
“Together forever? Good and bad market volatility shocks and international consumption risk sharing: A tale of a sign”

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Recent literature has shown that international financial integration facilitates cross-country consumption risk sharing. We extend this line of research and demonstrate that the decomposition of financial integration into good and bad plays an important role. We also 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. We document a decoupling of individual consumption growth from global risk sharing after episodes of negative cross-spillovers, and a recoupling after positive spillovers. Our results support current views in the literature that advocate for 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 in the literature that present capital market integration (without differentiating between positive and negative shocks) as a prerequisite for higher international consumption risk sharing. Overall, they cast doubts on the actual scope for consumption risk sharing across global financial markets.

JEL classification: F21; F36; E21; E44

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

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1. Introduction

“I, ___, take, ___, you for my lawful wife/husband, to have and to hold from this day forward, for better, for worse, for richer, for poorer, in sickness and health, until death do us part.”

These are the traditional catholic wedding vows, but the general idea is the same across many religions (and even civil marriage contracts): the two sides of the contract commit to be together in good and bad times. Yet, divorce is a phenomenon as common as marriage¹ and divorce rates are indeed sensitive to economic downturns². We explore whether something similar occurs to countries. Naturally, we need to be more specific than this. The hypothesis we want to test is whether good and bad volatility cross-spillovers do not only lead to *asymmetric capital market integration dynamics*, but also to *asymmetric coupling-decoupling dynamics with respect to the global consumption risk-sharing patterns*. That is, 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’ cross-spillovers in the global financial markets. We show that indeed this is the case. Countries decouple from the general trend of consumption risk sharing after episodes of negative volatility cross-spillovers in the stock market, and they synchronize when cross-spillovers are positive. These results emphasize the convenience of considering differentiated effects of good and bad volatility shocks from the financial markets to the real economy, and cast serious doubts on the ability of international financial markets to smooth consumption across different countries. If consumption risk-sharing increases only when good capital market integration is observed, it means that it does not precisely when it is more important: when bad news hit the market.

Enabling consumption risk sharing among agents is a fundamental function (if not *the* fundamental function) of financial markets. This is true not only within the borders of a given economy, but also across different national markets. For this reason, standard theories in international finance (Obstfeld and Rogoff, 1996) predict perfect international consumption risk sharing under capital markets perfectly integrated (as well as under homogeneous isoelastic utility functions). It does not come as a surprise that the literature has therefore devoted considerable efforts to test for the presence of international consumption risk sharing in the data. Starting with the seminal works by 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, considering fixed effects by country (see for instance, Sorensen and Yosha, 2000; Sorensen et al., 2007; Kose et al., 2009; Islamaj and Kose, 2016; Rangvid et al., 2016) or more sophisticated forms of heterogeneity across countries (Fuleky et al., 2015).

¹ See the American Psychological Association web site: <http://www.apa.org/topics/divorce/>

² Albeit in a seemingly counterintuitive manner, it seems that divorces reduce during recessions and they increase when the transaction costs of falling apart are lower. See Amato and Beattie (2011), Cohen (2014), and references therein.

As a measure of market integration, Rangvid et al. (2016) use the dispersion of equity return across countries as well as two alternative measures: one based on return exposures to common (global) factors, and one based on a world CAPM that we also include in our final regressions. These authors conclude that higher capital market integration forecasts more consumption risk sharing in the future. Islamaj and Kose (2016) use multiple de jure measures of financial integration that are based on the information drawn from the International Monetary Fund's Exchange Restrictions and Exchange Arrangements (AREAER). 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. The results show that a higher degree of financial integration is associated with a lower sensitivity of consumption to income. Kose et al. (2009a) use the same measures for financial integration and find only limited evidence suggesting that financial integration has helped improve risk sharing outcomes in industrial countries, and no evidence that it has done so for emerging markets.

This work's main contribution to the previous literature is to explore the impacts of capital market integration on the cross-sectional and time-series dynamics of international consumption risk sharing, distinguishing between good and bad capital market integration by the first time. Segal et al. (2015) have recently emphasized the fundamental asymmetry in the propagation of good and bad volatility shocks. These authors claim that good and bad macro-volatility shocks have different impacts on financial prices and on the real economy. Their study shows that actual investment, expected consumption, prices and other macro-indicators react asymmetrically to good and bad volatility shocks (with positive and negative responses respectively). They also show that the market prices those asymmetric risks in economical and statistical significant ways. Our work relies on crucial insights from that study, which allow us to enhance our comprehension of international consumption risk sharing, and also gives insights for future work that seek to analyze this kind of asymmetries from new theoretical and empirical perspectives. Our work also provides new measures of capital market integration that consider the evident asymmetries in the propagation of good and bad volatility shocks, and indices of the exposure of each individual country consumption growth to the general pattern of risk sharing.

Our starting point to analyze the relationship between capital market integration and international consumption risk sharing is to show that there are considerable differences in the degree of capital markets integration after good and bad volatility shocks. To properly measure the interaction of one country with the global financial market, we restrict ourselves to stock markets. We construct good and bad volatility indices for 17 mature and relatively open financial markets corresponding to United States, Japan, United Kingdom, Australia, Germany, France, Italy, Sweden, Canada, Singapore, Spain, Switzerland, Denmark, Belgium, The Netherlands, Norway, and Austria. Good and bad volatilities are, in this context, monthly-realized semivariances (RS) estimated with daily data (see Barndorff-Nielsen et al., 2010). Then, we use good and bad volatilities as inputs to build separate dynamic systems of good and bad volatility cross-spillovers. Those systems rely on traditional Vector Autoregressive (VAR) representations and Forecasted Error Variance

Decompositions (FEVD), which allow us to construct total volatility cross-spillovers and directional spillover statistics (Diebold and Yilmaz, 2014), but also 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 variation. 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 volatilities series were used in the estimation. We find that while the good volatility cross-spillover index has increased on a constant pace since 1996, the bad cross-spillover index exhibits clear cycles and has been more stable.

In a second step, we investigate whether there is time variation in international consumption risk-sharing. We construct a global index of consumption risk sharing from 1997 to 2017. We use quarterly data (unlike the extant literature) and a recent sample (also unlike the previous studies), which allows us to challenge current views stating that in the globalization period (1995-onwards) consumption risk sharing presents an unstoppable upwards trend (Lane and Milesi-Ferretti, 2007; Islamaj and Kose, 2016; Rangvid et al., 2016). We find that international consumption risk sharing is better described by cycles than by trends, in which clear patterns of more risk sharing and less risk sharing arise, following upturns and downturns of the global economic activity.

