Asymmetric volatility spillovers and consumption risk-sharing

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Abstract

Recent studies show that international financial integration facilitates cross-country consumption risk-sharing. We extend this line of research and demonstrate that breaking financial integration down into good and bad integration is important. We also propose new measures of capital market integration, based on *good* and *bad* volatility shocks, as well as country-specific indices of consumption risk-sharing. We document a decoupling of individual consumption growth from global risk-sharing after episodes of bad volatility cross-spillovers, and a recoupling after good spillovers. Our results support current views in the literature that advocate an asymmetric treatment of good and bad volatility shocks, in order to assess the macroeconomic dynamics that follow risk episodes. They also challenge previous views that present capital market integration (without differentiating between good and bad shocks) as a prerequisite for higher international consumption risk-sharing. Overall, our outcomes cast some doubt on the actual scope for consumption risk-sharing across global financial markets.

Keywords: Consumption risk-sharing; Capital market integration; Good and bad volatility; cross-spillovers

JEL codes: F21; F36; E21; E44

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1. Introduction

Enabling consumption risk-sharing between agents is a fundamental function of financial markets. This is true not only within the borders of a given economy, but also across different national markets. Standard theories in international finance (Obstfeld and Rogoff, 1996) predict perfect international consumption risk-sharing in perfectly integrated capital markets (as well as under homogeneous isoelastic utility functions). It comes as no surprise that the literature has therefore devoted considerable efforts to testing for the presence of international consumption risk-sharing in the data. Starting with the seminal works of Cochrane (1991), Mace (1991) and Obstfeld (1994), the empirical literature has assessed the extent of international consumption risk-sharing by conducting regressions of cross-sectionally demeaned consumption on cross-sectionally demeaned income, most of the times considering fixed effects by country (see for instance, Sorensen and Yosha, 2000; Sorensen et al., 2007; Kose et al, 2009b; Balli et al. 2013; Islamaj and Kose, 2016; Rangvid et al., 2016) or more sophisticated forms of heterogeneity across countries (Fuleky et al., 2015).

Despite the theoretical model's forecasts, the empirical evidence on the role of financial integration to improve consumption risk-sharing is heterogeneous. International consumption risk sharing studies ignore that financial integration depends on the asymmetries in the propagation of shocks. Therefore, ignoring the considerable differences in the degree of capital market integration after good and bad shocks may lead to incorrect assessments of international risk sharing gains. In this paper, we provide new perspectives to the literature. Our main contribution is to explore the impact of capital market integration on the cross-sectional and time-series dynamics of international consumption risk-sharing, distinguishing for the first time between good and bad capital market integration. Segal et al. (2015) recently emphasized the fundamental asymmetry in the propagation of good and bad volatility shocks. Our paper relies on crucial insights from this earlier study and proposes new measures of capital market integration that consider the evident asymmetries in the propagation of good and bad volatility shocks[1]. We also propose indices of the exposure of each individual country's consumption growth to the general pattern of risk sharing.

The hypothesis we seek to test is whether good and bad volatility cross-spillovers not only lead to *asymmetric capital market integration dynamics*, but also *to asymmetric coupling-decoupling dynamics with respect to global consumption risk-sharing patterns*. Put more simply, we analyze whether the degree of international consumption smoothing shared by a specific country with the global economy changes, in an asymmetric fashion, following 'good' or 'bad' volatility cross-spillovers in the global financial markets. We show that this is indeed the case. Countries decouple from the general trend of consumption risk-sharing following episodes of negative volatility cross-spillovers in the stock market, and they synchronize when these cross-spillovers are positive. These results emphasize the convenience of considering the differentiated effects of good and bad volatility shocks from the financial markets to the real

[1] See BenSaïda (2019).

economy and, moreover, they cast serious doubts on the ability of international financial markets to smooth consumption across different countries.

As a measure of market integration, Rangvid et al. (2016) use the dispersion of equity return across countries and two alternative measures: one based on return exposures to common (global) factors, the other based on a world capital asset pricing model (CAPM). Islamaj and Kose (2016) use multiple *de jure* measures of financial integration based on information drawn from the International Monetary Fund's Annual Report on Exchange Arrangements and Exchange Restrictions. They also check the robustness of their findings using *de facto* measures of financial integration: total stock of inflows (liabilities) and outflows (assets), foreign direct investment, equity, and debt flows. Kose et al. (2009a) use the same measures for financial integration. The measure of capital market integration based on cross-spillovers proposed herein belongs to the strand of the literature that estimates capital market integration using asset prices. The intuition behind it is that greater capital market integration will translate into greater price variability of each market due to price variability in foreign markets. In other words, the larger the cross-spillovers between markets, the larger the impact of common factors in the price formation of each domestic market, and naturally the larger the level of capital market integration across global stock markets. Our measure has the advantage (unlike extant common measures based on global CAPM models, or equity dispersion) that can be naturally decomposed into good and bad cross-volatility spillovers, allowing us to test our specific theoretical hypothesis.

The starting point for our analysis is to highlight the considerable differences in the degree of capital market integration after good and bad volatility shocks. Then, we use good and bad volatilities as inputs to build separate dynamic systems of good and bad volatility cross-spillovers. These systems allow us to propose new measures of capital market integration, which consider relevant asymmetries embedded in the sign of the volatility shocks, as well as time- and country-specific variations. Hence, good and bad capital market integration are measured as the total interaction of each market, both as receiver and exporter of volatility, with the system as a whole, depending on whether good or bad volatility series were used in the estimation. We find that while the good volatility cross-spillover index has increased at a constant pace since 1996, the bad cross-spillover index exhibits clear cycles and has been more stable.

In a second step, we construct a global index of consumption risk-sharing from 1997 to 2017. We use a recent sample and quarterly data (unlike the extant literature), which allows us to challenge current views stating that in the period of globalization (1995-ownwards) consumption risk-sharing presents an unstoppable upward trend (Lane and Milesi-Ferretti, 2007; Islamaj and Kose, 2016; Rangvid et al., 2016).

Finally, we explicitly analyze the relationship between capital market integration and coupling-decoupling dynamics with respect to global consumption risk-sharing patterns. Interestingly, synchronization is related not so much with the overall level of capital market integration than with the sign of the cross-spillovers. While bad volatility cross-spillovers reduce the synchronization of a country with global patterns of risk sharing, good volatility cross-spillovers have the opposite effect.

