\ln \bar{V}}{\bar{V}} \left(2 \ln V_L - 3 \ln \bar{V}\right) \begin{cases} > 0 & if \quad 2 \ln V_L < 3 \ln \bar{V} \\ < 0 & if \quad 2 \ln V_L > 3 \ln \bar{V} \end{cases}$$

We have $f_2(1) = f_2(V_L) = 0$ and $f_2(\bar{V})$ reaches its local minimum at $\bar{V} = V_L^{\frac{2}{3}}$. To check whether (72) holds, there are three cases we need to consider:

Case 1: Choose $k \leq \frac{V_L^{\frac{2\sqrt{3}}{9}}}{\theta}\left(1 - \frac{\sigma-1}{\sigma}\alpha\right)$. This implies $f_2(V_L^{\frac{2}{3}}) \geq (\ln V_1)^2 \ln V_L$. Because $f_2(V_L^{\frac{2}{3}})$ is a local minimum, (72) holds for all $\bar{V}$. It therefore follows that there is an equilibrium for all $\bar{V} \in [V_L, V_2\rangle$. In this case, $\bar{V}_2 = V_2$.

Case 2: Choose $\frac{V_L^{\frac{2\sqrt{3}}{9}}}{\theta}\left(1 - \frac{\sigma-1}{\sigma}\alpha\right) < k \leq \frac{V_L^{\frac{2}{3}}}{\theta}\left(1 - \frac{\sigma-1}{\sigma}\alpha A_L\right)$. $\sigma > \bar{\sigma}$ implies that the left hand side of this inequality is indeed less than the right hand side, so that such values of k exist. This means $f_2(V_L^{\frac{2}{3}}) < (\ln V_1)^2 \ln V_L$ and $V_2 \leq V_L^{\frac{2}{3}}$. $f_2(\bar{V})$ is monotonically decreasing on $[V_L, V_2]$. We then have two possibilities:

1. If $f_2(V_2) > (\ln V_1)^2 \ln V_L$, then (72) holds for all $\bar{V} < V_2$. In this case, $\bar{V}_2 = V_2$ and there are equilibria for all $\bar{V} \in \left[V_L, \bar{V}_2\right\rangle$.

2. If $f_2(V_2) \leq (\ln V_1)^2 \ln V_L$, then there exists a $\tilde{V} > V_L$ such that $f_2(\tilde{V}) = (\ln V_1)^2 \ln V_L$ and (72) holds for any $\bar{V} \in \left[V_L, \tilde{V}\right]$. In this case $\bar{V}_2 = \tilde{V}$ and there are equilibria for all $\bar{V} \in \left[V_L, \bar{V}_2\right]$.

Case 3: Choose $k > \frac{V_L^{\frac{2}{3}}}{\theta}\left(1 - \frac{\sigma-1}{\sigma}\alpha V_L^{\frac{1}{\alpha}}\right)$. This means $f_2(V_L^{\frac{2}{3}}) < (\ln V_1)^2 \ln V_L$ and $V_2 > V_L^{\frac{2}{3}}$. $\sigma > \bar{\sigma}$ implies $V_L^{\frac{2}{3}} > \left(\frac{V_2}{V_1}\right)^{\frac{3+\sqrt{3}}{2}}$. Together with $V_2 > V_L^{\frac{2}{3}}$ this implies

$V_1^{\sqrt{3}} > V_2$, so that $(\ln V_2)^2 > 3(\ln V_1)^2$. Therefore

$$\begin{aligned} & (\ln V_2)^2 \ln V_L - (\ln V_2)^3 - (\ln V_1)^2 \ln V_L \\ = & \left(\frac{1}{3}(\ln V_2)^2 - (\ln V_1)^2\right) \ln V_L + (\ln V_2)^2 \left(\frac{2}{3}\ln V_L - \ln V_2\right) < 0 \end{aligned}$$

Therefore there exists a $\tilde{V} > V_L$ such that $f_2(\tilde{V}) = (\ln V_1)^2 \ln V_L$ and (72) holds for any $\bar{V} \leq \tilde{V}$. In this case $\bar{V}_2 = \tilde{V}$ and there are equilibria for all $\bar{V} \in [V_L, \bar{V}_2]$.

In all three cases, since all countries in the region $[0, \tilde{\psi}_2]$ panic, it follows that for all $\bar{V} > V_L$ at most a subset of the remaining less integrated countries will panic.