Finally, we analyze explicitly the relation between capital market integration and international consumption risk sharing. Interestingly, the observed cycles in consumption risk-sharing are related, more than with the overall level of capital market integration, with the sign of the cross-spillovers. Our strategy to achieve this conclusion consists of first, measuring the exposure of the country-specific (cross-sectionally demeaned) real consumption growth rate to the general pattern of consumption risk sharing. Second, we include these statistics in a panel regression that controls for other measures of capital market integration, trade integration, and the level of exchange rate flexibility of every country, to calculate their association with our measures of good and bad capital market integration. It turns out that there is a strong economical and statistical significant association between exposure to consumption risk sharing and good and bad integration, prominently featured by an opposite sign. While bad volatility cross-spillovers reduce the synchronization of a country with the global patterns of risk sharing, good cross-spillovers produce the opposite effect.

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 gives 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 realized semivariances (Barndorff-Nielsen et al., 2010), and then we placed these series in different VAR systems, from which we extracted forecast error

variance decomposition (FEVD) series. Then, we constructed total cross-spillovers for the two systems and net spillovers for each country in the spirit of Diebold and Yilmaz (2012, 2014). Finally, we constructed our two measures of capital market integration by summing up the contribution of each market to the FEVD of the volatility of the rest of the system, and the contribution of the rest of the system 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 consumption growth to the general pattern of risk sharing.

Once (i) and (ii) were calculated, we evaluated the impacts of good and bad capital market integration in the cross-sectional and time-series dynamics of international consumption risk sharing. By doing this, we are able to provide evidence on *coupling* or *decoupling* processes faced by each country 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 variation 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 et al. (2010). The RV estimator of log asset prices Y can be expressed as:

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

where $0 = t_0 < t_1 < \dots < t_n = 1$ are the times at which prices are available. This has been proved to be an extremely useful methodology to estimate and forecast conditional variances for risk management and asset pricing³. Nevertheless, Barndorff-Nielsen et al. (2010) stress out that this measure is silent about the asymmetric behavior of jumps, which is important for example to estimate downside or upside risk. Thus, they propose a new RS estimator as follows:

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

where $\mathbf{1}_y$ is an indicator function taking the value of 1 if the argument y is true. The former equation provides a direct estimate of downside risk and the latter of upside risk. Barndorff-Nielsen et al. (2010) also provide the asymptotic properties of this estimator, using the arguments and the central limit theorem for bipower variations of uneven functions, developed by Kinnebrock and Podolskij (2008). In our estimations we used daily stock market data and we aggregated within months in order to compute the two

³ See Liu et al. (2015) and references therein.

semivariances required, which by construction have a monthly frequency. We used the estimators in equation 2 to construct good and bad volatility series for each of the $N=17$ markets in our sample. After this procedure we ended out with $i = 1 \dots N$ series of good volatility $RS_{i,t}^+$ and 17 series of bad volatility $RS_{i,t}^-$, which are the main input of the next step, the VAR representation.

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 forecast error variance decomposition (FEVD) statistics. The errors were estimated from the moving average representation of the VAR as follows:

$$X_t = \Theta(L)\varepsilon_t, \quad (4)$$

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

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, $A_i = \phi A_{i-1} + \phi A_{i-2} + \dots + \phi A_{i-p}$ 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 volatilities system, 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:

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

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 j -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:

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

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:

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

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:

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

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

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

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

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

The net spillover index measures the difference between the shocks transmitted to and those 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:

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

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 volatilities series were used in the estimation.

Naturally, the estimations above allow us to analyze static spillovers across stock markets, but they are silent about the dynamics in the system. Dynamics are introduced by estimating gross and net 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 include this sign from the beginning 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 equation⁴:

$$\Delta c_{i,t} - \overline{\Delta c_t} = \alpha + \beta(\Delta y_{i,t} - \overline{\Delta y_t}) + \varepsilon_{i,t}, \quad (13)$$

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 , $\Delta y_{i,t}$ is the real income growth rate of country i in period t , $\overline{\Delta y_t}$ 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, and as so, the higher the β the lower the consumption risk sharing, and vice versa. It is worth noticing that, as stressed out 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 the 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 pattern of individual countries in our sample. To do so, we estimated the following time varying relationship for each country:

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

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, while if b_i is negative, it means that the more risk is shared in the world, the lower the consumption is in country i . b_i , as such, is a direct measure of the benefits in terms of consumption that risk sharing portrays 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

⁴ See for a recent example Rangvid et al. (2016), but this strategy in the literature dates back to the works by Mace (1991), Cochrane (1991), and Lewis (1996).

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, United Kingdom, and United States. The market indices were retrieved with a daily frequency from February 2 1970 to November 21 2017, for a total of 12,472 observations. The real consumption and real income data to measure degree of consumption risk sharing were also obtained from Datastream with a quarterly frequency from 1996-Q1 to 2017-Q2 for a total of 86 quarters. We used the comparable series across countries and markets that are provided by Datastream in every case.

The sample period was selected mainly based on data availability considerations and feasibility of the VAR estimations (when the number of series is large, VAR models cannot be estimated consistently due to *the curse of dimensionality*). 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 allow 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 not waste of useful information and we can estimate a feasible VAR of 17 series with 300 monthly periods.

In order to carry out our analysis of international consumption risk sharing, it was necessary 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 the 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. By doing so we guaranteed a panel of $N=17 \times T=63$. 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 observations⁵. We will observe that there are both cross-sectional and time-series variation in the data, both in the regressor and the regressand, so as to guarantee the power in our hypothesis testing procedure.

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 exercises⁶, and ii) it also covers precisely the so called globalization period, in which international risk sharing is a consideration of first order importance, and which starts around 1995. Finally, iii) it also includes several financial and economic crises (1997-

⁵ We lost the last observation for Australia and Japan. In these cases data on import and exports were not available for 2017-Q2.

⁶ See Fuleky et al. (2015).

1998, 2001, 2007-2009, 2012-2014), and hence, we guarantee sufficient downturns in the global economic activity and *really* bad volatility shocks. There are of course also important and well-documented upturns of the economic activity and bullish episodes in the financial markets.