Notice that here we tackle the issue of whether a higher level of capital market integration leads to a higher level of synchronization of countries with the global trend of consumption risk-sharing. We focus on synchronization across countries and think of global consumption risk sharing as a global factor. This allows us to differentiate on a country basis the observed dynamics of consumption risk-sharing relative to the aggregate path. As such, our study takes distance from the previous studies that have analyzed consumption risk sharing only from an aggregate perspective and remain silent about the potential differences experienced by countries with different dynamics in terms of capital market integration.

The remainder of the paper is structured as follows. Section 2 describe the steps we follow to test our main hypothesis. Section 3 presents the data we use. Results are in Section 4. Section 5 presents our concluding remarks.

2. Methodology

We constructed: (i) indices of asymmetric capital market integration, and (ii) country specific indices of consumption risk-sharing. To calculate (i), first, we estimated good and bad volatilities using monthly realized semivariances (Barndorff-Nielsen et al., 2010), and then we constructed total cross-spillovers for the two systems in line with Diebold and Yilmaz (2012, 2014). Finally, we constructed our two measures of capital market integration by summing the contributions of each market to the FEVD of the volatility of the rest of the system, and the contribution of the rest of the system's volatility to the FEVD of each market's volatility. To obtain (ii), first, we estimated a quarterly measure of global consumption risk-sharing, calculated as the slope of a regression of idiosyncratic consumption growth on idiosyncratic income growth (after controlling for global real consumption and income). Then, we used this measure as a factor that allows us to calculate the exposure of each individual country's consumption growth to the general pattern of risk sharing.

Once (i) and (ii) were calculated, we evaluated the respective impacts of good and bad capital market integration on the cross-sectional and time-series dynamics of international consumption risk-sharing. By so doing, we are able to provide evidence about the *coupling* or *decoupling* processes each country faces after good and bad volatility cross-spillovers in the global financial markets. To this end, we used a panel regression that exploits cross-sectional and time-series variations in our data set, and we control for measures of exchange rate flexibility, trade integration, and a traditional proxy for (symmetric) capital market integration.

2.1. Good and bad volatility estimation

Consider the traditional realized volatility (RV) estimator, as explained for example in Andersen and Todorov (2010). The RV estimator of log asset prices Y can be expressed as:

$$RV = \sum_{j=1}^{n} \left(Y_{t_j} - Y_{t_{j-1}}\right)^2, \tag{1}$$

where $0 = t_0 < t_1 < \cdots < t_n = 1$ are the times at which prices are available. This has been proved to be an extremely useful methodology for estimating and forecasting conditional variances for risk management and asset pricing[2]. Nevertheless, Barndorff-Nielsen et al. (2010) stress that this measure is silent about the asymmetric behavior of jumps. Thus, they propose a new RS estimator as follows:

$$\begin{aligned} RS^- &= \sum_{j=1}^{t_j \leq 1} \left(Y_{t_j} - Y_{t_{j-1}}\right)^2 1_{Y_{t_j} - Y_{t_{j-1}} \leq 0} \\ RS^+ &= \sum_{j=1}^{t_j \leq 1} \left(Y_{t_j} - Y_{t_{j-1}}\right)^2 1_{Y_{t_j} - Y_{t_{j-1}} \geq 0} \end{aligned}, \tag{2}$$

where 1_y is an indicator function taking a value of 1 if argument *y* is true. The first equation provides a direct estimate of downside risk, while the latter does so for upside risk. In our estimations, we used daily stock market data and we aggregated within months in order to compute good and bad monthly volatility series ($RS_{i,t}^+$ and $RS_{i,t}^-$,) for each of the $N=17$ markets in our sample.

2.2. VAR and FEVD representations

Our good and bad spillover indices and our measures of capital market integration were built on two VAR systems, with $N=17$ in each case, and were drawn from associated FEVD statistics. The errors were estimated from the moving average representation of the VAR as follows:

$$X_t = \Theta(L)\varepsilon_t, \tag{4}$$

$$X_t = \sum_{i=0}^{\infty} A_i \varepsilon_{t-i}, \tag{5}$$

where X_t is a matrix $T \times N$, $\Theta(L) = (I - \phi(L))^{-1}$, ε_t is a vector of independently and identically distributed disturbances with zero mean, and Σ covariance matrix, $A_i = \phi A_{i-1} + \phi A_{i-2} + \cdots + \phi A_{i-p}$ is a matrix that contains the parameters of the system, *p* is the number of lags used in the estimation, and *T* is the last period (month) in the sample. Naturally $X_t = RS_t^+$ or $X_t = RS_t^-$ for the good and bad volatility systems, respectively. To estimate the FEVD from the h-step ahead forecast, we followed the generalized VAR proposed by Koop et al. (1996) and Pesaran and Shin (1998).

The errors in the FEVD can be divided into *own variance* shares or *cross variance* shares. The former are the fractions of the system errors that are related to a shock to x_i on itself, while the latter are the portion of the shocks on x_i related to the rest of the semivariances in the system. Thus, the h-step ahead FEVD can be defined as:

$$\theta_{ij}(H) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} (e_i{}' A_h \Sigma e_j)^2}{\sum_{h=0}^{H-1} (e_i{}' A_h \Sigma A_h{}' e_i)}, \tag{6}$$

[2] See Liu et al. (2015) and references therein.

where Σ is the variance matrix of ε_t, σ_{jj} is the standard deviation of the *j*-th equation, and e_j is a vector with ones in the *i*-th element and zero otherwise. To guarantee that the sum of each row equals 1, each entry of the variance decomposition must be normalized as follows:

$$\tilde{\theta}_{ij}(H) = \frac{\theta_{ij}(H)}{\sum_{j=1}^{N} \theta_{ij}(H)}, \tag{7}$$

where $\sum_{i,j=1}^{N} \tilde{\theta}_{ij}(H) = N$.

2.2.1. *Total and net spillovers*

With the normalized variance decomposition, the total spillover index proposed by Diebold and Yilmaz (2012, 2014) can be calculated as:

$$C(H) = \frac{\sum_{i,j=1, i\neq j}^{N} \tilde{\theta}_{ij}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}(H)} \times 100, \tag{8}$$

This index measures the percentage of the variance that is explained by cross-spillovers in the system. It can be extended to a *directional spillover* index, in which the effect of a shock to x_j on the variable x_i is given by the following quantity:

$$C_{i \leftarrow j}(H) = \frac{\sum_{j=1, i\neq j}^{N} \tilde{\theta}_{ij}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}(H)} \times 100, \tag{9}$$

conversely, a shock to x_i on x_j is given by:

$$C_{i \rightarrow j}(H) = \frac{\sum_{j=1, i\neq j}^{N} \tilde{\theta}_{ji}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}(H)} \times 100 \tag{10}$$

With the two directional spillover indices, we construct a *net spillover* index, given by:

$$C_i(H) = C_{i \rightarrow j}(H) - C_{i \leftarrow j}(H). \tag{11}$$

The net spillover index measures the difference between the shocks transmitted to, and received from, all other markets in the system. Therefore, each series within the system will be either a *net receiver* or a *net transmitter* of shocks.