D. Introducing a Non-tradable Sector

In order to allow the output contraction to vary across integrated countries in a panic equilibrium, in this appendix we extend the benchmark model by introducing non-tradable goods. Utility of households is now

$$\ln c_1^{T,i} + \nu_i \ln c_1^{N,i} + \lambda l_1^i + \beta\left(\ln c_2^{T,i} + \nu_i \ln c_2^{N,i} + \lambda l_2^i\right) \tag{73}$$

where $c_t^{T,i}$ is the same index of tradable goods as before and $c_t^{N,i}$ is consumption of a homogenous non-tradable good. The new budget constraints are

$$\begin{aligned} & P_1^{T,i} c_1^{T,i} + P_1^{N,i} c_1^{N,i} + B_i + M_1^i = W_1^i(1 - l_1^i) + \Pi_1^i + \bar{M}_1^i \\ & P_2^{T,i} c_2^{T,i} + P_2^{N,i} c_2^{N,i} + M_2^i = W_2^i(1 - l_2^i) + \Pi_2^i + M_1^i + R^i B_i + (\bar{M}_2^i - \bar{M}_1^i) \end{aligned}$$

Solving the household's problem, we have

$$\frac{W_t^i}{P_t^{T,i}} = \lambda c_t^{T,i} \tag{74}$$

$$\frac{1}{c_1^{T,i}} = \beta R^i \frac{P_1^{T,i}}{P_2^{T,i}} \frac{1}{c_2^{T,i}} \tag{75}$$

$$\nu_i P_t^{T,i} c_t^{T,i} = P_t^{N,i} c_t^{N,i} \tag{76}$$

The other intratemporal first-order conditions for tradable goods remain the same as before. We have assumed that labor can freely move between the two sectors, so that the wage rate is the same in both sectors.

On the production side the setup for the tradable sector remains the same as before. We assume that the non-tradable sector produces a homogenous good under perfect competition and that productivity is always equal to 1. Therefore $P_t^{N,i} = W_t^i$.

We will assume that only firms in the tradables sector can invest. As before, investment in period 1 affects productivity in period 2. We assume that the investment cost k is in terms of an index of tradables, so that the nominal investment cost is $kP_1^{T,i}$. In that case nothing has changed to the model regarding both the demand and supply of tradables. It is easy to check that the expressions for profits, consumption and output in the tradables sector are the same as before. Therefore Propositions 1 and 2 still hold as before.

Using (74) and (76), we find that output in the non-tradables sector is a constant that is unaffected by the panic:

$$y_t^{N,i} = c_t^{N,i} = \frac{\nu_i P_t^{T,i} c_t^{T,i}}{P_t^{N,i}} = \frac{\nu_i P_t^{T,i} c_t^{T,i}}{W_t^i} = \frac{\nu_i}{\lambda} \tag{77}$$

Therefore the drop in aggregate output of countries that panic is equal to the tradables production share, $1/(1 + \nu_i)$, times the percentage drop in tradables production. The latter remains equal to the percentage drop in V_i from 1 to V_L.

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TABLE 1: List of countries

Albania	Georgia	Nigeria
Algeria	Germany	Oman
Angola	Ghana	Pakistan
Antigua and Barbuda	Greece	Panama
Argentina	Grenada	Paraguay
Australia	Guatemala	Peru
Austria	Guinea	Philippines
Azerbaijan	Guinea-Bissau	Poland
Bahrain	Haiti	Portugal
Bangladesh	Honduras	Qatar
Belarus	Hong Kong SAR	Republic of Congo
Belgium	Hungary	Romania
Belize	Iceland	Russia
Benin	India	Samoa
Bhutan	Indonesia	Saudi Arabia
Bolivia	Ireland	Senegal
Botswana	Islamic Republic of Iran	Seychelles
Brazil	Israel	Sierra Leone
Brunei Darussalam	Italy	Singapore
Bulgaria	Jamaica	Slovak Republic
Burkina Faso	Japan	Slovenia
Burundi	Jordan	South Africa
Cabo Verde	Kazakhstan	Spain
Cameroon	Kenya	Sri Lanka
Canada	Korea	St. Kitts and Nevis
Central African Republic	Kuwait	St. Lucia
Chad	Kyrgyz Republic	St. Vincent and the Grenadines
Chile	Lao P.D.R.	Sudan
China	Latvia	Swaziland
Colombia	Lebanon	Sweden
Comoros	Lesotho	Switzerland
Costa Rica	Libya	São Tomé and Príncipe
Croatia	Lithuania	Tajikistan
Cyprus	Madagascar	Tanzania
Czech Republic	Malawi	Thailand
Côte d'Ivoire	Malaysia	The Gambia
Democratic Republic of the Congo	Maldives	Togo
Denmark	Mali	Tonga
Djibouti	Mauritius	Trinidad and Tobago
Dominica	Mexico	Tunisia
Dominican Republic	Moldova	Turkey
Egypt	Mongolia	Uganda
El Salvador	Morocco	Ukraine
Estonia	Mozambique	United Arab Emirates
Ethiopia	Namibia	United Kingdom
FYR Macedonia	Nepal	United States
Fiji	Netherlands	Uruguay
Finland	New Zealand	Vanuatu
France	Nicaragua	Venezuela
Gabon	Niger	Vietnam
		Zambia