4. Results

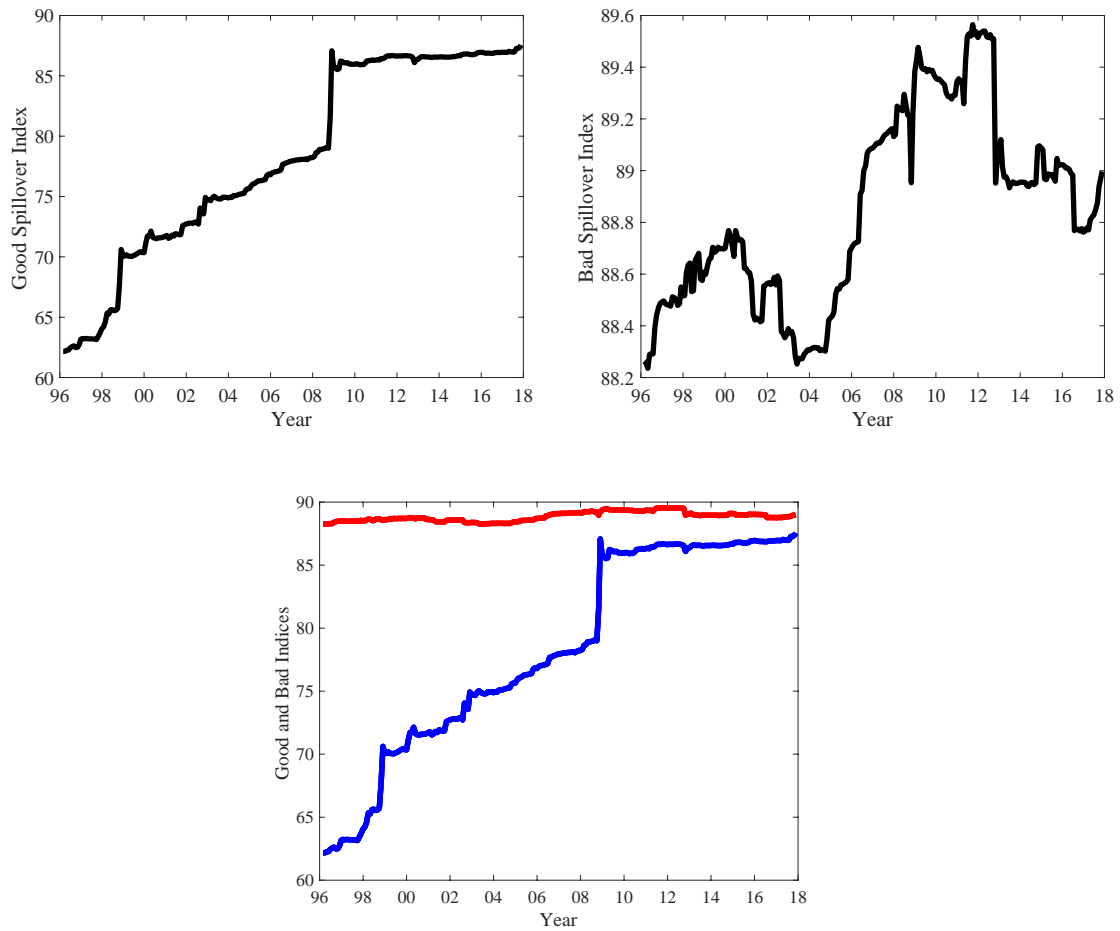
In Section 4.1 we present the dynamic statistics that measure good and bad volatility cross-spillovers in the stock markets. These measures provide evidence in favor of a remarkable asymmetric dynamics in the propagation of volatility, which depends on the underlying sign of the shocks. We also report net-spillover statistics by country, which accordingly, exhibit a differentiated behavior whether the volatility shock is good or bad. In section 4.2 we present our measures of (good and bad) capital market integration, which rely on considering cross-volatility shocks as a common risk factor for the global stock markets. As explained before, the two measures are constructed by summing up the contribution of each market to the FEV of the volatility of the rest of the system, and the contribution of the rest of the system volatility to the FEV of each market's volatility. They are built upon sub-samples with rolling windows of 300 monthly observations, and once again differentiating between good and bad volatility shocks. In section 4.3 we present a quarterly measure of consumption risk sharing in the global economy from 1996-Q1 to 2017-Q2 (the so called globalization period) and we estimate the time-varying exposures to this general trend by individual economies, this time using rolling windows of 20 quarters. Finally, in section 4.4 we provide evidence in favor of our compounded starting hypothesis: good and bad volatility cross-spillovers do 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*. We discuss the main implications of these findings at the end of the section.

4.1. Good and bad international volatility spillovers

Figure 1 contrasts good and bad volatility cross-spillovers in the global stock market, which correspond to the dynamic versions of equation 8. The differences between the two indices are obvious. While the good volatility index (on the left) has increased on a constant pace since 1996 (with a pronounced positive jump in the aftermaths of the global financial crisis, around 2009), the bad volatility index (on the right) exhibits cycles of small magnitude. In the bottom panel of the figure we plotted together the two indices, in order to emphasize the relative stability of the bad volatility propagation compared to the clear 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 with the end of the sample, in terms of good cross-spillovers we observe an increase by more than 24 percentage points (from 62% to 86%), while in the same period the increment in the bad spillovers has been less than one percentage point (from 88.2% to 89.0%). If we aim to

measure capital market integration, during the last two decades, we certainly reach different conclusions depending on which side of the volatility we want to emphasize.

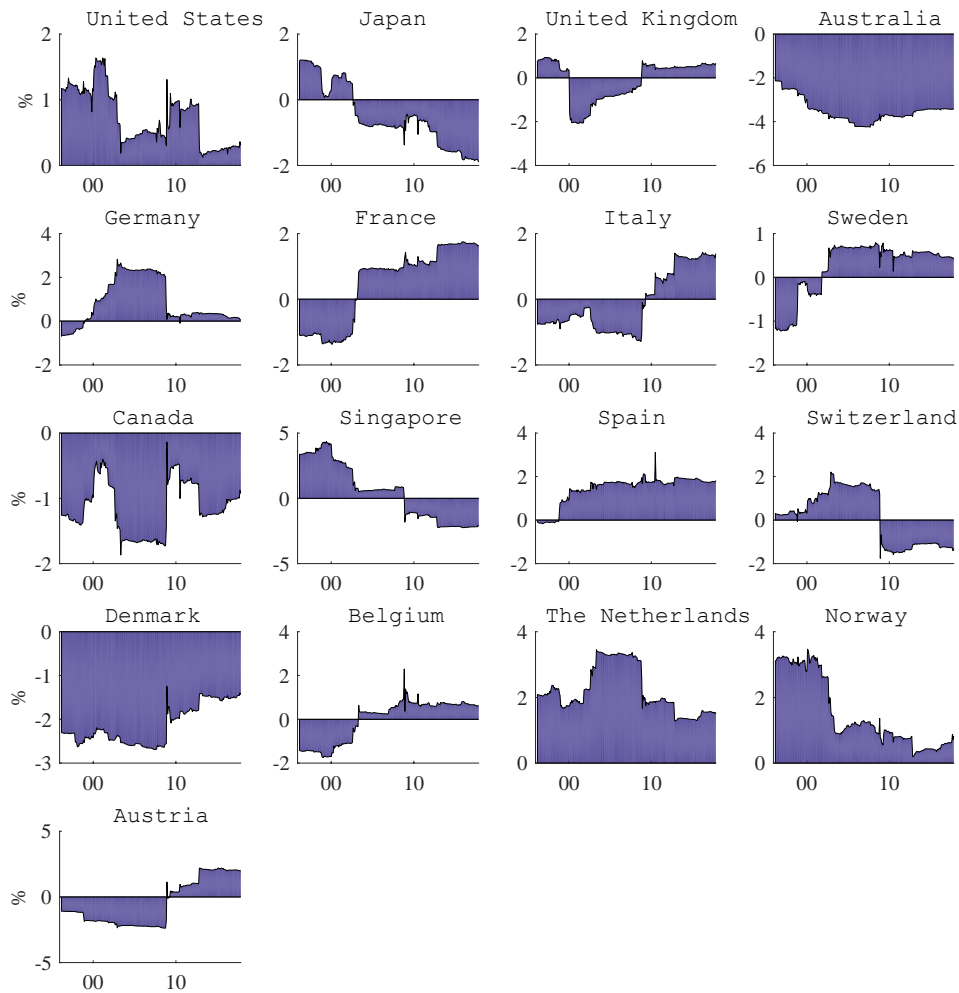
Figure 1. Good and Bad Volatility Cross-Spillovers in the Global Stock Market. The figure shows good and bad volatility cross-spillovers in the global stock market for the full sample, which runs from February 2 1970 to November 21 2017. The estimations were performed using rolling windows of 300 observations,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