2.2.2. Capital market integration (good and bad)

Analogously, a measure of the total interaction of a given market with the rest of the system can be constructed by replacing the negative sign in equation 11 with a positive one, as follows:

$$I_i(H) = C_{i \rightarrow j}(H) + C_{i \leftarrow j}(H). \tag{12}$$

We propose $I_i(H)$ in (12) (the total interaction of each market, both as receiver and exporter of volatility, with the system as a whole) as our measure of good and bad capital market integration, depending on whether good or bad volatility series were used in the estimation.

Naturally, the estimations above allow us to analyze static spillovers across stock markets. Dynamics are introduced by estimating spillovers as well as capital market integration statistics using rolling windows in the estimation procedure. In this case, an additional subscript signal time variation will appear in the above equations. We do not initially include this sign so as to avoid an unnecessarily cumbersome notation.

2.3. Measures of international consumption risk-sharing

The most traditional measure of time-varying consumption risk-sharing in the literature is given by the following equation[3]:

$$\Delta c_{i,t} - \overline{\Delta c_t} = \alpha + \beta\left(\Delta \mathrm{y}_{i,t} - \overline{\Delta \mathrm{y}_t}\right) + \varepsilon_{i,t}, \tag{13}$$

where $\Delta c_{i,t}$ is the real consumption growth rate of country i in period t, $\overline{\Delta c_t}$ is the global real consumption growth rate in period t, $\Delta \mathrm{y}_{i,t}$ is the real income growth rate of country i in period t, $\overline{\Delta \mathrm{y}_t}$ is the global real income growth rate in period t, and as usual $\varepsilon_{i,t}$ is white noise. In equation (13), β measures the relationship between idiosyncratic consumption growth and idiosyncratic income growth, so that the higher β, the lower the consumption risk-sharing, and vice versa. It is worth noting that, as stressed by Fuleky et al. (2015), this relationship works better when similar (developed) countries with relatively open capital markets are included in the sample. Otherwise, nothing guarantees that the 1 imposed in front of $\overline{\Delta c_t}$ in equation 13 holds in all cases. In our sample we only included countries with these two characteristics and, thus, we estimated quarterly cross-sectional regressions following equation (13).

As stated before, we are interested in analyzing *coupling* (or *decoupling*) processes between the global trend (cycle) of consumption risk-sharing and the consumption patterns of individual countries in our sample. To do so, we estimated the following time varying relationship for each country:

$$\Delta c_{i,s} - \overline{\Delta c_s} = a_{i,s} + b_{i,s} crs_s + u_{i,s}, \tag{14}$$

for $i = 1 \dots N$ and $s = t + w$, where $t = 1, \dots, T$, and w is the length of the window. crs_t stands for consumption risk-sharing and is calculated as $crs_t = 100 - 100 * \beta_t$, so that higher levels imply more risk sharing. Here, b_i measures the exposure of idiosyncratic consumption of country i to the general pattern of consumption risk-sharing. High values of b_i signal a high synchronization between country i's consumption and the general pattern of consumption risk-sharing. If b_i is positive and large, it means that consumption in country i benefits from a greater level of consumption risk-sharing in the global economy. b_i, as such, is a direct measure of the benefits in terms of consumption that risk sharing represents

3 See for a recent example Rangvid et al. (2016), but this strategy in the literature dates back to Mace (1991), Cochrane (1991), and Lewis (1996).

for country i as well as of its level of synchronization with the global pattern of consumption risk-sharing.

Given that $b_{i,s}$ is time varying itself, we can now proceed to analyze whether these benefits obtained via consumption risk-sharing change, in an asymmetric fashion, following 'good' or 'bad' interactions with the global financial markets. To this end, we estimated a panel regression.

3. Data

Our main source of data was Datastream International. We used MSCI indices provided by Thomson Reuters for the following markets: Australia, Austria, Belgium, Canada, Denmark, France, Germany, Italy, Japan, Norway, Singapore, Spain, Sweden, Switzerland, the Netherlands, the United Kingdom, and the United States. The market indices were retrieved daily from February 2 1970 to November 21 2017, for a total of 12,472 observations. The real consumption and real income data were also obtained from Datastream, though here each quarter, from 1996-Q1 to 2017-Q2, for a total of 86 quarters. We used the comparable series across countries and markets provided by Datastream for each case.

The sample period was selected based mainly on data availability considerations and the feasibility of the VAR estimations. The 17 countries in our sample are those for which two conditions were satisfied: times series of (homogeneous) daily stock indexes can be retrieved at least since 1970, and time series of (homogeneous) consumption and income can be consulted at least since 1996. Fortunately, our daily sample starts before our quarterly sample. Thus, starting in the early 70s allows us to estimate our first VAR rolling-window with the first 25 years of data (from 1970 to 1995), which corresponds to the first 300 months in the sample. In this way, there is no waste of useful information and we can estimate a feasible VAR of 17 series with 300 monthly periods.

To conduct our analysis of international consumption risk-sharing synchronization, we had to design a panel that included both capital market integration measures and time-varying risk exposure to the consumption risk-sharing factor. We used end of quarter measures of cross-volatility shocks (which are monthly as explained above) and rolling windows of 20 quarters in the regressions of idiosyncratic consumption on the international risk-sharing factor. In so doing, we guaranteed a panel of $N=17$ X $T=63$. The first 23 observations were lost in the first rolling window estimation of the consumption risk-sharing statistics (20 observations) and the calculation of the annual growth rates of real income and real consumption (3 observations). Our final panel consists therefore of 1,069 observations[4]. It can be seen that there are both cross-sectional and time-series variations in the data, both in the regressor and the regressand, so as to guarantee the power in our hypothesis testing procedure.

[4] We lost the last observations for Australia and Japan. In these cases, import and export data were not available for 2017-Q2.

Our sample presents the additional advantages of i) being restricted to relatively integrated and homogeneous countries in terms of economic development and capital market openness, which is a traditionally overlooked assumption of international risk-sharing empirical exercises[5], and ii) covering precisely the so-called globalization period, in which international risk-sharing is a consideration of paramount importance, and which starts around 1995. Finally, iii) the sample also includes several financial and economic crises and, of course, also well-documented, major upturns in economic activity and bullish episodes in the financial markets.