TABLE 2: Descriptive statistics and data source

Variable	Mean	Std. Dev.	Min	Max	Source
Forecast error 09	-5.11	4.38	-20.35	5.80	WEO April 2008 and April 2014
GDP growth 09	-0.15	5.14	-17.70	11.96	WEO April 2014
GDP growth trend 96/07	4.43	2.28	0.70	15.29	WEO April 2014
Avrg. GDP growth 04/07	5.69	3.17	-0.71	24.03	WEO April 2014
Trade openness	92.95	50.55	25.21	398.66	World Bank WDI
Financial openness	290.33	418.86	47.75	2604.66	Lane and Milesi-Ferretti
GDPpc (thousands of 2007 dollars)	12.11	16.41	0.17	69.17	WEO April 2014
GDP (billions of 2007 dollars)	365.40	1334.82	0.14	14480.35	WEO April 2014
Population (in millions)	41.45	145.84	0.05	1321.29	WEO April 2014
Manufacturing share	13.55	6.91	1.99	40.78	United Nations database
Current account (% of GDP)	-2.34	13.02	-31.91	47.82	WEO April 2014
Net foreign assets (% of GDP)	-15.95	161.56	-201.39	1618.02	Lane and Milesi-Ferretti
Reserves minus gold (% of GDP)	19.26	17.92	0.21	117.31	Lane and Milesi-Ferretti
Private credit growth 04/07 (% of GDP)	33.39	45.93	-41.18	287.91	World Bank WDI

TABLE 3: Regressions without integration dummies

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Forecast error	GDP growth 09	Forecast error	Forecast error	Forecast error	GDP growth 09
Log(Trade openness)	-1.774	-0.589	-1.906*	-2.080*	-2.301**	-1.660
	(1.1057)	(1.1415)	(1.0700)	(1.0962)	(1.0032)	(1.0556)
Log(Financial openness)	-0.679	-1.116	0.125	0.058	0.743	0.848
	(1.1011)	(1.1730)	(0.9351)	(0.9542)	(0.8433)	(0.9990)
Current account	0.044	0.013	0.027	0.109**	0.081*	0.090*
	(0.0734)	(0.0879)	(0.0546)	(0.0535)	(0.0455)	(0.0524)
Net foreign assets	-0.002	0.002	0.001	-0.007	-0.000	0.001
	(0.0068)	(0.0079)	(0.0017)	(0.0057)	(0.0017)	(0.0019)
Reserves	-0.021	-0.014	-0.012	-0.025	-0.021	-0.024
	(0.0333)	(0.0347)	(0.0316)	(0.0301)	(0.0295)	(0.0292)
Credit growth 04/07	-0.036**	-0.046**	-0.035**	-0.018*	-0.018*	-0.017
	(0.0172)	(0.0193)	(0.0169)	(0.0102)	(0.0106)	(0.0105)
Manufacturing share	-0.069	-0.151	-0.036	-0.085	-0.067	-0.150**
	(0.0869)	(0.0938)	(0.0740)	(0.0708)	(0.0613)	(0.0653)
Growth trend	0.042	0.396	0.062	0.158	0.169	0.440**
	(0.2597)	(0.2386)	(0.2507)	(0.2762)	(0.2589)	(0.2186)
Avrg. GDP growth 04/07	-0.187	0.108	-0.157	-0.272	-0.244	0.011
	(0.2061)	(0.2265)	(0.1978)	(0.2010)	(0.1891)	(0.2014)
Peg dummy	0.439	-0.087	-0.024	0.639	0.323	-0.130
	(0.8667)	(0.8715)	(0.8309)	(0.7240)	(0.7093)	(0.7591)
Oil dummy	-0.665	0.649	-0.490	-1.510	-1.658	-0.869
	(1.5216)	(1.6488)	(1.4453)	(1.2915)	(1.2445)	(1.3775)
GDPpc	-0.038	-0.069	-0.039	-0.082	-0.088*	-0.149**
	(0.0589)	(0.0730)	(0.0498)	(0.0557)	(0.0463)	(0.0625)
GDP	-0.000	-0.000	-0.000	0.000	-0.000	-0.000
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Log(Population)	0.203	0.512	0.151	0.129	0.122	0.392
	(0.3192)	(0.3543)	(0.2846)	(0.2806)	(0.2514)	(0.2785)
Constant	6.172	1.679	2.839	5.613	3.177	-0.115
	(9.6579)	(10.7313)	(8.0674)	(8.5209)	(7.1908)	(8.4511)
Observations	110	110	117	144	151	151
R-squared	0.232	0.319	0.214	0.235	0.213	0.319