Figures 2 and 3 complement the discussion above. They show the net spillovers from each market to the rest of the system, for good and bad volatility shocks, respectively, which correspond to the dynamic versions of equation 11. In figure 2, a positive value of the index indicates that a certain market gives to the system more shocks of what it receives from it, in terms of good volatility. Accordingly, in figure 3 the same information is presented but this time regarding bad volatility. The differences are remarkable once again. For example, let us considering the case of Australia. Australia behaves as a net receiver of good volatility shocks during the whole sample (from 1996 to 2017), that is, it receives more good volatility shocks from the system of what it produces. In marked contrast, it behaves as an exporter of bad volatility shocks for most of the sample period, from 1996

to 2011. The same sort of asymmetries are also found in the cases of United Kingdom, Germany, France, Italy, Sweden, Spain, Switzerland, and The Netherlands. The more symmetric exporters and receivers of good and bad volatility are United States, Canada, Belgium, Singapore, Denmark, Austria and Norway. But even in these latter cases the differences in the propagation of good and bad volatility shocks between stock markets in the global economy are considerable.

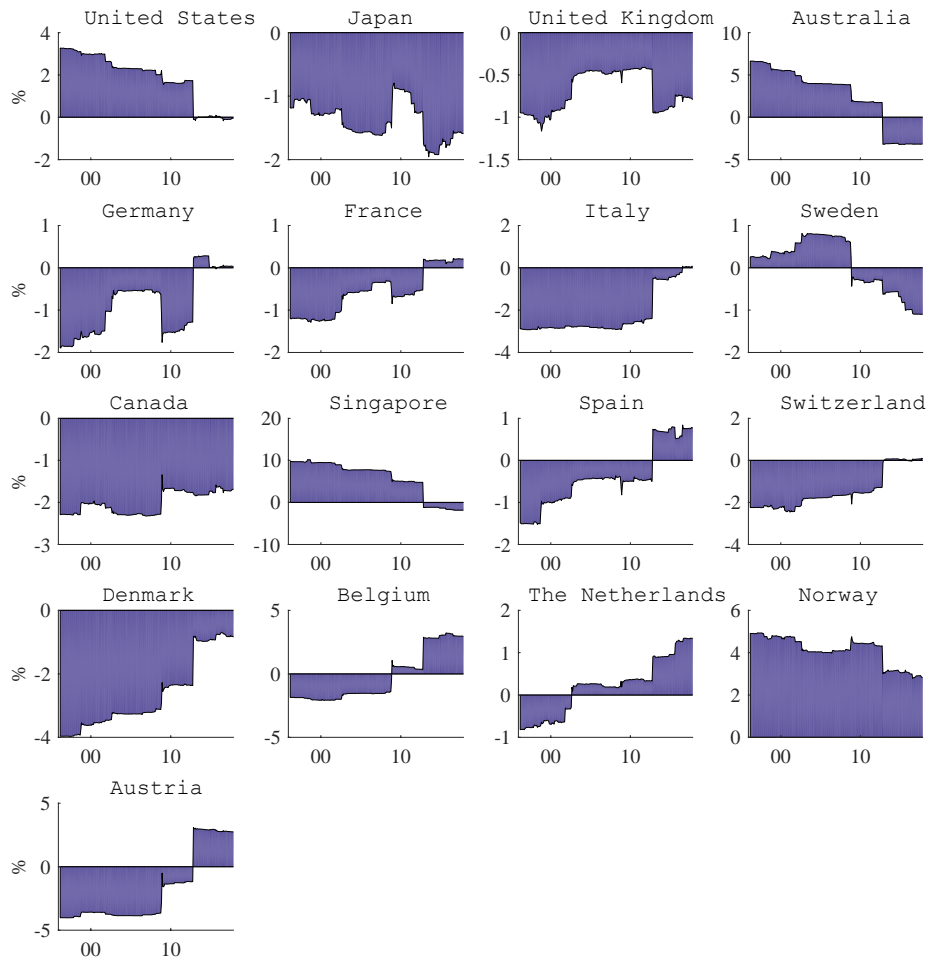
Figure 2. Net good volatility cross-spillovers from each market to the rest of the system. The figure shows net good volatility shocks from each market to the rest of the system for the period January 1996 to November 2017. The estimations were performed using rolling windows of 300 observations, forecasting horizon of 1 day, and 1 lag (based on the Akaike Information Criteria (AIC)).



There is an additional uncovered asymmetry after observing figures 2 and 3. The size of the net volatility cross-spillovers is different whether volatility shocks are good or bad. By general rule, bad volatility shocks propagate more than good volatility shocks. In the case

of the US, for instance, net bad volatility cross-spillovers are twice as large as net good cross-spillovers. But this difference is not restricted to the US market. The differences in this respect are also notorious in the cases of Australia, Denmark, Singapore, Australia, Italy and The Netherlands (but interestingly in this latter case good volatility propagates more than the bad one). There are also considerable differences across countries, which become evident when we compare for example net good volatility cross-spillovers in the US or the UK with those in Singapore, Norway, Belgium or Denmark, twice as large in the latter than in the former markets. The same holds for net bad volatility propagation, if anything, more evidently.

Figure 3. Net bad volatility cross-spillovers from each market to the rest of the system. The figure shows bad volatility shocks from each market to the rest of the system for the period January 1996 to November 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)).