4. Results

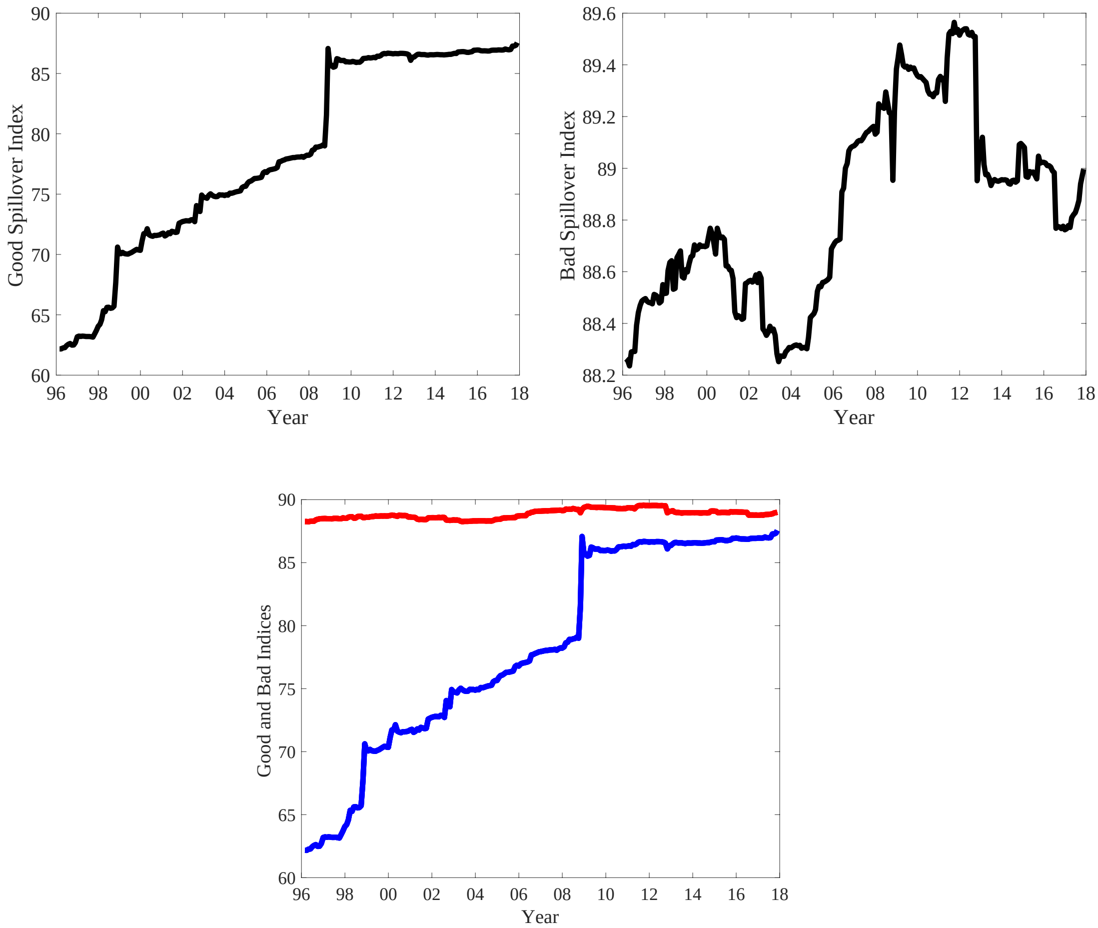
In section 4.1, we present the dynamic statistics that measure good and bad volatility cross-spillovers in the stock markets. In section 4.2, we present our measures of (good and bad) capital market integration. In section 4.3, we present a quarterly measure of consumption risk-sharing in the global economy from 1996-Q1 to 2017-Q2 and we estimate the time-varying exposures to this general trend by individual economies. Finally, in section 4.4, we provide evidence in favor of our initial hypothesis: good and bad volatility cross-spillovers not only lead to *asymmetric capital market integration dynamics*, but also *to asymmetric coupling-decoupling dynamics with respect to the global consumption risk-sharing pattern.*

4.1. Good and bad international volatility spillovers

Figure 1 contrasts good and bad volatility cross-spillovers in the global stock market, corresponding to the dynamic versions of equation 8. The differences between the two indices are obvious. While the good volatility index has increased at a constant pace since 1996 (with a marked positive leap in the aftermath of the global financial crisis, around 2009), the bad volatility index exhibits cycles of fairly small magnitude. The bottom panel of the figure plots the two indices simultaneously so as to emphasize the relative stability of the propagation of bad volatility compared to the markedly upward trend exhibited by the good volatility cross-spillovers. The variation in the bad volatility index occurs in the cyclical domain, while the variation in good volatility is more pronounced in the trend component. Consequently, if we compare the beginning of the sample with the end, in the case of good cross-spillovers there is an increase of more than 24 percentage points (from 62 to 86%), while in the same period the increment in bad spillovers is less than one percentage point (from 88.2 to 89.0%). Thus, if our aim is to measure capital market integration over the last two decades, we reach decidedly different conclusions depending on which side of the volatility we wish to emphasize.

[5] See Fuleky et al. (2015).

Figure 1. Good and Bad Volatility Cross-Spillovers in the Global Stock Market. The figure shows good and bad volatility cross-spillovers for the full sample (from February 2 1970 to November 21 2017). The estimations were performed using rolling windows of 300 observations, forecasting horizon of 1 day, and 1 lag (based on the Akaike Information Criteria (AIC)). The bottom panel of the figure shows the good (blue line) and the bad spillover indices (red line) simultaneously.



4.2. Good and Bad Capital Market Integration

We construct two indices: one of them is built on good volatility shocks, the other on bad volatility shocks. Both are constructed as the sum of the FEDV of volatility in the VAR representation, predicted by each market for the rest of the system, and the FEDV of volatility that the rest of the system contributes to each market. In this way, we seek to encapsulate at each point in time the total interaction of each market, both as receiver and exporter of volatility, with the system as a whole. Our indices do not provide a net value of the total effect, as this would underestimate the integration of a given market with the global market.

Figure 2. Index of Capital Market Integration Constructed with Good Volatility Shocks. The figure shows the total interaction of each market, both as receiver and exporter of good volatility shocks, with the system as a whole (Equation 12).