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

TABLE 4: Regressions with integration dummies

	(1)	(2)	(3)
VARIABLES	Forecast error	Forecast error	Forecast error
Trade dummy	-3.011**		
	(1.3572)		
Financial dummy		-4.541***	
		(1.1794)	
Joint dummy			-4.716***
			(1.2050)
Log(Trade openness)	0.779	-1.973*	-1.458
	(1.5560)	(1.0923)	(1.0370)
Log(Financial openness)	-0.408	2.019	1.963
	(1.1011)	(1.2854)	(1.2686)
Current account	0.054	0.036	0.031
	(0.0720)	(0.0731)	(0.0737)
Net foreign assets	-0.002	-0.005	-0.005
	(0.0069)	(0.0067)	(0.0068)
Reserves	-0.019	-0.004	-0.004
	(0.0327)	(0.0321)	(0.0321)
Credit growth 04/07	-0.035**	-0.038**	-0.038**
	(0.0155)	(0.0163)	(0.0161)
Manufacturing share	-0.060	-0.044	-0.055
	(0.0830)	(0.0711)	(0.0706)
Growth trend	-0.032	0.079	0.120
	(0.2246)	(0.2069)	(0.2102)
Avrg. GDP growth 04/07	-0.100	-0.169	-0.215
	(0.1844)	(0.1912)	(0.1923)
Peg dummy	0.484	0.356	0.164
	(0.8470)	(0.8264)	(0.8270)
Oil dummy	-0.376	-0.213	-0.065
	(1.5516)	(1.4742)	(1.4753)
GDPpc	-0.040	-0.042	-0.036
	(0.0589)	(0.0596)	(0.0599)
GDP	0.000	0.000	0.000
	(0.0002)	(0.0002)	(0.0002)
Log(Population)	0.035	0.060	0.082
	(0.3409)	(0.2898)	(0.2888)
Constant	-2.708	-2.926	-4.987
	(8.8620)	(9.2963)	(9.3826)
Observations	110	110	110
R-squared	0.265	0.325	0.330

Robust standard errors in parentheses
***** p<0.01, ** p<0.05, * p<0.1**

TABLE 5: List of less integrated countries

Albania	India
Algeria	Indonesia
Angola	Islamic Republic of Iran
Argentina	Korea
Azerbaijan	Maldives
Belarus	Mexico
Bolivia	Mongolia
Brazil	Morocco
Cameroon	Nigeria
China	Oman
Colombia	Peru
Costa Rica	Philippines
Dominican Republic	Poland
Egypt	Romania
El Salvador	Samoa
Fiji	Sri Lanka
Gabon	Swaziland
Georgia	Tonga
Ghana	Turkey
Guatemala	Venezuela
Honduras	