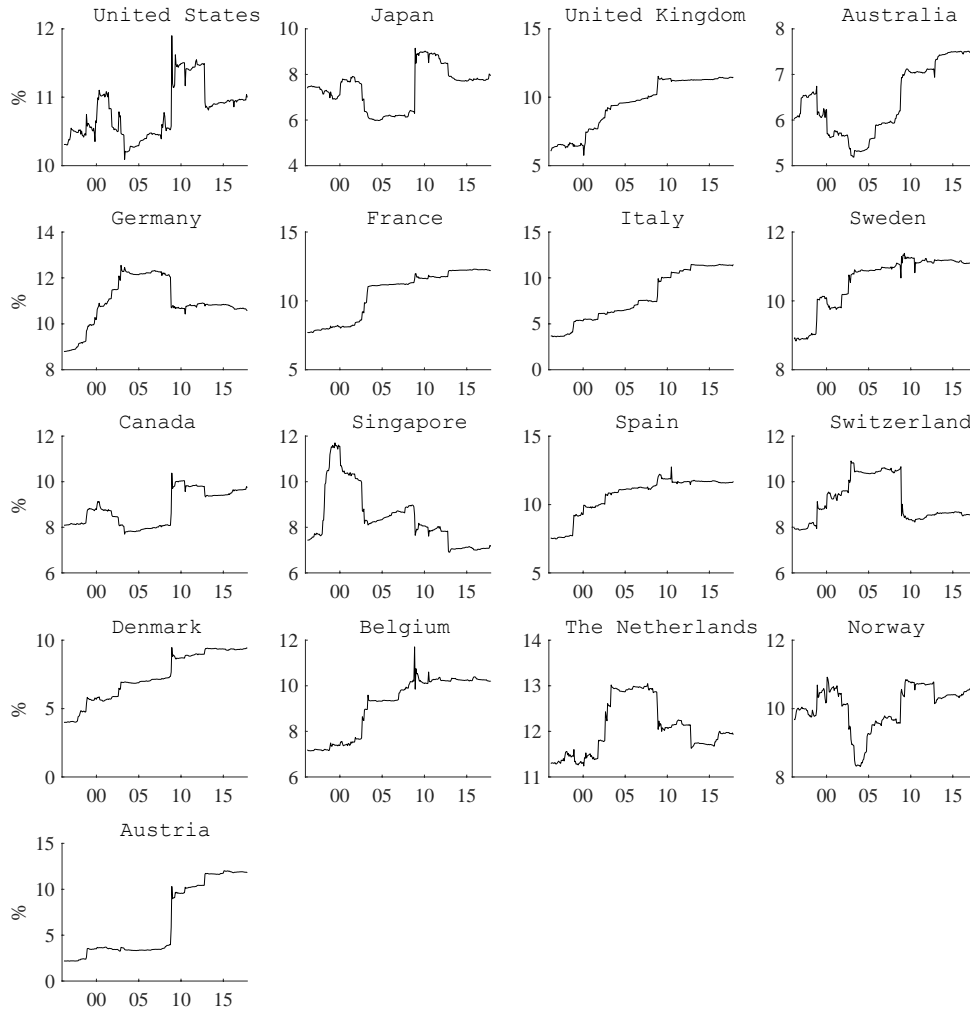


4.2. Good and Bad Capital Market Integration

The previously documented asymmetries in the propagation of good and bad volatility shocks across the global stock markets are worthwhile on their own merits. They provide relevant information for international investors seeking to design optimal hedging mechanisms, facing asymmetric volatility shocks; or willing to construct well-balanced and well-diversified portfolios; and also in terms of asset pricing, as in the case of option pricing, when the relevant moment of the underlying spot price distribution is the volatility itself. Nevertheless, they also serve to motivate our indices of capital market integration. We construct two indices: one of them stands on good volatility shocks, while the other does 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 in every moment the total interaction of each market both, as receiver and exporter of volatility, with the system as a whole. Our indices do not net the total effect, which certainly would lead us to underestimate the integration of a given market with the global market in a certain period of time. Furthermore we are not particularly interested (at least not yet) in exploring the asymmetries between given and receiving shocks, but instead we want to focus in good or bad market integration episodes.

In this way, we aim to point out the differences in terms of consumption risk sharing implied by different levels of capital market integration fostered by good or bad news to the market. In figure 4 we present the indices constructed for each market drawing from the good volatility spillovers. We observe both cross-variation between the markets, and time-variation along the sample period. In general, there is a positive trend in terms of good capital market integration, understood as a larger interaction between each market and the rest of the system with regard to good volatility transmission. This upward trend starts very early in countries such as Italy, Denmark, and the United Kingdom (from the beginning of the sample period) and holds until the end of the sample. For other countries (US, Canada, The Netherlands, Norway), however, the situation is better described by cycles of integration and disintegration, in terms of volatility transmission. Furthermore, for markets such as Singapore, Japan or Switzerland there is not clear upward trend, and in the former case if there is any trend, it is downwards.

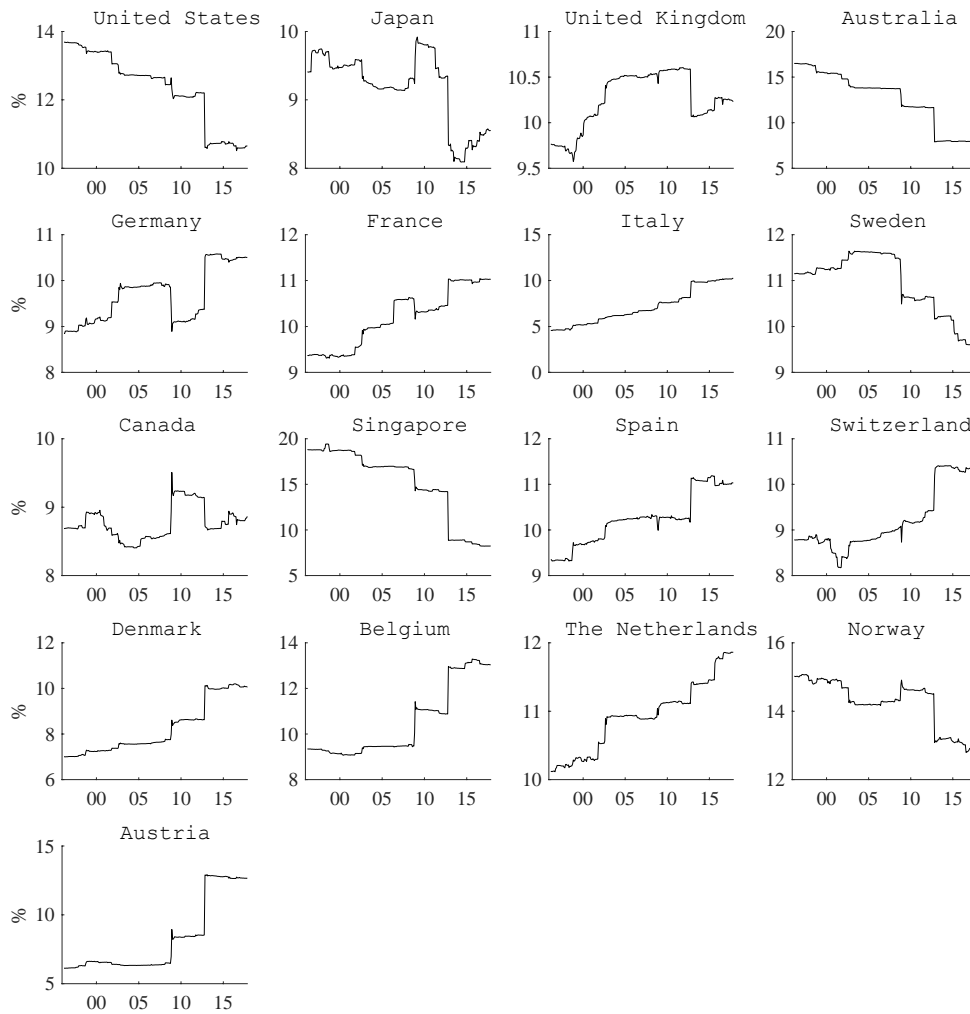
Figure 4. Index of Capital Market Integration Constructed with Good Volatility Shocks. The Figure shows the total interaction of each market both, as receiver and exporter of good volatility, with the system as a whole. The index of good capital market integration has been constructed using Equation (12).