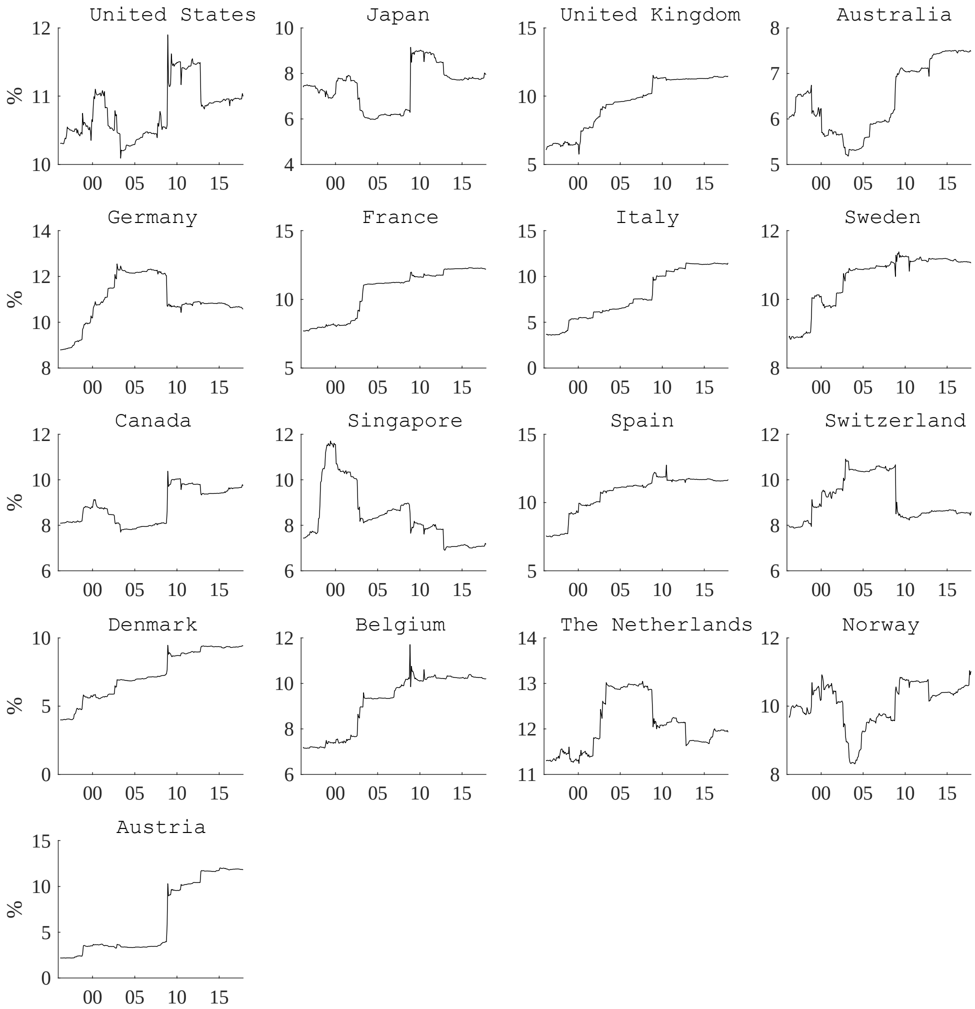
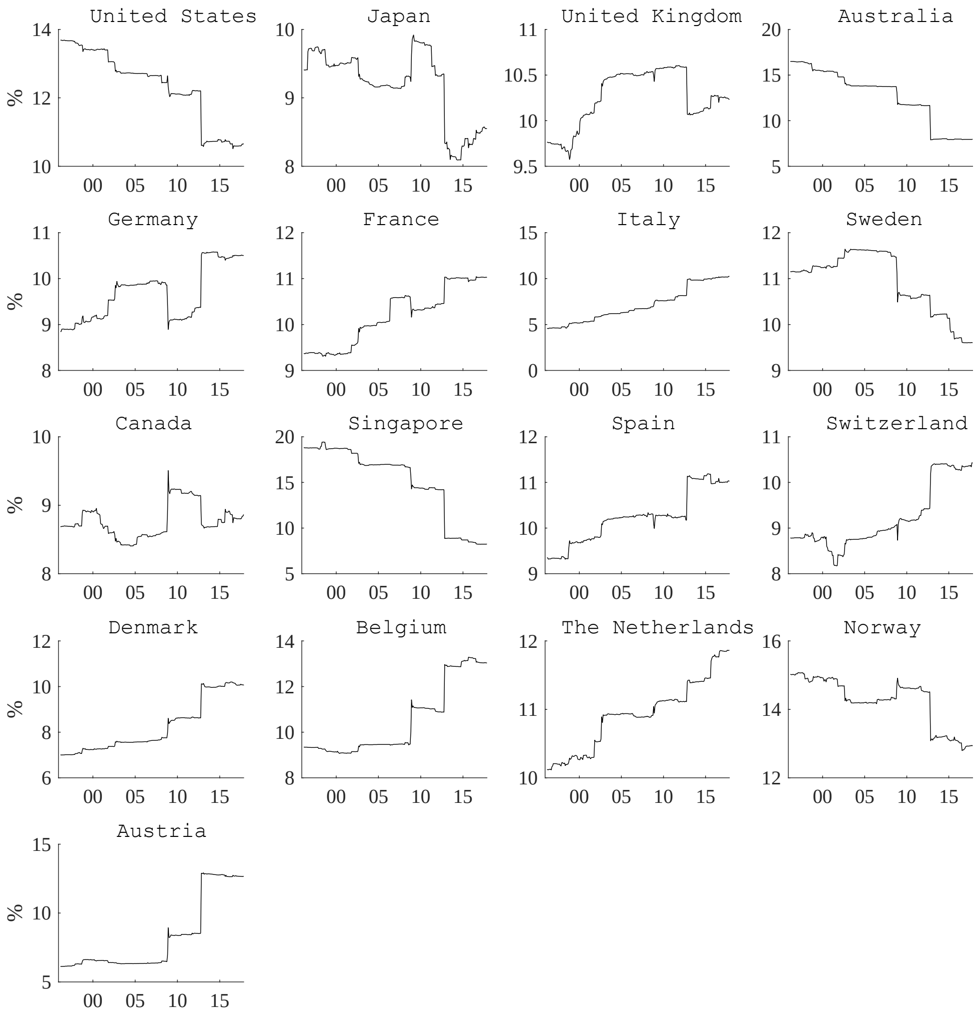


Figure 2 presents the indices constructed for each market when drawing from good volatility spillovers. We observe both cross-variation between the markets, and time-variation across the sample period. In general, there is a positive trend in terms of good capital market integration, understood as greater interaction between each market and the rest of the system as regards good volatility transmission. This upward trend was recorded at a very early date in such countries as Italy, Denmark and the United Kingdom and holds until the end of the sample. For other countries (most notably, the US, Japan, Canada, the Netherlands, and Norway), however, the situation is better described by cycles of integration and disintegration. Furthermore, for markets such as those in Germany, Singapore and

Switzerland, there is no clear upward trend looking at the Figure. Indeed, as shown in table A1 in the Appendix, the trend is downwards[6].