TABLE 6

PERCENTILE	19	21	23	25	27	29	31	33	35	37	39	41	43	45
ALPHA														
0	**-2.50**	**-2.52**	**-2.27**	**-2.36**	**-2.28**	**-2.61**	**-3.59**	**-4.35**	**-3.69**	**-3.32**	**-3.38**	**-2.51**	-0.19	0.02
0.05	**-2.50**	**-2.36**	**-2.27**	**-2.45**	**-2.28**	**-2.33**	**-3.59**	**-4.35**	**-3.69**	**-3.61**	**-3.17**	**-2.51**	-0.19	0.02
0.1	**-2.98**	**-2.36**	**-2.41**	**-2.45**	**-2.28**	**-2.33**	**-3.29**	**-3.91**	**-4.72**	**-3.61**	**-3.29**	**-2.51**	-0.19	-0.06
0.15	**-2.64**	**-2.36**	**-2.59**	**-2.45**	**-2.25**	**-2.33**	**-3.09**	**-3.64**	**-4.32**	**-3.61**	**-3.29**	-1.87	-0.19	-0.06
0.2	**-2.64**	**-2.58**	**-2.59**	**-2.45**	**-2.25**	**-2.33**	**-3.09**	**-3.64**	**-3.35**	**-3.61**	**-3.29**	-2.10	-0.19	-0.12
0.25	**-2.64**	-2.11	**-2.59**	**-2.45**	**-2.52**	**-2.79**	**-3.06**	**-3.64**	**-3.35**	**-3.32**	-2.01	-1.57	-0.06	0.08
0.3	**-3.29**	**-2.61**	**-2.48**	**-2.45**	**-2.52**	**-2.56**	**-3.48**	**-3.41**	**-3.35**	**-3.32**	-2.04	-1.18	0.59	0.32
0.35	**-3.29**	**-2.93**	**-2.48**	**-2.45**	**-2.49**	**-2.56**	**-2.84**	**-3.41**	**-3.35**	-1.50	-0.87	-1.18	-0.63	-0.51
0.4	**-3.29**	**-2.93**	**-2.81**	-2.22	**-2.51**	**-2.56**	**-2.84**	**-3.41**	**-3.35**	-1.50	-1.29	-0.74	-0.63	-0.51
0.45	**-3.29**	**-2.93**	**-2.78**	**-2.49**	-2.01	**-2.30**	**-2.84**	**-3.41**	**-2.62**	-1.14	-1.38	-0.74	0.41	0.56
0.5	**-3.29**	**-3.13**	**-2.86**	**-2.46**	**-2.30**	**-2.36**	**-2.84**	**-3.41**	**-3.02**	-1.14	-1.38	-0.74	0.40	0.56
0.55	**-3.20**	**-2.93**	**-2.86**	**-2.46**	**-3.08**	**-3.09**	**-2.78**	**-2.81**	-2.01	**-2.58**	-0.58	-0.25	0.40	0.56
0.6	**-3.20**	**-2.57**	**-2.74**	**-2.44**	**-2.25**	-1.88	**-2.30**	-1.98	-2.16	**-2.58**	-0.58	-0.70	0.50	0.56
0.65	**-3.44**	**-2.57**	**-2.22**	-1.71	-2.04	-1.54	**-2.38**	**-2.41**	**-2.82**	**-2.58**	-1.36	-0.54	-1.44	-0.83
0.7	-1.91	**-2.63**	-1.28	-1.71	**-2.41**	**-2.33**	-2.15	**-2.22**	**-2.69**	**-3.54**	**-2.28**	-2.23	-0.60	-0.83
0.75	-1.91	-0.58	-1.85	-1.77	-1.96	**-2.47**	**-3.21**	**-3.15**	**-2.90**	**-3.21**	**-2.24**	-1.66	-1.02	-0.43
0.8	-1.23	-1.05	-1.83	**-2.63**	**-2.84**	**-2.88**	**-3.05**	**-3.47**	**-2.90**	**-2.84**	-1.91	-0.91	-1.53	-1.12
0.85	-0.98	-1.77	-1.78	-1.48	**-2.82**	**-3.55**	**-2.88**	**-3.34**	**-3.12**	**-2.48**	**-2.64**	-1.67	-1.29	-1.80
0.9	-0.98	-1.94	-1.78	-1.57	-1.54	**-2.93**	**-3.06**	**-2.96**	**-3.42**	**-3.02**	**-2.51**	-1.72	-1.58	-0.94
0.95	-0.44	-0.51	**-1.94**	-1.81	-1.64	-1.17	-1.69	-2.09	**-3.24**	**-3.61**	**-4.13**	**-2.77**	**-2.02**	-1.24
1	0.89	0.30	0.45	-0.83	-1.38	-1.80	-1.23	-1.26	-1.54	-1.30	-1.50	**-3.01**	-2.33	**-2.85**