When we turn our attention to figure 5, where a very different (and somehow contrasting) landscape emerges. Consider the case of US. In figure 4, US *good capital market integration* can be said to have increased from 2004 to the end of the sample, with a pronounced jump of particularly positive integration in the aftermaths of the subprime crisis and until the mid of the European debt crisis, around 2012. However, when we focus on figure 5, the US displays a persistent downward trend during the same period. That is, while US positive interactions with the rest of the system have considerably increased from 1996 onwards, its negative interactions have decreased (for 14% to slightly above 10%). The cases of Australia, Sweden, Switzerland, Norway, and The Netherlands are equally contrasting. On their side, the markets of France, Italy, Canada, Spain, and Austria can be said to be more

symmetric in their dynamics regarding good or bad market integration. The other markets are in-between this two extreme scenarios, sometimes the good and bad volatility –based measures evolve in the same direction, other times they wander into divergent paths⁷.

Figure 5. 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, with the system as a whole. The index of bad capital market integration has been constructed using Equation (12).



⁷ Our results contrast with those in 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-up since the beginning of our sample period until 2011, when their sample ends.

4.3. International Consumption Risk Sharing

So far we have shown that capital market integration, when it is measured as the degree of interaction of each market with the rest of the system (as receptor and transmitter of volatility), is not as homogeneous as previously thought, even among highly developed and globalized markets. Thus, we can assert that indeed each country has idiosyncratic trajectories in terms of financial integration that have been mainly overlooked by the previous literature. We have also shown that capital market integration depends on the underlying sign of the shocks (good or bad). Now we 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. Thus, we obtain an estimate of consumption risk sharing for each quarter. Even though 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 starting before our analysis, for example as far as 1875 as in Rangvid et al. (2016), but it allows us to increase the number of observations regarding the so called globalization period, which starts around 1995. This is theoretically feasible, because there is not restriction 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 on the frequency of the growth rates in the analysis.

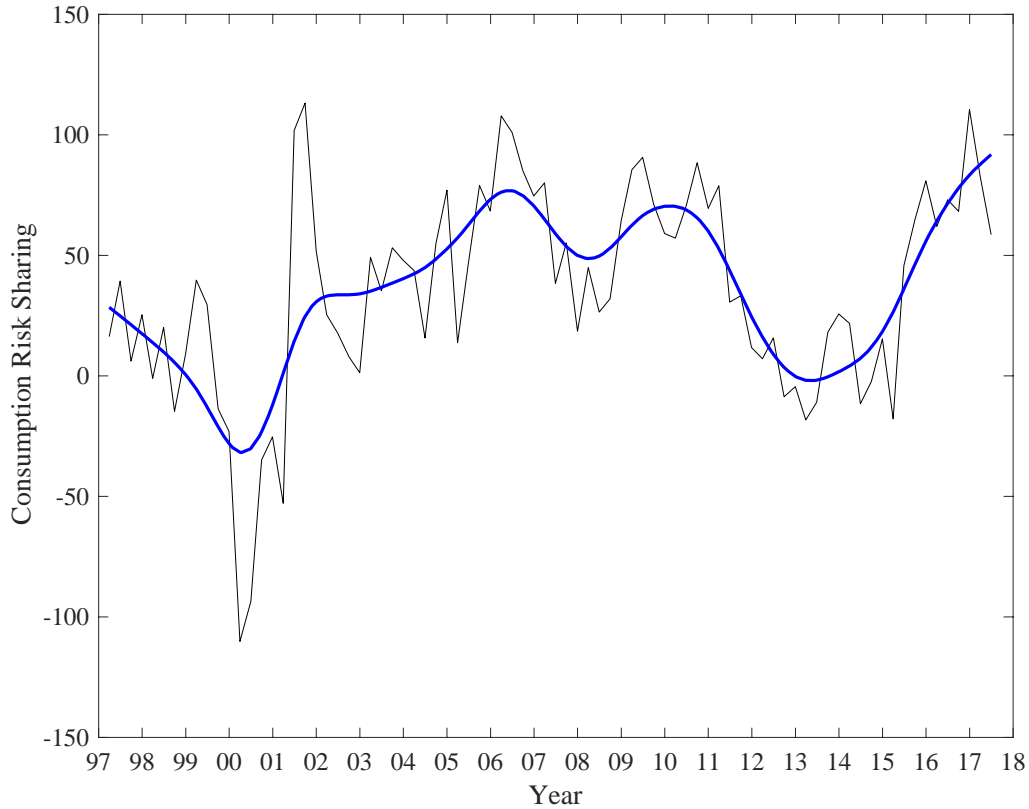
In figure 6 we report our main findings in this respect. There we plot consumption risk sharing, which corresponds to $crs_t = 100 - 100 * \beta_t$. We present both smoothed and unsmoothed versions of our statistic. Interestingly, we do not observe in the last two decades an unstoppable upward trend in consumption risk sharing. In fact, the risk sharing dynamics is better described by cycles than by trends. Actually, it is possible to observe one full cycle of risk sharing in the sample period. The expansive phase of the cycle starts in a trough around 2000-Q1 and reach the peak (when consumption risk sharing is maximum) around 2007-Q3. Then starts the contraction phase that lasts till 2014-Q2, before and after this long cycle of 14 years, the end of a previous cycle and the beginning of a new one are observed in the plot.

It seems that consumption risk sharing is by a matter of fact very volatile. This volatility concentrates in the cyclical component of the series spectrum, rather than in the trend component. It is also evident that the dynamics of consumption risk sharing depends on the cycles of the global economy activity. Noticeable, risk sharing reaches its maximum when the subprime crisis starts, so that it coincides with a peak in the global economic activity (or at least in the economic activity of the US). The down phase lasts until the end of the European debt crisis. 2007-Q2 to 2014-Q4 is a crisis period in the financial and real side of the global economies, and this is especially true for those countries included in our sample. Thus, there is time variation in the level of global consumption risk sharing, when we analyze the last two decades of data and reductions in the level of consumption risk

sharing are associated with downturns of the global economic activity, and with financial crises.

Figure 6. Cycles of Consumption Risk Sharing in the Global Economy (1996-2017).