Figure 3. Index of Capital Market Integration Constructed with Bad Volatility Shocks. The figure shows the total interaction of each market, both as receiver and exporter of bad volatility shocks, with the system as a whole (Equation 12).



Inspection of Figure 3 shows a very different landscape. If we consider the case of the US, in Figure 2, the country's *good capital market integration* can be said to have increased overall from 2004 to the end of the sample, with a pronounced leap being recorded in positive

6 Table A1 in the Appendix shows the results of the regression $y_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \varepsilon_t$ to test for a linear or quadratic trend in the indexes of (good and bad) capital market integration displayed in Figures 2 and 3. The non-parametric Mann-Kendall test for monotonic trends is also included. The results show that in most of the cases there exist both a linear and a quadratic term in the original series.

integration in the aftermath of the subprime crisis until the middle of the European debt crisis, around 2012. However, if we focus on Figure 3, the US's *bad capital market integration* displays a persistent downward trend over the same period. That is, while US positive interactions with the rest of the system increased markedly from 1996 onwards, its negative interactions decreased (from 14% to just above 10%). The cases of Australia, Sweden, Switzerland, and the Netherlands are equally contrasting. However, the markets of France, Italy, Canada, Spain, and Austria are more symmetrical in their respective dynamics. The behavior of all the other markets lies in-between these two extreme scenarios: that is, on some occasions the good and bad volatility-based measures evolve in the same direction, on others they take diverging paths[7].

4.3. International Consumption Risk-Sharing

We now turn our attention to international consumption risk-sharing. First, we construct quarterly measures of consumption risk-sharing as in equation 13, using cross-sectional regressions for each quarter in our sample, starting in 1997-Q1 and ending in 2017-Q2. In this way, we obtain an estimate of consumption risk-sharing for each quarter. Although our cross-sectional regressions have a quarterly frequency, we compute annual consumption and income growth rates, by differentiating the logs of the two variables with four lags in between.

Using quarterly data prevents us from initiating our analysis at an earlier date – see, for example, Rangvid et al. (2016) who begin their calculations as far back as 1875 – but it allows us to increase the number of observations for the so-called period of globalization period. This is feasible theoretically, because there are no restrictions on the frequency of the data for which equation 13 should hold. A β equal to zero indicates a perfect sharing of the consumption risk across the global economy, independently of the frequency of the growth rates in the analysis.

Figure 4 reports our main findings in this respect. The graph plots consumption risk -sharing, corresponding to $crs_t = 100 - 100 * \beta_t$. We present both the smoothed and unsmoothed versions of our statistic. Interestingly, there has not been an unrestrained upward trend in consumption risk-sharing over the last two decades. In fact, the risk- sharing dynamics are best described by cycles rather than by trends. Indeed, it is possible to identify one complete cycle of risk sharing in the sample period. The expansive phase of the cycle emerges out of a trough recorded in 2000-Q1, reaching a peak around 2007-Q3. The ensuing contraction phase lasts until 2014-Q2, completing this long 14-year cycle. Thus, the end of the previous cycle and the beginning of a new one are both apparent in the plot.

It seems that consumption risk-sharing is highly volatile. This volatility concentrates in the cyclical component of the series spectrum, rather than in its trend component. It is also

[7] Our results contrast with those reported by Islamaj and Kose (2016) and Rangvid et al. (2016). Using alternative measures for capital market integration, these authors find that the level of capital market integration has generally been trending upward since the beginning of our sample period until 2011, when their sample ends.

evident that the dynamics of consumption risk-sharing depend on cycles of global economy activity. It is perfectly evident that risk sharing reached its maximum with the onset of the subprime crisis, coinciding with a peak in global economic activity (or at least in the economic activity of the US). The down phase lasted until the end of the European debt crisis. The period 2007-Q2 to 2014-Q4 was one of crisis in both the financial and real sides of global economies. Thus, our analysis of the last two decades of data shows there is a time variation in the level of global consumption risk-sharing. Moreover, reductions in the level of consumption risk-sharing are associated with downturns in global economic activity and financial crises.

Figure 4. Cycles of Consumption Risk-Sharing in the Global Economy (1997-2017). The figure shows consumption risk-sharing between 1997 and 2017. The blue (black) line shows the smoothed (unsmoothed) versions of our statistics. The smoothed version is based on a kernel regression.