Notes: bold numbers imply significance at the 10% level at least

TABLE 7: Robustness checks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	Forecast error	GDP growth 09	Forecast error	Forecast error	Forecast error	Forecast error	GDP growth 09
Joint dummy	-4.716***	-4.413***	-2.895***	-4.454***	-3.714***	-3.457***	-2.792**
	(1.2050)	(1.2721)	(0.9886)	(1.0596)	(1.1579)	(1.0382)	(1.1807)
Log(Trade openness)	-1.458	-0.294	-1.588	-1.716*	-2.057*	-2.310**	-1.667
	(1.0370)	(1.1670)	(0.9591)	(0.9934)	(1.0760)	(0.9952)	(1.0973)
Log(Financial openness)	1.963	1.357	1.500	1.803*	2.305*	2.420**	2.203*
	(1.2686)	(1.3848)	(1.1052)	(1.0062)	(1.2180)	(1.0478)	(1.2796)
Current account	0.031	0.000	-0.034	0.006	0.113**	0.076*	0.086*
	(0.0737)	(0.0884)	(0.0648)	(0.0535)	(0.0531)	(0.0445)	(0.0516)
Net foreign assets	-0.005	-0.001	-0.001	-0.001	-0.011*	-0.003	-0.001
	(0.0068)	(0.0080)	(0.0062)	(0.0019)	(0.0059)	(0.0021)	(0.0024)
Reserves	-0.004	0.002	0.007	-0.004	-0.016	-0.018	-0.021
	(0.0321)	(0.0333)	(0.0297)	(0.0281)	(0.0282)	(0.0266)	(0.0272)
Credit growth 04/07	-0.038**	-0.048***	-0.029**	-0.040**	-0.019*	-0.019*	-0.018
	(0.0161)	(0.0183)	(0.0143)	(0.0157)	(0.0101)	(0.0107)	(0.0107)
Manufacturing share	-0.055	-0.138*	-0.032	-0.039	-0.078	-0.060	-0.143**
	(0.0706)	(0.0806)	(0.0617)	(0.0601)	(0.0626)	(0.0535)	(0.0610)
Growth trend	0.120	0.469**	0.069	0.102	0.166	0.158	0.431**
	(0.2102)	(0.2252)	(0.2078)	(0.2031)	(0.2352)	(0.2216)	(0.2079)
Avrg. GDP growth 04/07	-0.215	0.082	-0.046	-0.197	-0.265	-0.254	0.003
	(0.1923)	(0.2266)	(0.1714)	(0.1857)	(0.1906)	(0.1802)	(0.2056)
Peg dummy	0.164	-0.344	0.805	-0.095	0.454	0.165	-0.257
	(0.8270)	(0.8410)	(0.7240)	(0.7663)	(0.7030)	(0.6885)	(0.7590)
Oil dummy	-0.065	1.210	0.085	0.070	-1.203	-1.252	-0.541
	(1.4753)	(1.6049)	(1.2201)	(1.3980)	(1.2171)	(1.1742)	(1.3339)
GDPpc	-0.036	-0.067	-0.042	-0.037	-0.086	-0.098*	-0.157**
	(0.0599)	(0.0744)	(0.0496)	(0.0519)	(0.0584)	(0.0503)	(0.0672)
GDP	0.000	-0.000	0.000	0.000	0.000	0.000	-0.000
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Log(Population)	0.082	0.398	0.161	0.038	0.045	0.015	0.306
	(0.2888)	(0.3288)	(0.2863)	(0.2552)	(0.2621)	(0.2343)	(0.2693)
Constant	-4.987	-8.765	-5.614	-2.488	-2.932	-1.855	-4.180
	(9.3826)	(10.6979)	(8.8354)	(7.9585)	(8.5642)	(7.4135)	(9.1567)
Observations	110	110	103	117	144	151	151
R-squared	0.330	0.383	0.240	0.326	0.294	0.278	0.349