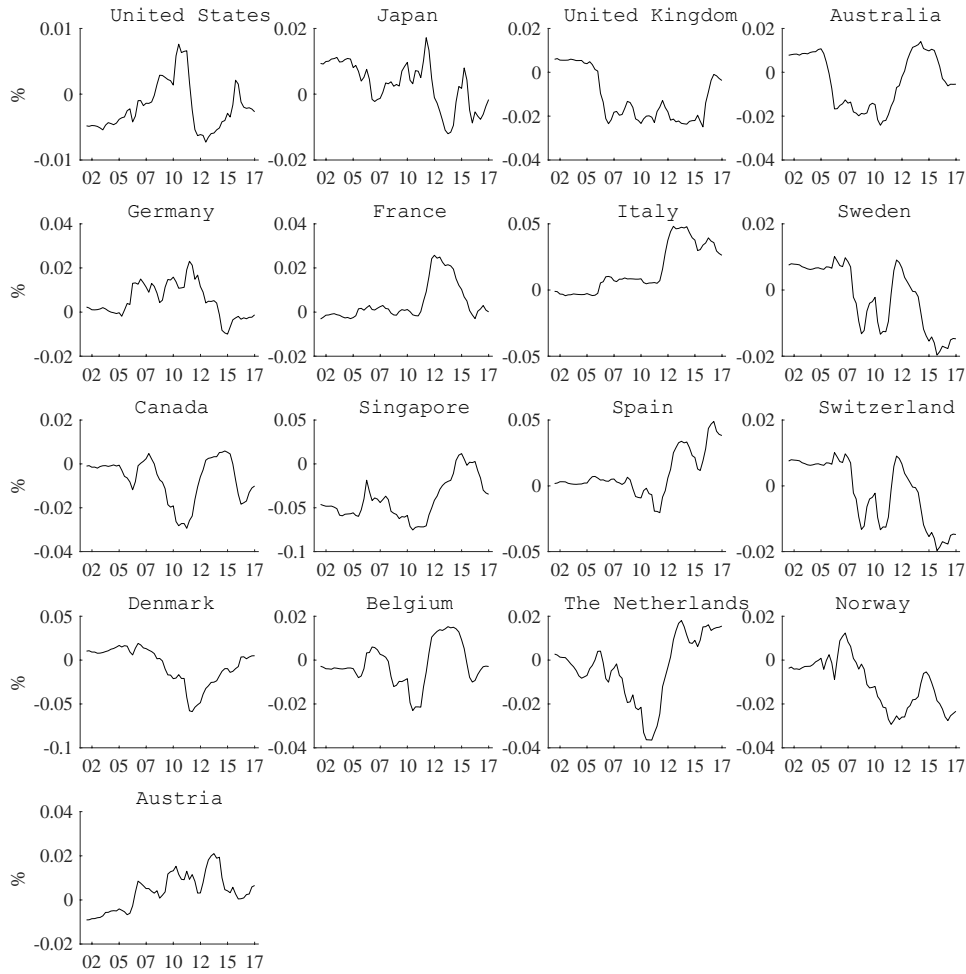
The Figure shows consumption risk sharing over the period 1997 to 2017. The blue (black) line shows the smoothed (unsmoothed) versions of our statistics. The smoothed version is based on a kernel regression.



Next, in figure 7 we present our estimates of the time-varying country-specific exposure to the global factor of consumption risk sharing, following equation 14. As can be noticed, time variation is an important feature of this exposure. Any country displays only positive or only negative exposures to the general trends in consumption risk sharing during the sample period, using rolling windows of five years. We can observe that while countries such as Australia or Canada display a more negative exposure to the global cycle of consumption risk sharing (so that their own consumption growth tend 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 count the US, Norway and Austria are more neutral regarding this exposure. However, in all the cases the exposure evolves going from positive to negative (or from negative to positive) in all the cases along the sample period. The t statistics of these time varying exposures are presented in Figure A1 of the appendix. Noticeably, even using as few as 20 observations for each

regression suffices to reject the null hypothesis of statistical insignificance in most of the periods of the sample, and this holds for all the countries analyzed.

Figure 7. 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.



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. Following the earlier literature, we include an alternative measure of capital market integration, a control for trade integration, and indicators of country exchange rate flexibility.

On the one hand, World CAPM absolute residuals (or intercepts) have been used as a measure of capital market integration for instance in the studies of Rangvi et al. (2016) and Korajczyk (1996). The general idea of 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 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 countries⁸. We then save the residual time-series and took the absolute value to use them as our measure of *disintegration*, on a quarterly basis.

On the other hand, exchange rate flexibility may improve risk sharing via changes in terms of trade as pointed out by Cole and Obstfeld (1991). We capture this relevant insight in our estimates by including in our regressions the recently proposed typology by Ilzetzi et al. (2017)⁹. These authors' algorithm accounts for the possibility of multiple currency poles, and it aims to classify the level of *de facto* exchange rate flexibility according to the most relevant anchor currencies in the global economy. These authors update and refine the classification of Reinhart and Rogoff (2004), and provide data through 2016 (which can be easily extended for the developed countries in our sample up to 2017), whereas the formerly wide used existing series ends in 2001. The broad categories provided by these authors are pegs (category 1), narrow bands (category 2), broad bands/ managed floats (category 3), and freely floating (category 4)¹⁰. In our regressions we include several indicator variables that take the value of one when a country belongs to one of the aforementioned categories in a given period of time, and zero otherwise.

Finally, we also include an indicator of trade openness, following Kose et al. (2009b), who argue that trade openness also matters (joint to capital market integration) for international risk sharing. Following Rangvi et al. (2016), who also consider trade openness in their regressions, we compute trade openness as the sum of exports and imports relative to

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

⁹ The classification provided by Ilzetzi et al. (2017) goes until December 2016. We use the classification of 2016 for the year 2017. Doing so seems consistent because during the sample period the exchange rate classification is very persistent and most of the variability is presented across countries and not in time.

¹⁰ The data can be download from Carmen Reinhart's web page at: <http://www.carmenreinhardt.com/data/browse-by-topic/topics/11/>

GDP for the 17 countries in our sample. Trade openness depicts a unit root. For this reason we included the first differences of the series in our regressions instead of the series in levels as done as well by the previous literature.

We first conducted a Hausman's test to identify 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 A2 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, presented in Table 1. 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 A1 of the Appendix, the estimations using both fixed and random effects, 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 the cases.

We document statistically significant effects in the two cases (good and bad capital market integration), but with opposite signs. While, good cross-spillovers with the rest of the world (i.e. giving or receiving good volatility from all the other markets) increases country exposure to the global risk-sharing factor, bad cross-spillovers leads to a decoupling with the rest of the world pattern in terms of risk sharing. This asymmetric relationship is about twice as large in the latter (-0.28) than in the former case (0.18). Given that the most important benefits of international consumption risk sharing are due precisely 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. A generalized trend of risk sharing across countries is fostered by good interactions with the rest of the world, and it is reduced when bad integration episodes are observed. In other words, risk shares the least when it is more required to do so.