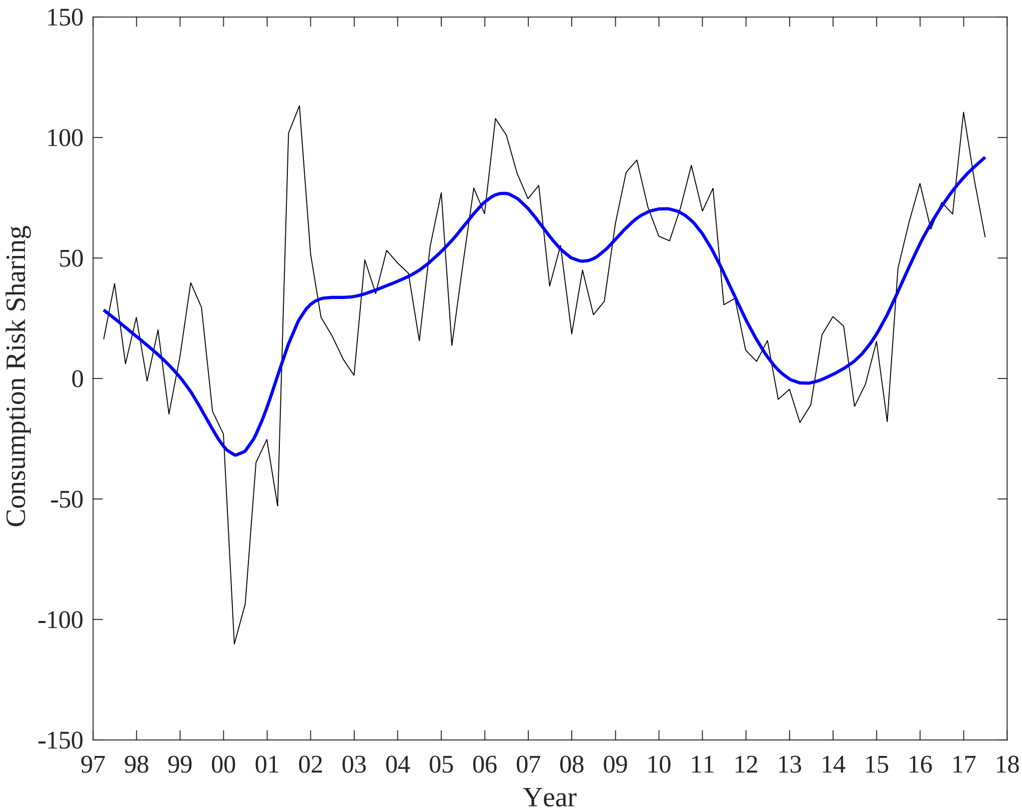
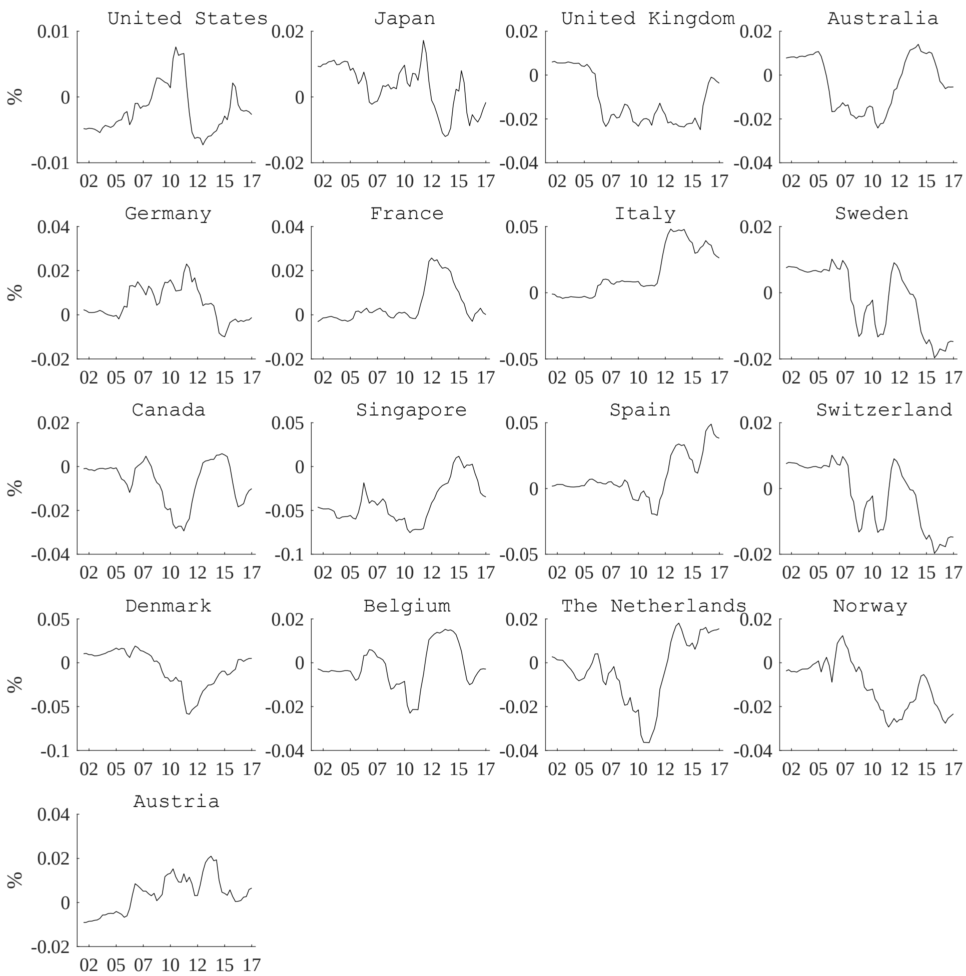


Figure 5 presents our estimates of time-varying, country-specific exposure to the global factor of consumption risk-sharing, following equation (14). As is evident, time variation is an important feature of this exposure. No country displays solely positive or solely negative exposure to general trends in consumption risk-sharing during the sample period, using rolling five-year windows. It can be seen that while countries such as Australia and Canada display a more negative exposure to the global cycle of consumption risk-sharing (to the extent that their own consumption growth tends to decrease when risk sharing increases), other countries such as Italy, Spain, and France display the opposite behavior most of the time. A third group of countries, in which we can include the US, Norway and, Austria, are more neutral with regard to this exposure. However, in all cases, exposure means an evolution from positive to negative (or from negative to positive) values across the sample period. The *t* statistics of these time-varying exposures are presented in Figure A1 in the Appendix. It should be stressed that even using as few as 20 observations for each regression is sufficient to reject the null hypothesis of statistical insignificance in most of the periods of the sample.

Figure 5. Time-Varying Exposure to Global Risk Sharing by Country. The figure shows the exposure of idiosyncratic consumption of country i to the general pattern of consumption risk-sharing over the period 2002 to 2017. The estimations were performed using rolling windows of 20 observations.



4.4. Consumption Risk-Sharing and the Effects of Good and Bad Capital Market Integration

In this section, we estimate the relationship between individual country levels of risk sharing, as explained above, and individual good and bad capital market integration. To this end, we use a panel framework that allows us to use the time-series and cross-sectional information available in the data. That is, we regress crs-betas (Equation 14) on good and bad capital market integration country-specific indices and some additional control variables. In line with the literature, we include an alternative measure of capital market integration, a control for trade integration, and indicators of country exchange rate flexibility.

Rangvid et al. (2016) and Korajczyk (1996), for example, use world CAPM absolute residuals (or intercepts) as a measure of capital market integration. The general idea underpinning this procedure is that in a model in which assets are priced according to their exposure to the world market portfolio, more integrated capital markets will tend to present lower cross-country dispersion of idiosyncratic risk. To calculate the idiosyncratic risk of each country, we estimate a world-CAPM over the full sample period for each of the 17 countries[8]. We then save the residual time-series and take the absolute value as our measure of *disintegration*, on a quarterly basis.

Moreover, exchange rate flexibility may, according to Cole and Obstfeld (1991), improve risk sharing via changes in terms of trade. We capture this relevant insight by including in our regressions the typology recently proposed by Ilzetzki et al. (2017)[9]. The algorithm devised by these authors accounts for the possibility of multiple currency poles as it seeks to classify the level of *de facto* exchange rate flexibility according to the most relevant anchor currencies in the global economy. Ilzetzki et al. (2017) update and refine the classification proposed by Reinhart and Rogoff (2004), and provide data through 2016 (readily extendable for the developed countries in our sample up to 2017), whereas the previously, widely used series ends in 2001. The broad categories provided by these authors comprise pegs, narrow bands, broad bands/managed floats, and free floats[10]. In our regressions, we include several indicator variables that take a value of one when a country belongs to one of the aforementioned categories in a given time period, and zero otherwise.