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Figure 1

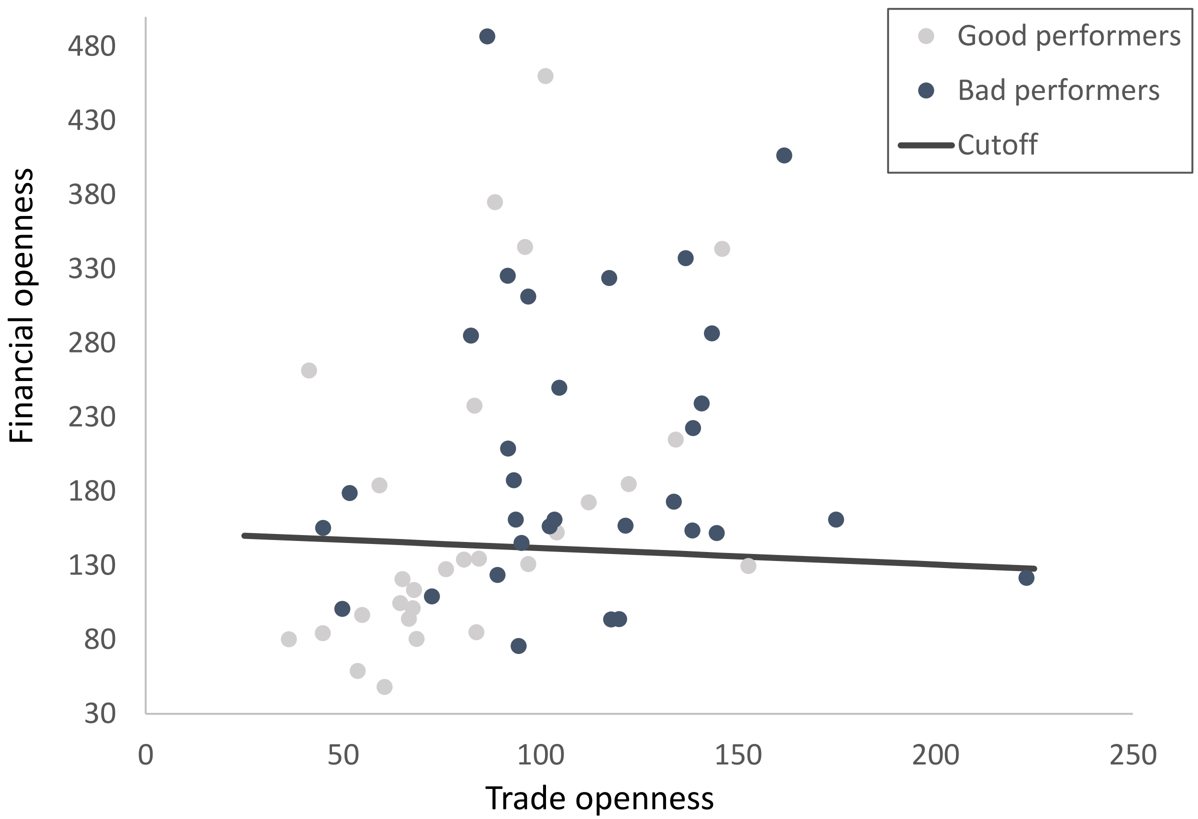
Good performers
Bad performers
Cutoff
Financial openness
480
430
380
330
280
230
180
130
80
30
0
50
100
150
200
250
Trade openness

Figure 2 Three Scenarios for Profit Schedules

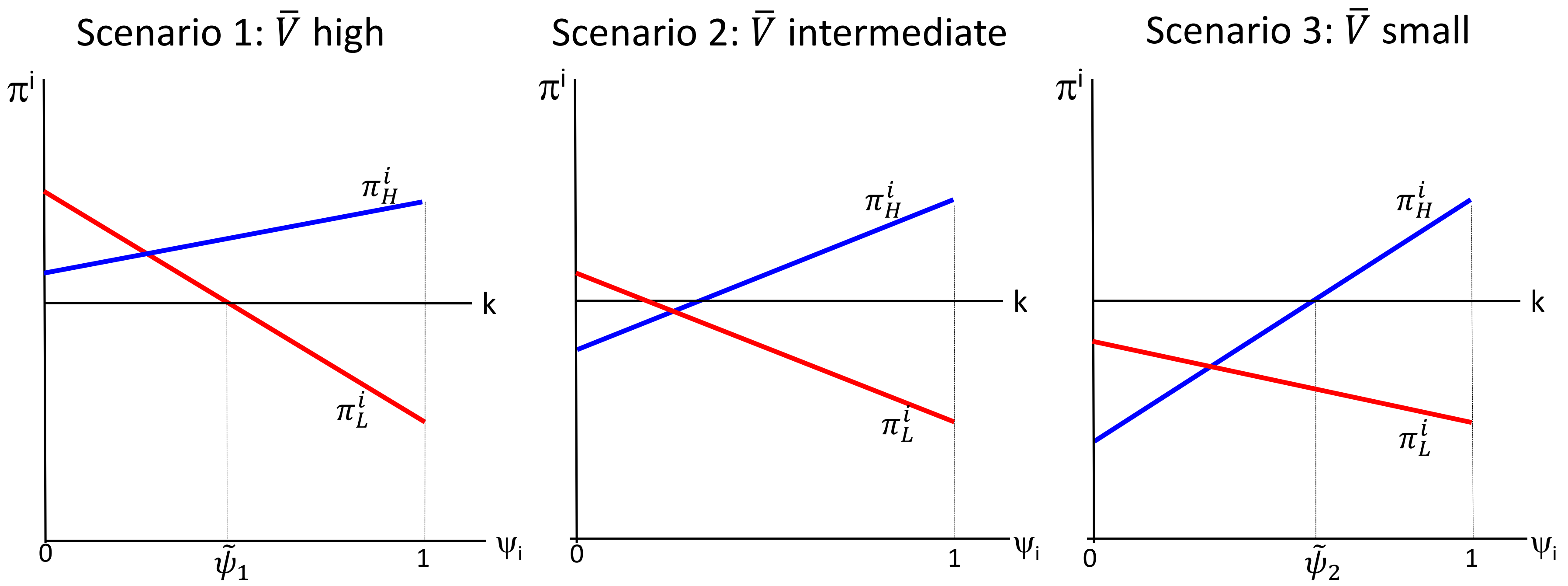

Figure 3 Numerical Illustration

(σ=2; α=0.6; A_L=0.8; k=0.682)