With respect to our control variables, although the CAPM residuals depict the expected sign (i.e. more disintegration leads to less synchronization in terms of risk sharing), they are not statistically significant in our main specification (they are in the alternative estimates in the appendix). On their side, there is not a clear conclusion regarding the role of certain exchange rate arrangements over others, as a factor explaining 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 on a first glance. However, it is worth noticing that most of the countries classified as pegs by Ilzetzi et al. (2017), in our sample belong to the Eurozone, and even when they belong to a currency union, one can naturally expect a greater level of international consumption risk sharing among them, compared to the rest of the world. Finally the trade openness control turned out to be non-significant, despite the theoretical reasons that underlie its inclusion.

Table 1. Consumption Risk Sharing and Good and Bad Capital Markets 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 bands indicator	0.553** (0.252)
Managed-floats indicator	-1.152*** (0.257)
Free-floating 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 the 1% level, 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.

5. Conclusions

How does capital market integration impact on consumption risk sharing? Our results shows that the answer depends on the decomposition of capital market integration into good and bad integration. 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 markets integration after good and bad volatility shocks. While the good cross-spillover index has increased on a constant pace since 1996, the bad cross-spillover index has been more stable. Thus, if we aim to measure capital market integration, we certainly find different results depending on which side of the volatility we want to emphasize. Contrary to the previous literature and thanks to the use of quarterly data, we also find that international consumption risk sharing is better described by cycles than by trends, and that its dynamics depends on the cycles of the global economy activity.

Finally, results show that variations on bad and good capital market integration have significant opposing impacts on consumption risk sharing. 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. As with traditional couples, decoupling is more likely to occur when things are going bad, than when past and present

prospects are good. This result highlights a key finding of our paper, the risk sharing benefits of international financial integration are more apparent in “good times”.

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APPENDIX

**Table A1. Consumption Risk Sharing and Good and Bad Capital Markets
Integration: Alternative Specifications**

	Random Effects	Fixed Effects
Constant	0.576 (0.399)	—
Bad capital market integration	-0.164*** (0.029)	-0.118*** (0.031)
Good capital market integration	0.145*** (0.033)	0.107*** (0.034)
CAPM absolute residuals	-2.141*** (0.704)	-2.085*** (0.711)
Trade openness (in differences)	-0.760 (0.813)	-0.644 (0.821)
Narrow bands indicator	0.998** (0.398)	—
Managed-floats indicator	-0.487* (0.268)	—
Free-floating indicator	-1.313*** (0.333)	—
N=1,069		

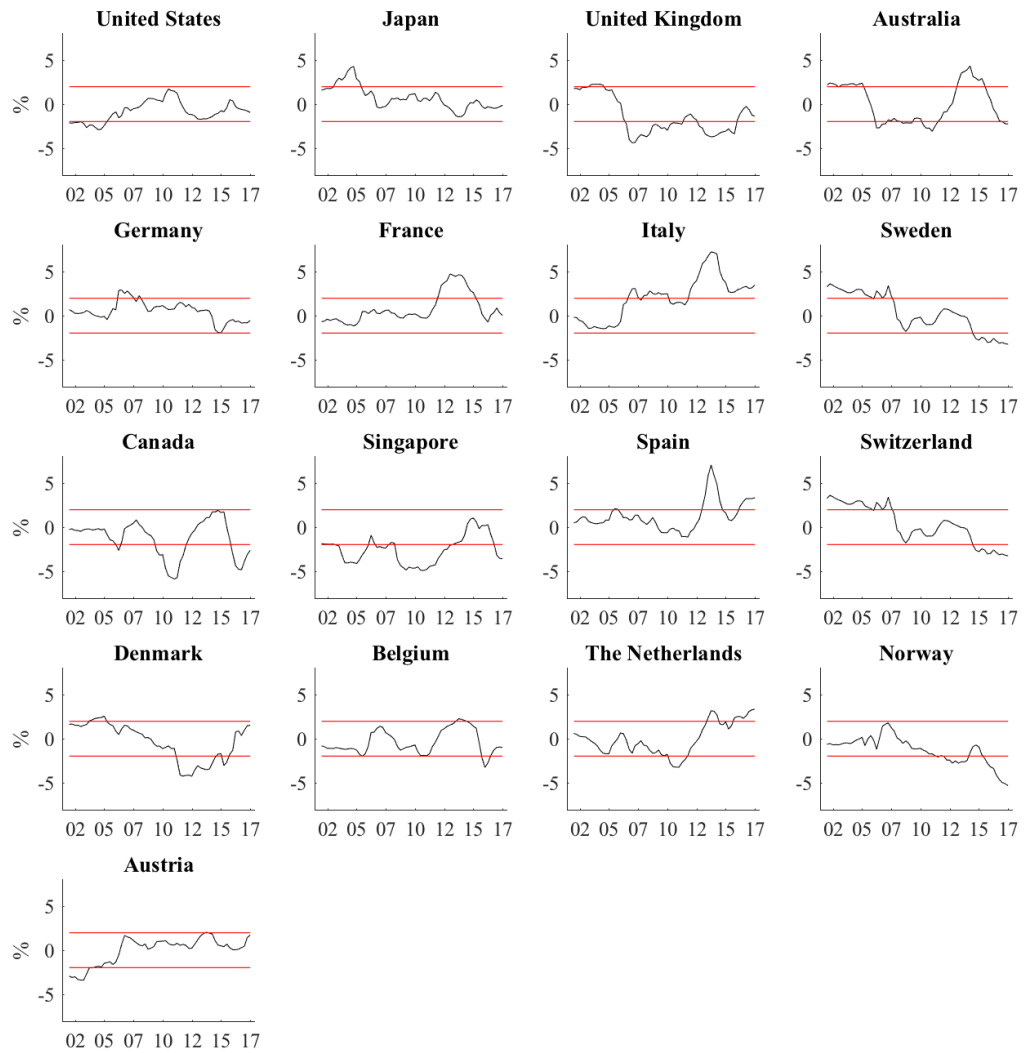
This table shows the results of panel regressions by GLS and fixed effects. *, **, and *** indicate statistical significance at the 10%, 5%, and the 1% level, respectively. The base category measured by the intercept are “pegs” which includes currency unions.

Table A2. Hausman test for a restricted model

	Fixed Effects	Random Effects	Coef. Diff	S.E. Diff
Bad capital market integration	-0.117	-0.136	0.018	0.018
Good capital market integration	0.107	0.120	-0.013	0.008
CAPM absolute residuals	-2.084	-2.044	-0.040	<0.001
Trade openness (in differences)	-0.644	-0.619	-0.024	<0.001
H=7.435 (p-value=0.1146)				

This table shows the results of the Hausman’s test fitted on a restricted version of the model that does not include dummy regressors (which are ruled out by the fixed effects specification). Under both the null and the alternative hypotheses the fixed effects estimator is consistent, while the random effects is consistent only under the null. In this case the H statistic indicates that the null cannot be rejected.

Figure A1. 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 (black line) and the 95% confidence interval (red lines).





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