Finally, we also include an indicator of trade openness, following Kose et al. (2009b), who argue that trade openness also matters (together with capital market integration) for international risk-sharing. Following Rangvid et al. (2016) we compute trade openness as the sum of exports and imports relative to GDP for the 17 countries in our sample. Since trade

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[8] We use the average of the countries' returns to calculate the world market index.

[9] The classification provided by Ilzetzki et al. (2017) runs through to December 2016. Here, we opt to use the 2016 classification for 2017. This decision seems to be consistent given that during the sample period the exchange rate classification is highly persistent and most of the variability occurs across countries and not over time.

[10] The data can be downloaded from Carmen Reinhart's webpage at: http://www.carmenreinhart.com/data/browse-by-topic/topics/11/

openness presents a unit root, we included the first differences of the series in our regressions.

We first conducted a Hausman test to determine whether country-specific fixed effects should be included in the panel regressions to guarantee the consistency of the estimator without fixed effects. Naturally, the indicator variables were excluded from the test in this first step, as they do not present notable variability in time. We did not reject the null of consistency under both the null and the alternative, so we opted for the more efficient estimates (see Table A3 in the Appendix). Nevertheless, in order to consider the presence of heteroscedasticity and autocorrelation in the errors we use Newey-West robust standard errors in our calculations. In this way, we avoid having to specify the shape of the var-cov matrix in the GLS procedure (which could lead to biases if incorrectly addressed). We also include in Table A2 in the Appendix the estimations using both fixed and random effects, so as to provide a point of comparison. Our main conclusions regarding the effect of good and bad capital market integration on international consumption risk-sharing remain unaltered in all cases.

We document statistically significant effects in the two cases (i.e. good and bad capital market integration), though they present opposite signs. Thus, while good cross-spillovers with the rest of the world (i.e. giving or receiving good volatility from all the other markets) increase country exposure to the global risk-sharing factor, bad cross-spillovers lead to a decoupling with the risk-sharing pattern for the rest of the world. This asymmetric relationship is about twice as large in the case of the latter (-0.28) than in that of the former (0.18). Given that the most important benefits of international consumption risk-sharing are directly attributable to the ability of capital markets to smooth consumption fluctuations in "bad times" (sharing the risk across countries or individuals), our results show that these alleged benefits may be very limited in practice.

As far as our control variables are concerned, although the CAPM residuals present the expected sign (i.e. greater disintegration leads to less synchronization in terms of risk sharing), they are not statistically significant in our main specification (though, note, that they are significant in the alternative estimates in the Appendix). Moreover, no clear conclusions can be drawn regarding the comparative roles played by different exchange rate arrangements, as a factor accounting for the dynamics of our measure of international consumption risk-sharing. Managed floats and free floats induce a lower level of international consumption risk-sharing with respect to pegs (which is the base category), while narrow bands induce a higher level of synchronization in terms of risk-sharing. This result might seem counterintuitive at first glance. However, it is worth noting that most of the countries classified as pegs by Ilzetzki et al. (2017) belong to the Eurozone in our sample, and even when they belong to a currency union, one would naturally expect a greater level of international consumption-risk sharing between them, compared to the rest of the world. Finally, the trade openness control proved to be non-significant, despite the theoretical reasons underlying its inclusion.

Table 1. Consumption Risk Sharing and Good and Bad Capital Market Integration

	Consumption risk-sharing
Constant	1.357** (0.528)
Bad capital market integration	-0.275*** (0.073)
Good capital market integration	0.175*** (0.067)
CAPM absolute residuals	-1.450 (0.943)
Trade openness (in diff.)	-0.618 (0.703)
Narrow-band indicator	0.553** (0.252)
Managed-float indicator	-1.152*** (0.257)
Free-float indicator	-0.161 (0.307)
N=1,069 *R*=0.283	

This table shows the results of panel regressions with robust standard errors in brackets. *, **, and *** indicate statistical significance at the 10, 5, and 1% levels, respectively. A Hausman test of a restricted version of the model with no indicator variables was used to discard the presence of fixed effects. The base category measured by the intercept are "pegs", which includes currency unions.

Our findings in terms of coupling-decoupling consumption risk-sharing dynamics following positive and negative cross-spillovers from the global markets are in line with the general intuition that countries tend to modify their international reserves and to reallocate financial capital shares (i.e. to reduce net public debt or to aim specifically for lower exposure to international currencies in their portfolios, see Dooley, 2009), or to implement *de facto* capital control measures aimed at reducing international capital mobility (in particular, that of capital outflows), following crisis episodes in the global financial markets[11]. Moreover, crises are known to trigger protectionist measures from domestic economies that seek to isolate themselves from global financial shocks so as to preserve their own financial stability. Isolation from the global economy, both in real and financial terms, is a phenomenon that reduces the possibility of capital markets of facilitating international risk sharing and such isolation is likely to follow bad capital integration, as defined here. In contrast, we show that good capital market integration promotes international consumption risk-sharing through closer synchronization between individual consumption patterns and the general trend of risk sharing in the global economy. The effects of good capital market integration, in terms of consumption risk-sharing, are only possible when there is a political will to open up capital and trade accounts and to permit an increase in cross-border capital mobility on the part of

[11] See Chinn and Ito (2006) for a survey of these measures and their interaction with legal and institutional environments.

the domestic economies – that is, when international financial markets generate profits and surpluses in the national capital markets.

5. Conclusions

How does capital market integration impact coupling-decoupling consumption risk-sharing dynamics? Our results show that the answer depends on breaking this integration down into good and bad. To reach this conclusion, we propose new measures of countries' capital market integration, based on *good* and *bad* volatility shocks, as well as country-specific indices of consumption risk-sharing.

Our results show that there are indeed considerable differences in the degree of capital market integration after good and bad volatility shocks. While the good cross-spillover index has increased at a constant pace since 1996, the bad cross-spillover index has remained more stable. Thus, if our goal is to measure capital market integration, we obtain decidedly different results according to which side of the volatility we wish to emphasize. In contrast with findings in the literature, and thanks to our use of quarterly data, we find that international consumption risk-sharing is better described by cycles than it is by trends, and, as such, its dynamics depend on the cycles of global economy activity.

Finally, our results show that the variations in bad and good capital market integration have significant opposite impacts on coupling-decoupling consumption risk-sharing dynamics. While there is a decoupling of individual consumption growth from global risk-sharing after episodes of bad cross-spillovers, we observe a recoupling after good cross-spillovers. This result highlights the key finding to emerge from our paper: namely, the risk-sharing benefits of international financial integration are more apparent in "good times".

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