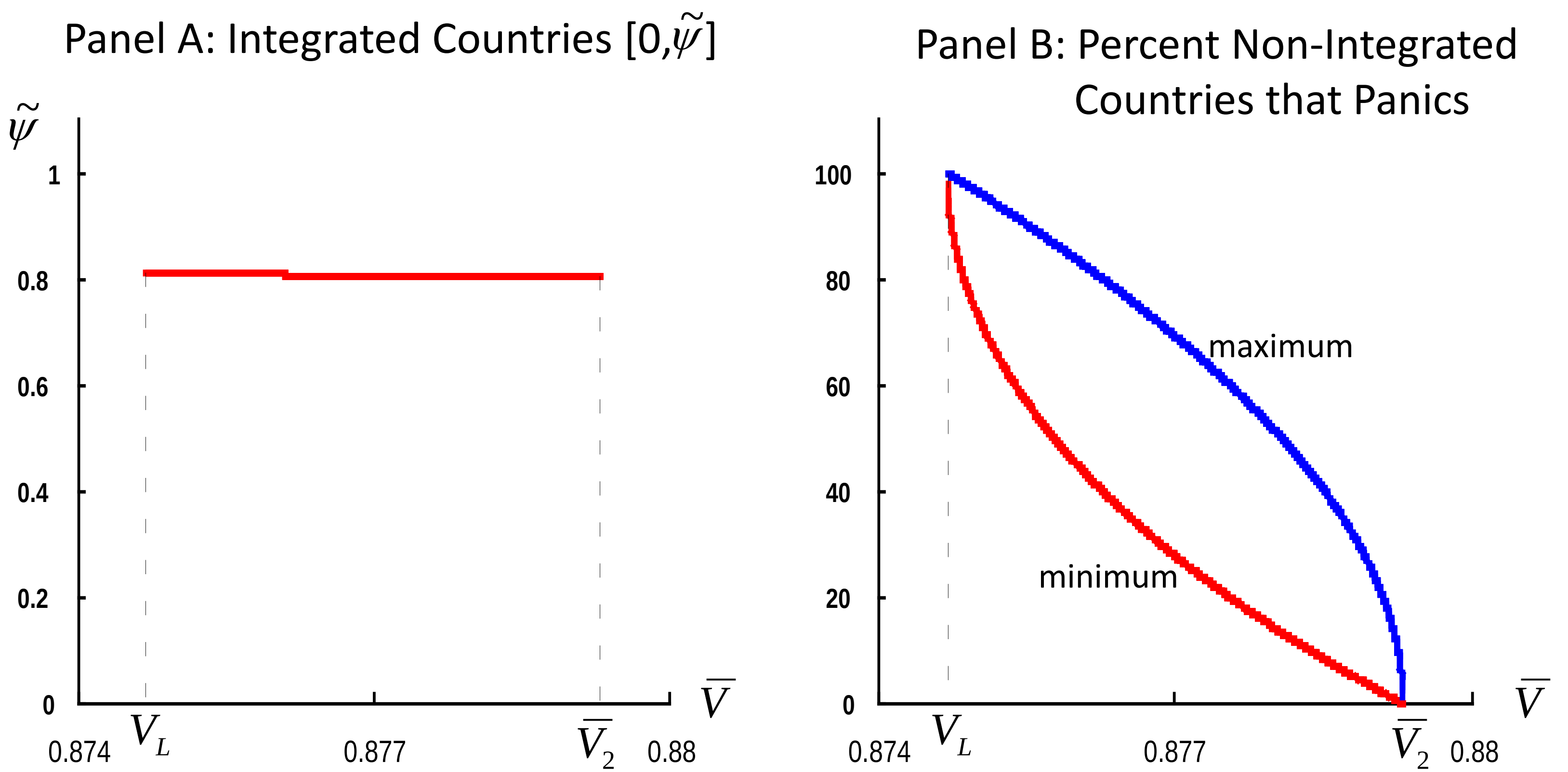

Figure 4 Numerical Illustration with Large Country

(σ=1.4; α=1; A_L=0.6; k=0.68, N=0.4, ψ_B=0.1)